COMPENDIUM OF TRAINING MATERIALS FOR IMPROVING MANAGEMENT OF THE IMPACT OF OIL AND GAS ON BIODIVERSITY AND ENVIRONMENT

Module 5: Socioeconomic and Health Impacts

Credit: Steve Amooti-Nsita

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Cover Photo Caption: Training local forest owners in Hoima District in inventory of biodiversity in natural forests.

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MODULE 5: SOCIOECONOMIC AND HEALTH IMPACTS

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ACRONYMS AND ABBREVIATIONS

µR/hr	MicroRoentgens Per Hour
ACEMP	Africa Center for Mineral Policy
ACGIH	American Conference of Governmental Industrial Hygienists
ADCRA	Alaska Department of Community and Regional Affairs
ADF&G	Alaska Department of Fish and Game
AML	Acute Myeloid Leukemia
API	American Petroleum Institute
ASM	Artisanal Small-Scale Mining
b/d	Barrels Per Day
BEI	Biological Exposure Indices
BLEVE	Boiling Liquid Expanding Vapor Explosion
BOP	Blow Out Preventer
BP	British Petroleum
Bq/cm2	Becquerels Per Square Centimeter
BSEE	Bureau of Safety and Environmental Enforcement
BS	British Standards
BSI	Behavioral Science Institute
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
CAES	College of Agricultural and Environmental Sciences
CCGT	Combined Cycle Gas Turbine
CCSRP	*Collège de Contrôle et de Surveillance des Resources Pétrolières*
CEPMLP	Center for Energy Petroleum and Mineral Law and Policy
CERD	Committee on the Elimination of Racial Discrimination
CFC	Chlorofluorocarbon
CFR	*Code of Federal Regulations*
CHIP	Chemicals Hazard Information and Packaging for Supply
cm/sec	Centimeters per second
CNOOC	China National Offshore Oil Corporation
CONAS	College of Natural Sciences
COP	Chief of Party
COPD	Chronic Obstructive Pulmonary Disease
COSHH	Control of Substances Hazardous to Health
COVAB	College of Veterinary Medicine, Animal Resources, and Biosecurity
CSCO	Civil Society Coalition on Oil and Gas
CSO	Civil Society Organization
CSR	Corporate Social Responsibility
CVCE	Confined Vapor Cloud Explosion
CWA	Clean Water Act
dBA	Decibel
DNA	Deoxyribonucleic Acid
DROP	Daily Rate of Production
EAP	Employee Support Program
ECOWAS	Economic Community of West African States
ECP	Exposure Control Plan

EHS	Environmental Health and Safety
EIA	Environmental Impact Assessment
EITI	Extractive Industries Transparency Initiative
ELSA	Emergency Life Support Apparatus
ELV	Exposure Limit Value
EMS	Emergency Management System
EMV	Expected Monetary Value
EOC	Emergency Operations Center
EPI	Environmental Pillar Institution
EPRC	European Policies Research Centre
ESA	Environmental Site Assessment
ESIA	Environmental and Social Impact Analysis
FAST	Faculty of Applied Sciences and Technology
FEK	Faculty of Engineering, Kyambogo University
FOEN	Federal Office for the Environment, Switzerland
FPIC	Free, Prior Informed Consent
FSK	Faculty of Science, Kyambogo University
FV	Future Value
GDP	Gross Domestic Product
GGFR	Global Gas Flaring Reduction Partnership
GHG	Greenhouse Gas
GNP	Gross National Product
GTL	Gas-to-Liquids
H&S	Health and Safety
HAB	Harmful Algal Blooms
HAZID	Hazard Identification Study
HAZOP	Hazard and Operability Study
HCL	Havilah Company Limited
HEMP	Hazard and Effect Management
HFO	Heavy Fuel Oil
HOGL	Heritage Oil and Gas Limited
HSE	Health, Safety, and Environment
IAEA	International Atomic Energy Agency
IARC	International Agency for Research on Cancer
ICAO	International Civil Aviation Organization
ICMM	International Council on Mining and Metals
IEA	International Energy Agency
IPIECA	International Petroleum Industry Environmental and Conservation Association
IFC	International Finance Corporation
IFI	International financial institution
IHD	Ischemic Heart Disease
ILO	International Labor Organization
IMF	International Monetary Fund
IOC	International Oil Companies
IR	Infrared
ISO	International Organization for Standards
IUCN	International Union for Conservation Network

JHA	Job Hazard Analysis
JIC	Joint Information Center
km	Kilometer
KYU	Kyambogo University
LAV	Lower Action Value
LEL	Lower Explosive Limit
LG	Local Government
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LSA	Low Specific Activity
MAK	Makerere University
MD	Marginal Damage
MEDIVAC	Emergency Medical Evacuation
mg/L	Milligrams Per Liter
MdP	Market Development Program
MoF	Ministry of Finance
MOSOP	Movement for the Survival of the Ogoni People
MoU	Memorandum of Understanding
mrem	Millirem
MS	Management System
MSDS	Material Safety Data Sheet
MUST	Mbarara University of Science and Technology
MWth	Megawatt hours thermal
NADF	Non-aqueous Drilling Fluids
NCHE	National Council for Higher Education
NEBOSH	National Examination Board in Occupational Safety and Health
NEMA	National Environment Management Authority
NEPA	National Environmental Protection Act
NFA	National Forest Authority
NFC	Nyabyeya Forestry College
NFPA	National Fire Protection Association
NGL	Natural Gas Liquid
NGO	Nongovernmental Organization
NIOSH	National Institute of Occupational Safety and Health
NNPC	Nigerian National Petroleum Corporation
NOC	National Oil Company
NOGP	National Oil and Gas Policy of 2008
NORM	Naturally Occurring Radioactive Material
NPV	Net Present Value
NRC	National Research Council
NRM	National Resistance Movement
O&G	Oil and Gas
OBM	Oil-Based Muds
OECD	Organization for Economic Cooperation and Development
OEL	Occupational Exposure Limit
OGP	International Association of Oil & Gas Producers
OHSAS	Occupational Health and Safety Standard

OML	Oil Mining License
OPEC	Organization of Petroleum Exporting Countries
OSHA	Occupational Safety and Health Administration
pCi/g	Picocuries Per Gram
PEL	Permissible Exposure Limit
PIAC	Public Interest and Accountability Committee
PMB	Private Marginal Benefit
PMC	Private Marginal Cost
ppb	Parts Per Billion
ppm	Parts Per Million
PPP	Polluter Pays Principle
PTW	Permit to Work
PV	Present Value
Q&A	Questions and Answers
QMS	Quality Management System
RF	Radio Frequency
RIIA	Regional Implementation Annex for Africa
ROR	Rate of Return
SBM	Synthetic-Based Muds
SCADA	Supervisory Control and Data Acquisition
SCBA	Self-Contained Breathing Apparatus
CO	Surface Contaminated Object
SEA	Strategic Environmental Assessment
SEC	Security and Exchange Commission
SMB	Social Marginal Benefit
SMC	Social Marginal Cost
SPA	Sale and Purchase Agreement
SPDC	Shell Petroleum Development Company
SRAS	Short-Run Aggregate Supply
SSA	Sub-Saharan Africa
SUV	Sports Utility Vehicles
STOIIP	Stock-Tank Oil Initially in Place
SWP	Safe Work Practice
TAMU	Texas A & M University
TENORM	Technologically Enhanced Naturally Occurring Radioactive Material
TLV	Threshold Limit Value
UAV	Upper Action Value
UDHR	Universal Declaration of Human Rights
UK	United Kingdom
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Program
UNDRIP	United Nations Declaration on the Rights of Indigenous Peoples
UNEP	United Nations Environmental Program
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UPIK	Uganda Petroleum Institute, Kigumba
URA	Uganda Revenue Authority
USAID	United States Agency for International Development

USFWS	U.S. Fish and Wildlife Service
UV	Ultraviolet
UVCE	Unconfined Vapor Cloud Explosion
UWA	Ugandan Wildlife Authority
UWRTI	Uganda Wildlife Research and Training Institute
VOC	Volatile Organic Compound
WBDF	Water-Based Drilling Fluids
WBM	Water-Based Muds
WEL	Workplace Exposure Limits
WHO	World Health Organization
WSIB	Workplace Safety and Insurance Board
WTI	West Texas Intermediate
ZEFS	Zoology, Entomology and Fisheries Sciences

INTRODUCTION AND CONTEXT

1. BACKGROUND

A wide variety of ecosystems are found in Uganda's Albertine Graben, including montane forests, tropical moist forests, savannah woodlands, grasslands, wetlands, and open water (lakes and rivers). The rich and varied flora of the region provides habitat for a wide diversity of species (NEMA, 2012a) and the region is a global biodiversity hotspot, forming part of the Afromontane Archipelago that stretches from the Horn of Africa to the tip of southern Africa.

The Albertine Graben also is the site of oil reserves, and over 3.5 billion barrels of stock-tank oil initially in place (STOIIP) had been established.[1] As a result, the oil and gas sector is expected to grow with considerable economic benefits for Uganda. Nevertheless, development of oil and gas in the Albertine Graben will inevitably come with negative impacts on the environment and society. Accordingly, the Government of Uganda's (GOU) National Oil and Gas Policy (2008) states as a matter of principle, the need to balance human development, the environment, and biodiversity in pursuit of sustainable development.

Various studies (NEMA, 2012b; Ministry of Energy and Mineral Development, 2013; Lahm, 2014) have shown that government agencies and civil society organizations (CSOs) currently have inadequate capacity to monitor and manage the impacts of oil and gas development on the environment and biodiversity. Assessment of the training needs of staff of the local governments (LGs) in the Albertine Rift and Environmental Pillar Institutions[2] (EPIs) by the USAID/Uganda Environmental Management of the Oil Sector Activity (hereinafter referred to as "the Activity") established that the staff were generally well trained in their respective professions, but that they lacked the requisite knowledge and skills to monitor and deal with the impacts of oil and gas activities on the environment and biodiversity. They were not trained for this during formal training at college, since oil and gas is a recent development in Uganda (USAID, 2014). The USAID Capacity Assessment Assistance Report for the Environmental Management of the Oil Sector Activity (2014a) noted that:

> *Staff (both field and HQ) of the EPIs already possess a solid skill and knowledge base on which to build. As such, the Activity can focus its efforts on 'topping up' staff skills with specific knowledge about [oil and gas]. It was also re-confirmed that the largest needs (biggest capacity gaps) are at the field level …*
>
> *While a few field staff reported that they had attended awareness-raising sessions on potential environmental and social impacts of oil and gas, no one reported that they had received any technical training of any kind, to date. There is a strong, pent-up demand for such training, and ample opportunity for the Activity to enhance knowledge and skills at these levels where 'the rubber meets the road' …*
>
> *Much of the required training and capacity building involve the practical training in the collection and testing of physical samples—whether water, soil, air, tissue, or blood—or other field data, such as species counts, transects, tree girth, or other parameters.*

In pursuit of these capacity gaps, Tetra Tech is implementing the USAID/Uganda Environmental Management for the Oil Sector Activity to support Ugandan private, civil society, and public sector institutions at national and sub-national levels to improve their capacity to manage, monitor, and mitigate the impacts of oil and gas development activities on the environment and biodiversity in general, and in the Albertine Graben in particular. As a direct contribution to the knowledge and skills development, the Activity has developed a set of training and resource materials that are

[1] STOIIP is the volume of oil in a reservoir prior to production.

[2] Environmental Pillar Institutions include "*lead agencies*" for various aspects of environmental management within the Ministry of Water and Environment, and Directorate of Petroleum, which is the lead agency for the oil and gas sector.

crafted to meet the different training needs identified by the Activity. All the training and resource materials have been organized into a compendium, which serves as a one-stop resource center for the development of training, outreach and awareness materials related to oil and gas development and its impacts on the environment and biodiversity in Uganda.

2. PROCESS OF DEVELOPING THE COMPENDIUM

As mentioned above, all Activity-sponsored studies on national and local capacity to monitor and manage oil and gas impacts on the environment and biodiversity showed that EPI and LG staff are inadequately equipped with the knowledge, skills, and necessary logistical support to fulfill their mandates (see USAID, 2014a and USAID, 2014b). To this end, the Activity designed short training courses for EPI and LG practitioners who need additional knowledge and technical skills to collect, analyze, and interpret field data for the planning and implementation needed to monitor oil and gas activities effectively, especially in areas where their institutions hold management mandates.

Development of the short courses began with training needs assessment of the EPIs and the LGs. Alongside the training needs studies for EPIs and LGs, the EMOS team undertook similar assessments for the training institutions (universities and technical training institutions in the environment and natural resources sector), in recognition of these institutions' significant contributions to formal capacity building.

The assessments led to identification of 99 "lectures" on specific topics.[3] These lectures were then grouped into nine modules. As the process of identifying the lectures generated more content than had been anticipated for the short courses, it was decided to compile this compendium as a source book for development of targeted curricula.

The Activity then invited a number of experts in a variety of fields to develop outlines for each of the lectures. The experts also prepared detailed teaching notes and put together teaching materials for each lecture.

3. PURPOSE AND SCOPE OF THE COMPENDIUM

This compendium is not designed as a textbook on the impacts of oil and gas on the environment and biodiversity. It is designed along the lines of a curriculum, but not for a specific course. It is designed as a resource document for trainers, instructors, professors, and others who provide knowledge and skills at the interface between oil and gas development activities and the environment and biodiversity. It provides a generic syllabus and detailed notes that will guide those who will be teaching the subject matter, either through formal curricula or informal training programs. It draws from a wide range of resources that are available in online libraries.

[3] In this compendium, the term "lecture" refers to the units within the module. Each topic within a lecture can be taught in a number of one-hour teaching periods employing a variety of teaching methods, including the lecture method.

4. WHO IS THE COMPENDIUM FOR?

a) Target Audiences

This compendium was developed with EPI and LG mid-level managers in mind. The content and design are aimed at this cadre of in-service personnel who will apply what they learn immediately upon returning to their duty stations. But this compendium is also a reference document from which curricula targeting other groups will draw content and obtain guidance about teaching methods and materials. The mid-level managers link senior managers and frontline staff. Therefore, it is easy to customize training curricula and programs from the compendium to suit the needs of either category of target groups. On the other hand, mid-level managers are the primary products of universities and therefore, the compendium will provide useful material for the design of curricula for undergraduate and post-graduate training.

During preparation of materials for this compendium, the target audiences for whom curricula and training programs have been developed are shown below:

TABLE 1: CHARACTERISTICS OF TARGET GROUPS

TARGET GROUP	CHARACTERISTICS
Senior Managers (e.g., directors, national level heads of departments, chief administrative officers, and resident district commissioners)	This group makes policy and strategic management decisions for their organizations. They give directions to staff who implement their decisions, and influence budget allocation and release of actual funds. Many will have progressed along their career paths, and their main motivations will be to make better-informed decisions rather than obtaining additional academic qualifications.
Mid-level Managers (e.g., inventory, land management specialists, project coordinators, National Forestry Authority [NFA] Range Managers, Regional Water Officers, Senior Game Wardens, Heads of LG Departments, NFA Sector Managers; UWA Game Wardens, etc.)	These are normally subject matter specialists, some at the sub-national level. Members of this target group translate policy/strategic decisions into actionable plans and design tools, supervise data collection, interpret data generated from the field, and advise senior management. Most hold university degrees, in many cases at the master's level. Their job descriptions usually require them to train others. Many will be on their way up the career ladder, therefore their motivations will be to enhance their upward mobility in their career or to widen the pool of potential jobs. They will be interested in formal academic qualifications to boost their curricula vitae.
Frontline Staff Operating at Management Unit/Community Level (e.g., NFA Forest Supervisors, UWA Game Rangers, Assistant Fisheries Officers, LG Assistant Forest Officers, Assistant Agriculture Officers, and Sub-County Technical Staff)	This group implements actions at the management unit level, collect data and transmit it to headquarters, are in day-to-day contact with communities, and carry out law enforcement. Some members of this group hold university degrees, diplomas, and/or certificates in the areas of their specialization. Job descriptions

TARGET GROUP	CHARACTERISTICS
	usually require them to sensitize and train local communities. The younger members of this target group will be interested in a formal academic qualifications to boost their curricula vitae. In addition, on-the-job practical training will be very useful to standardize data collection methods and improve data quality.
Staff in Universities and Technical Training Institutions – Relevant Colleges at MAK, MUST, KYU, NFC, UWTI, and UPIK	This group educates people entering service in the oil and gas, environment and natural resources sectors at national and sub-national levels. Most of the trainees will have advanced degrees in their areas of specialization. They will be expected to undergo the same training before they can be called upon to train others.

b) Curriculum Developers

The compendium will be useful to trainers, educators, and other curriculum developers at all levels of learning. The modules, topics, and sub-topics are resource materials that can be of value in the areas of applied biodiversity or the oil and gas value chain. The trainer may adopt and/or adapt the outlines in the syllabus according to the target group and emerging knowledge and technology. However, in the process of adopting and adapting, the teacher should be guided primarily by the learning needs of the target group (translated into learning outcomes) rather than the trainer's convenience in delivering the material.

c) Public Education and Awareness Programs

The compendium will also be useful to those seeking content to develop public information and awareness programming in the relevant field.

d) Researchers, Policy Makers, and Planners

The compendium will be a useful source of technical information to those engaged in research, policy development, and planning about the interface between oil and gas and the environment and biodiversity.

5. ARRANGEMENT OF THE COMPENDIUM

The compendium is structured along a modular approach. There are nine different modules as outlined in Table 2 below. The modules are published as separate standalone documents, but together they make the whole part of the compendium.

TABLE 2: LIST OF MODULES IN THE COMPENDIUM

MODULE	TITLE
Module 1	Phases in the Oil and Gas Value Chain Development
Module 2	Applied Biodiversity
Module 3	Ecotoxicology
Module 4	Impacts of Oil and Gas Operations on the Environment and Biodiversity
Module 5	Socioeconomic and Health Impacts
Module 6	Monitoring Oil and Gas Threats and Impacts
Module 7	Environmental Data Acquisition and Use
Module 8	Policy, Legal, and Institutional Framework for Oil and Gas Development
Module 9	Mitigation of the Impacts of the Oil and Gas Industry

Each module consists of a number of lectures. Where the scope of a lecture is quite broad, it has been broken down into "sub-lectures." Each lecture/sub-lecture made up of two parts:

i) A syllabus that outlines the teaching objectives, learning outcomes, and an outline of lecture content (topic, suggested teaching/learning methods and materials, and estimated time to cover each topic; and
ii) Detailed notes, in most cases arranged following the topics outlined under the relevant syllabus.

Some lectures end with guidance on prolonged field work aimed at building the skills of trainees in accordance with the stated learning outcomes.

6. HOW TO USE THE COMPENDIUM

Each module can be taught as a short course or training program. However, it will often be necessary to bring in topics from other volumes to strengthen the teaching/learning process in a particular volume. For example, a short course based on Module 9 (Mitigation of the Impacts of the Oil and Gas Industry) may need to include some topics from Module 4 (Environmental Impacts Threats and, Risks), or even from all the other volumes.

Because the notes have been compiled by different experts, the style in which they were originally prepared has not altered much during the editing process. Some were prepared as PowerPoint presentations and have been converted into narrative for inclusion in the compendium. Others present high levels of detail, while others are presented in outline format and will require the trainer to do much more reading during lesson preparation.

The lecture syllabus and the detailed notes are interlinked. The user will normally start with the syllabus to determine the outline of a particular course or program. The individual trainer will then proceed to use the detailed teaching notes as a starting point for lesson preparation for a given lecture. References have been given to stimulate further reading.

7. A NOTE ON SOURCES

The Compendium draws on a wide range of sources, most of which are available online for educational use. All efforts have been made to credit the authors of materials that are either directly quoted, or paraphrased as content in the compendium. Quotations are used to identify material within sections that has been directly quoted, and the source is identified parenthetically at the end of the quotation. However, in the case where whole subsections have been drawn wholesale from sources, the source is identified at the top of the subsection and quotations are not used. Finally, where sources have been paraphrased, the source of the idea is acknowledge parenthetically.

A list of references is included at the end of each section within the compendium to enable compendium users to easily access and credit sources in the development and use of their own materials.

8. THE CONTENT OF THIS MODULE

The lectures for Module 5 (Socioeconomic and Health Impacts) are outlined in Table 3 below.

TABLE 3: LIST OF LECTURES UNDER MODULE 5

LECTURE	TITLE
Introduction	Introduction and Context
1	Enhancing the Positive Impacts of Oil and Gas Development
2	Conflicts and Social Impacts Associated with Oil and Gas Developments
3	Cumulative Environmental and Socioeconomic Impacts
4	Multiplier Effects of Oil and Gas Resources
5	Local and National Economics of the Oil and Gas Industry
6	Minimizing the Social Costs of Oil and Gas Development
7	Health Threats of Oil and Gas Activities
8	Specialized Hazards
9	Health, Safety, and Environment Management Systems
10	Enhancing the Positive Impacts of Petroleum Development

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LECTURE 1: ENHANCING THE POSITIVE IMPACTS OF OIL AND GAS DEVELOPMENT

SYLLABUS

Teaching Aims

(i) To build student's appreciation of the positive impacts of oil and gas development.

(ii) To enhance students' ability to provide practical advice to national and sub-national stakeholders regarding potential positive impacts of oil and gas development.

Learning Outcomes

The trainee will be able to:

(i) Articulate positive impacts of oil and gas development.

(ii) Explain positive impacts related to gender.

(iii) Recommend actions to enhance impacts.

Outline of Lecture Content

Topic and Subtopic	Suggested Approach, Methods & Equipment
1. Background to Uganda's Petroleum Industry	Link to Module 2 through Q&A to elicit an overview of the petroleum industry in Uganda and Africa in general
2. Oil Curse and Mismanagement of Resources	Q&A to elicit an overview of the Oil Curse
3. Potential Positive Oil and Gas (O&G) Sector Impacts	Brainstorming exercise to generate positive impacts
4. The Challenges Likely to Hinder Positive Impact	Brainstorming exercise to generate the challenges
5. Current Efforts to Achieve Positive Impact in the Environmental Areas	Class discussions to elicit trainees experiences
6. Recommendations and Conclusions	Recommendations should have come up in earlier discussions. This session should help to bring key recommendations into sharper focus.
7. Case Studies	Done in groups followed by presentations in plenary
8. Practical exercise	During a field trip, discuss experiences with practitioners, local leaders, and communities regarding issues raised during class discussions, and observe what is actually happening on the ground.

DETAILED NOTES

1. BACKGROUND TO UGANDA'S PETROLEUM INDUSTRY

Development of Uganda's Oil and Gas (O&G) Sector

FIGURE 1.1 OIL AND GAS PRODUCTION IN THE ALBERTINE GRABEN

Source: Swiftdale Geological Consultants, n.d.

Uganda's first oil exploration started in the 1930s around the Butiaba escarpment but was interrupted by political instabilities and economic turmoil. However, with the new government under President Museveni in 1986 that brought peace and stability, oil exploration activities found the presence of oil in several locations in the 25,000-square mile stretch of Albertine Graben. This graben is part of the Western Rift Valley shared by countries of Uganda, Congo, and Sudan, and the whole area is suspected to have elements of hydrocarbon deposits.

In 2006, the government announced discovery of oil in commercially viable quantities at a prayer breakfast, when the President of Uganda stated that "We thank God for at last turning successive layers of buried vegetation into crude petroleum of good quality, Secondly, we also thank him that he has given us the wisdom and foresight to develop the capacity to discover this oil while all the previous efforts had failed." These deposits are described by some as the largest on-shore discoveries in Africa within the last 20 years, with confirmed reserves of 6.5 billion barrels in the area of the Albertine Graben that has been explored thus far (about 40%). With production expected to start in 2017 at 125,000 barrels per day and gradually reaching 200,000 barrels per day at peak production, Uganda will be ranked as a mid-sized oil producer among other large players such as Gabon, Chad, Togo, and Trinidad Tobago.

However, experiences from other oil-producing countries have shown that this can be a curse rather than a blessing if challenging issues are not addressed. The government has formulated various policies and laws to ensure efficient management of the resource to enhance benefits from the industry.

As mentioned earlier, petroleum exploration started seriously in 1986 when the National Resistance Movement (NRM) came to power after many decades of insecurity and war. The NRM government brought stability and peace, which laid the foundation for exploration in the Albertine Graben and for establishment of institutions and laws to enable exploration. Subsequently in 1991, the Petroleum Exploration and Production Department was created. Its main functions were to acquire, process, and interpret geophysical, geological, and geochemical data; promote petroleum explorations; and monitor and regulate licensees carrying out petroleum exploration and production.

In 1992, Uganda attracted interest from Petrofina, an international oil company licensed to explore the whole of the Lake Albert Rift Valley. However, Petrofina withdrew in 1993 without any work done. In 1993, the Petroleum Exploration and Production Regulation came into effect, which emphasized exploration and operation and led to the subdivision of the Albertine Graben into 12 exploration areas. In1997, Heritage Oil and Gas Uganda Ltd (HOGL, of the Heritage Group) became the first international oil company to operate in Uganda, with Energy Africa joining the following year. Hardman from Australia came on board in 2001, and more companies joined the competition for the oilfields, including Dominion and Tower Resources (Neptune). In 2001, the Heritage Group provided 50% of the license to Energy Africa, which was subsequently acquired by Tullow Oil PLC, a British exploration company. On December 18, 2009, Heritage announced that it and its wholly owned subsidiary HOGL had entered into a Sale and Purchase Agreement (SPA) with ENI International B.V for sale of its 50% interest (the percent shared with Tullow Oil PLC). Tullow chose to exercise its rights of pre-emption, thus fully acquiring ENI's rights in Uganda on January 17, 2010.

In 2006, Waraga-1 reservoir was discovered, and a year later, Uganda confirmed commercially viable oil in the Albert Graben with Mputa, Waranga, and Kingfisher showing a good flow and huge reservoirs—estimated reserves were more than 2.5 billion barrels of Stock Tank Oil Initially In-Place (STOIIP). One billion barrels is recoverable, and bigger players have been attracted to the sector including Total and China National Offshore Oil Corporation (CNOOC).

Institutional Roles and Responsibilities

Effective petroleum sector management depends on clear definition of institutional roles and responsibilities. Listed below are the key institutions in the oil and gas sector and their responsibilities.

Legislature

- Drafting, debate, and enactment of legislation (petroleum law and model contracts, petroleum tax laws, petroleum revenue management laws, midstream/downstream and natural gas legislation);
- Expert committee oversight (hearings on sector issues); and
- Budget review and enactment (ministries, agencies, and National Oil Company [NOC]).

Ministry of Energy and Mineral Development

- Sector strategies, policy formulation and promulgation;
- Drafting of legislation and contracts;
- Inter-ministerial coordination;
- Major licensing rounds and negotiations;
- High-level review of investment projects;
- External relations and dissemination of information; and
- Linkage of petroleum sector (natural gas and downstream) to power and industrial development.

Directorate of Petroleum

- Repository of technical data on the sector (geological, engineering, production, costs, etc.);
- Active resource mapping and planning (regional location and pace of exploration and development, etc.);
- Technical and economic review of investment proposals;
- Support to Ministry of Planning on technical issues;
- Support to Ministry of Finance (MoF) on cost audits;
- Work program compliance;

- Health, safety, and environment (HSE) oversight and compliance; and
- Permitting and approvals (technical).

Ministry of Finance

- Fiscal policy for the petroleum sector;
- Drafting of legislation (including fiscal provisions in contracts);
- Tax and fiscal administration (collection of bonuses, royalties, taxes, and other oil revenues);
- Fiscal and cost audits (volume audits);
- Monitoring and reporting of financial flows; and
- Macroeconomic planning and forecasts.

Ministry of Planning

- Linkage of sector policies and activities with overall economic objectives and outlook.

Ministry of Water and Environment

- Consistency of petroleum sector activities with national environmental standards and objectives primarily through the National Environment Management Authority (NEMA).

Revenue Collection Body (URA)

- Collection of all taxes and setting an attractive fiscal regime in line with MoF's policies.

Central Bank

- Critical role in foreign exchange and overall debt management and petroleum fund management.

Policy and Laws Governing O&G Operations in Uganda

Uganda had laws that existed specifically to regulate petroleum activities in the country before the country made the huge oil discoveries, but these laws were outdated. The old laws included:

- 5th of December 1957, Petroleum Act Cap 149;
- 1985 Petroleum (Exploration and Production) Act, Cap 150; and
- Petroleum Supply Act of 2003.

These old laws that have been replaced recently by newly enacted legislations. The government, through the Ministry of Energy and Mineral Development, established the National Oil and Gas Policy of 2008 (NOGP) after recognizing the various challenges in the petroleum industry. Its goal was to "use the country's oil and gas resources to contribute to early achievement of poverty eradication and create lasting value to society." Thus, it was necessary to create certain laws to effect the policy by proposing various bills to be enacted into law. Three laws have been passed and accepted by the president:

Petroleum Exploration, Development and Production Act, 2012. The objectives and principles of this act are to give effect to Article 244 of the Constitution; regulate petroleum exploration, development, and production; and establish the Petroleum Authority of Uganda. The Act provides for the NOC; regulates licensing and participation of commercial entities in petroleum activities; provides for an open, transparent, and competitive process of licensing; creates an appropriate environment for promotion and exploration of Uganda's petroleum potential; provides for efficient and safe petroleum activities; and provides for cessation of petroleum activities and decommissioning of infrastructure. This bill was discussed and signed by the president into law.

The Petroleum Refining, Gas Processing, Conversion, Transportation and Storage Act, 2012. Objectives were to give effect to Article 244 of the Constitution; regulate petroleum refining, gas processing and conversion, transportation, and storage of petroleum; and promote policy formulation, coordination, and management of petroleum refining. The Act ensures third-party access to infrastructure; provides for an open, transparent, and competitive process of licensing by the Minister responsible for petroleum; ensures a healthy and safe environment; provides for cessation of petroleum activities and decommissioning of petroleum facilities and infrastructure; and provides for related matters.

Public Finance Act, 2012. This bill seeks to regulate revenue management in the oil sector. The MoF intends to outlaw the Budget Act of 2001 and the Public Finance and Accountability Act of 2003, and replace the two with the Public Finance Management Act of 2015, thereby enabling control of management of revenue from petroleum.

2. OIL CURSE AND MISMANAGEMENT OF RESOURCES

Source: Karl, 2006.

Mineral, especially oil-led development, is often promoted as a key path for countries seeking sustained economic growth. But the oil-led development model of today is significantly different from the role that energy played in the late 19th and early 20th centuries in the United States, Canada, and Australia. In those earlier and more successful experiences, mining and oil exploitation contributed a very small percentage of total economic output, never dominated exports, and did not approach the magnitude of dependence that characterizes contemporary oil-led development. While exerting a considerable regional impact, oil and minerals were never the motor of development.

Today, to the contrary, oil-led development means that countries are overwhelmingly dependent on revenues gleaned from export of petroleum. This dependence generally is measured by the ratio of petroleum exports to gross domestic product (GDP); in countries that live off petroleum rents, this figure ranges from a low of 4.9% (in Cameroon, a dependent country running out of oil) to a high of 86% (in Equatorial Guinea, one of the newest oil producers). Dependence is also reflected in export profiles, with oil in dependent countries generally making up from 60 to 95% of a country's total exports. Oil-dependent countries can be found in all geographic regions of the world, although they are most commonly associated with the Middle East, and more recently, Africa.

Oil-dependent countries suffer from what economists call the "resource curse." In its simplest form, this refers to the inverse relationship of growth and dependence on natural resource revenues, especially from minerals and oil. This association repeatedly has been observed across time and in countries that vary by population, size, and composition; income level; and type of government. It is so persistent that has been called a "constant motif" of economic history. Specifically, countries that are resource poor (without petroleum) grew four times more rapidly than resource rich (with petroleum) countries between 1970 and 1993—despite the fact that they had half the savings. Similar findings have been replicated through a study of the members of the Organization of Petroleum Exporting Countries (OPEC), using a different and longer time period from 1965 to 1998. OPEC members experienced an average decrease in their per capita gross national products (GNP) of 1.3% per year during this period, while lower and middle-income developing countries as a whole grew by an average rate of 2.2% per year over the same time. Moreover, studies show that the greater the dependence on oil and mineral resources, the worse the growth performance. Finally, countries dependent on the export of oil have not only performed worse than their resource-poor counterparts; they have also performed far worse than they should have given their revenue streams.

Causes of this resource curse are a matter of debate, but the negative association between growth and oil and mineral wealth is not attributed to mere existence of the natural resource itself. Oil in itself cannot encourage or hinder growth. Instead, this association is less direct and, while the weight of various specific causal mechanisms is still under debate, it is generally attributed to some combination of the following factors:

First, oil windfalls can hurt other sectors of the economy by pushing up the real exchange rate of a country's currency and thus rendering most other exports non-competitive—a phenomenon called the "Dutch Disease." The reduced competitiveness in agricultural and manufacturing exports "crowds out" other productive sectors and renders diversification of the economy particularly difficult. This in turn reinforces dependence on oil, and over time can result in permanent loss of competitiveness.

Second, the long-term price deflation and price volatility of the international primary commodities market hinders economic development. Since 1970, this volatility has grown worse, and oil prices are twice as variable as those of other commodities. This means that oil economies are more likely to face more economic shocks, with their attendant problems, and they are especially susceptible to acute boom-bust cycles. This oil price volatility exerts a strong negative influence on budgetary discipline and control of public finances, as well as state planning, which subsequently means that economic performance deviates from planned targets by as much as 30%. Volatility also exerts a negative influence on investment, income distribution, and poverty alleviation.

Third, the enclave character of the industry, combined with its capital intensity, fosters especially weak linkages to the broader economy and does little to create employment. Because oil is the world's most capital-intensive industry, the sector creates few jobs per unit of capital invested, and the skills required by these jobs usually do not fit the profile of the unemployed. If growth in the oil sector had a significant multiplier effect, this would not be such a great problem, but productive linkages between this sector and the rest of the economy tend to be weak. Furthermore, opportunities for technology diffusion are limited, and so is infrastructure development. Downstream processing industries have typically not emerged, and when they do, they are often at a competitive disadvantage.

Perhaps most important, petroleum may be one of the hardest resources to utilize well; countries dependent on oil exports seem particularly susceptible to policy failure. The reason lies in the weakness of preexisting institutions in places where oil for export is found, their frequently authoritarian character, and the ease with which they can be transformed by an overwhelmingly powerful export sector. Generally, oil rents produce a rentier state—one that lives off profits of oil rather than extraction of a surplus from its own population. In rentier states, economic and political power is especially concentrated, lines between public and private are blurred, and rent-seeking as a wealth creation strategy is rampant. Rentier states are notoriously inefficient because productive activity suffers and self-reinforcing "vicious" development cycles can set in. Together, all of these factors slow growth, raise powerful barriers to diversification away from petroleum dependence, and produce skewed development patterns described by the resource curse.

3. POTENTIAL POSITIVE O&G SECTOR IMPACTS

Infrastructure Development

Corporate social responsibility of the petroleum exploration companies (the developer) to communities will be to support/provide education and health facilities.

Economic Development – a mixed review

It is hoped that oil drilling and exploration activities will result in more money spent within the area, which will increase the general income levels of the population and create business opportunities for local traders to provide goods and services. However, this has not always been the case. In Nigeria, "[d]espite their oil wealth, poverty remains widespread in oil-producing countries. Even at peak production, Nigeria—with its large population of which 92% survive on less than $2 a day (UNESCO, 2010)—produces only around 6–7 barrels of petroleum equivalent per person per year, worth no more than a few hundred dollars for every Nigerian. Without a massive multiplier effect, this will not sustainably develop Nigeria on its own (Myers, 2005). Implementation of federal and state government plans for development of the Niger Delta region has fallen far short of expectations" (*Baumuller et al., 2011).*

"In Angola, the government estimates that as much as 68% of the population live on less than $1.70 a day, according to a household survey carried out in 2000/01 (Market Development Program, 2004). Hodges (2004) claims that Angola features all three characteristics of the Resource Curse: Dutch Disease, exposure to price fluctuations, and lack of a long-term economic and social development strategy owing to its long civil war. The unsustainable use of oil revenues (such as high spending on internal security and defense, high dependence on imports, and subsidies on fuel, water, and electricity), enrichment of regime families in Luanda, and the effects of Dutch Disease lead to negative effects on the national economy. In 2007, the agriculture sector accounted for just 8% of gross domestic product (GDP) (although this excludes subsistence agriculture) (OECD/AfDB, 2009)." (*Baumuller et al., 2011).*

Employment Opportunities

Oil drilling and exploration activities will require both skilled and non-skilled labor for local personnel. The number of local jobs is likely to increase during the course of the activities. The global employment gap has renewed discussions on how jobs are defined and created. Of note in these discussions is evidence of predominance of the informal sector as a main arena for employment at present. Artisanal small scale mining has grown from 10 million in 1999 (ILO, 1999) to potentially upward of 20-30 million (Buxton, 2013). This increase, largely still informal, provides a rich policy ground for promoting a good job agenda. This agenda would focus on making available the necessary knowledge and technological resources to increase productivity, coupled with provision of social protection and fair labor standards at the workplace.

"Employment potential in the oil sector has generally not lived up to communities' expectations. While jobs in oil companies tend to be among the highest paid in oil-producing countries, they often may remain out of reach of the country's nationals, particularly members of local communities, owing to shortages in technical skills. Even where companies provide technical training, the capital-intensive nature of the industry means that overall employment opportunities remain small. Moreover, the oil sector is an enclave economy with limited forward and backward linkages, thus limiting multiplier effects on the broader economy. This can be corrected through legislation; for example, Nigeria in April 2010 signed into law the Nigerian Oil and Gas Industry Local Content Bill, which obligates international and local oil companies to capacity building and use of Nigerian services and personnel." (Baumuller et al., 2011).

"Lack of employment opportunities has been one of the factors stimulating the emergence of an illegal and highly risky local refining 'industry' in the Niger Delta. Oil from the swamps of the Niger Delta is boiled in barrels to evaporate the diesel, which then flows through a water-cooled pipe and drips into a container at the other end. In the absence of alternatives and because of high fuel costs, local refining can generate a steady income despite the risks of injury from explosions and fires, and of disease from contact with the oil and breathing in the fumes. Local refining, which is spread over a wide area, can also cause significant environmental damage.

Expectations of employment generation have also been disappointed in Angola, although they have so far not been as conflictual as in Nigeria. 'Angolanization' of the workforce in the oil sector has seen limited progress because of a lack of high-quality graduates. For instance, Angolan faculties of engineering only produce between 12 and 20 high-calibre Angolan graduates, while BP alone around 100. Another example is Soyo where the 30-year presences of the 'Base do Kwanda', run by a joint venture between Sonangol and Delong Hersent Lda, has brought little real advances in terms of general education or professionalization of the workforce. There are only around a dozen local staff in higher management, and no faculties for higher education exist in Soyo. For the last three decades training was confined to (primary education) teacher training. Expectations amongst the town's 200,000 inhabitants for employment in the Angola LNG Plant are again high. These hopes are bound to be dashed as there is a very limited need for unskilled labor. Around 50 youngsters from Soyo have been hired by Angola LNG and are currently being trained as operators in Canada and Indonesia." (Government of Nigeria, 2010)

Revenue Sharing Among Provinces

Source: Baumuller et al., 2011.

"Oil revenues are shared among the provinces that produce oil and local governments, thus stimulating development in these areas. However, this has brought issues and points of contention in most oil-producing areas like Nigeria and Angola. In Nigeria, long-standing disagreements regarding distribution of oil revenues were partly blamed for the Biafra War in 1966-1970, when oil-producing provinces tried to secede from the rest of the country (Ahmad and Singh, 2003). After decades of divisions, the 1999 Constitution stipulated that 13% of revenues must be transferred to the oil-producing states, while the remaining 87% is to be split among the federal government (52.7%), the states (26.7%), and local governments (20.6%). Since 2003, the federal government has been publishing the monthly revenue allocations that are transferred from the federal to state and local governments to avoid under-reporting by provincial authorities."

Rural Development

The petroleum industry assists rural households in building more dynamic and resilient livelihood strategies portfolios by, for instance, "dovetailing" farming economies. It is a stimulus for trade and subsidiary business development around oil field sites. The question of linkages—how petroleum development interplays with other aspects of local economies—and how to promote better integrated rural development strategies to capture mineral benefit remains significant.

Market Linkages

Though globalization of mining processes is not new, it has led to new sourcing of raw materials in resource-rich but also more isolated areas of sub-Saharan Africa (SSA), Latin and South America, and Southeast Asia. This more pronounced penetration of minerals and petroleum buyers and small investors into isolated regions of the world raises further concerns about how countries are impacted by these markets demands, and accordingly respond.

4. THE CHALLENGES LIKELY TO HINDER POSITIVE IMPACT

Questions to be answered include:

- How can the social, cultural, and economic impacts of major developments on communities be managed to counteract the vulnerability of communities to unwanted change in their economic base, and to counteract destabilization of their family and social life?
- What approaches to resource management will minimize fluctuations in the prospective non-renewable resource development activity?
- How can governments meet the costs of development—both overall cost to the territorial government of development, and increased cost of infrastructure and municipal services that fall on municipalities?
- How does Uganda promote sustainable development? How can the government ensure that value-added opportunities are exploited, and that gains from non-renewable resource development are converted into infrastructure and economic activities to support the population when resources run out?

Many observers have noted the irony that, all too frequently, development outcomes in the extractive industries are different and less beneficial than had been expected. Resource-rich developing countries typically underperform economically relative to non-resource-rich peers: they score badly against critical human development indicators; they experience environmental degradation; and they undergo more than their fair share of social and political instability and violent conflict. Taken together, factors such as these have led some to describe the outcomes as the resource curse or the "Paradox of Plenty." These negative results have been attributed to a wide range of both technical and political factors characteristic of, and in some cases unique to, the extractive industries.

Technical Factors

The three technical factors most commonly identified as contributing to the resource curse are: (1) the Dutch Disease, (2) revenue volatility, and (3) resource exhaustion.

Dutch Disease

Dutch Disease involves a significant appreciation of the resource-rich country's real exchange rate and upward pressure on domestic prices attributable to a sudden and major inflow of foreign exchange associated with resource exports. As a result, non-resource exports lose their competitiveness, and domestic labor and capital shift to the resource and non-tradable sectors. This diminishes the host country's economic diversity, often with adverse consequences on employment since the shrinking sectors (i.e., agriculture) are typically labor-intensive, while the expanding sectors are not. It also increases a country's vulnerability to shocks stemming from the resource sector. In addition to its unwelcome economic impact, Dutch Disease frequently precipitates social and political unrest. Exchange rate appreciation can also be a factor in this, underscoring the point that policy responses really matter.

Revenue Volatility

Volatility of petroleum and mineral prices and revenues is well documented. Over the past 10 years alone, for example, the price of oil has increased fivefold, fallen 50%, and then doubled again. Over a longer period, the average annual change in oil prices has been close to 30%. Mineral prices have shown similar volatility. Volatility on this scale renders macroeconomic management difficult under the best of circumstances. Disruptive boom-bust expenditure cycles have been the standard response. The challenge of volatility is compounded by the fact that the scale and direction of price changes are unknown, or at least uncertain. Price forecasts in the resource sectors have been notoriously inaccurate. While price volatility is the most common source of resource revenue volatility, volatility may also result from discovery and exploitation of major new and unexpected resources.

Exhaustibility

Oil, gas, and mineral resources are by their nature exhaustible. This puts an onus on policymakers to plan for a situation of resource decline and eventual cessation of commercial operations, even if exact timing of this cannot be predicted. However, planning for the decline and eventual end to resource exploitation and associated revenues is a demanding exercise, rarely observed in developing countries but equally not commonly found in developed countries either. A failure to plan, however, is very likely to result in a need for wrenching and destabilizing economic adjustments. The appropriate remedies that policy makers must implement to address these challenges are as follows: (1) policies to smooth expenditure of volatile revenues, (2) introduction of resource funds for saving and stabilization, (3) improvements in macroeconomic planning, and (4) forecasting and expenditure policies directed at improving the framework for investment and promotion of economic diversification.

Political Factors

In addition to the technical factors that contribute to the Resource Curse are a number of political factors that also play a role; and it is these factors that have proven even more difficult for policy makers to address.

Due to the capital-intensive nature of the petroleum industry, and the fact that in most cases, the industry is foreign-dominated, there are few linkages with the rest of the producing country's economy. When a state depends on the sector for revenue, the country's taxation system may also be distorted, which in turn may undermine accountability of rulers. Parallels with this are evident in the mining industries. Independence of resource revenues from the general population has made it easier for elites in some countries to manipulate those revenues for personal or political gain at the expense of the public good. Complexity and opacity characteristic of many resource-sector operations have tended to obscure waste and abuse. The sheer scale of resource revenues, whether measured in absolute terms or in terms of the margins they generate, has also encouraged graft and corruption.

These considerations have eroded accountability not only in the resource sectors, but in society and the economy as a whole. When scored against almost any indicator of good governance, those developing countries with a high dependence upon resources for their development find themselves, more often than not, in the bottom one-third of the league tables. However, it is sometimes argued that failures to properly manage resource wealth are the consequence of preexisting governance problems. There appears to be ample evidence to support the claim that causality runs from resource wealth to weakened governance. At the same time, evidence suggests that the impact of this effect is strongly influenced by a country's political and institutional governance systems, and whether they are accountable and transparent to their constituents.

Appropriation of Public Wealth

How is a government to ensure that the economic rent goes to the "owner" (i.e., the public rather than the private investor whose primary objective is to maximize private gain) without undermining the investor's confidence in undertaking the risk. In practice, many factors come into play regarding a decision on how economic benefits are split, including considerations such as maturity of the sector in a country, element of political risk, and types of commodity involved.

Designing a Competitive Legal Framework

In view of the global competition for capital among host governments, how is a government to design the kind of legal regime that is relatively competitive vis-à-vis those found in other similarly situated resource-producing countries? This challenge must be met in a manner that fosters gradual and sustainable growth and a diversification of the non-extractive industry (EI) sector economy.

Guarantees of Long-Term Stability

What guarantees should a government provide to foreign investors that limit its freedom to make changes later? Such guarantees will usually be sought at the initial stage prior to investment commitment, and are often under strain when that bargaining power of the parties changes at a later stage in the event of geological and commercial success, and more in-depth consideration of these issues could occur.

Energy Conservation, Environmental and Wildlife Protection

FIGURE 1.2 WILDLIFE IN THE ALBERTINE RIFT

Source: Joel Sartore for National Geographic

How is a government to "improve the efficiency of operations and reduce emissions and other impacts on the environment through well-defined policies and appropriate guidelines?" Even in cases where mineral resource development has made a positive economic contribution (i.e., Guyana and the Philippines), environmental costs have been high, and have not been well managed and mitigated. Nowadays, good practice in petroleum and mineral development strongly argues in favor of mechanisms that minimize the environmental footprint and provide beneficial social impacts.

5. CURRENT EFFORTS TO ACHIEVE POSITIVE IMPACT IN THE ENVIROMENTAL AREAS

The Ugandan government has recognized that its environmental management system is not at capacity and lacks the legal force to address the complexities of environmental impacts arising in the petroleum sector. The 1995 Constitution provides every Ugandan "the right to a clean, safe and productive environment." This right was emphasized in the 2008 NOGP, which established principles for future legislation to follow, and emphasized high standards for environmental protection. The NOGP states that the government will create regulations that will ensure best practices in clean technology such as "use of green dragon burners for flaring during flow testing of petroleum wells instead of other types of burners which produce more smoke and harmful fumes and are therefore less friendly to the environment."

The NOGP places responsibility for environmental protection on the companies producing petroleum, and states that the government's responsibility is to monitor compliance. The NOGP boldly states that the government will perform due diligence on companies prior to licensing, considering not only a company's ability to meet financial obligations and technical requirements, but qualifying that company's environmental standards. The NOGP rightly asserts its position to "put in place the necessary regulatory framework for prohibiting venting and restricting flaring in order to avoid wastage of the resources and safeguarding the environment." To ensure the petroleum sector operates in a way that conserves the natural environment and biodiversity, the government has committed to a commendable series of strategies and actions, including the following:

- Institutional and regulatory reform to address environmental- and biodiversity-related issues pertaining to the petroleum sector, as well as the necessary capital and capacity to empower these new institutional branches

- Mandating compliance through use of best practices and self-regulation by both companies and their contractors
- A mandate that all disturbances be rehabilitated to their previous state
- Implementation of "physical master plans, environmental sensitivity mapping, and oil spill contingency plans" for both the oil-producing region and any transportation corridor to be used.

The Oil for Development program in Uganda is divided into three segments: resource management, revenue management, and environmental management. The Environmental Management segment has made a strategic environmental assessment (SEA) of the oil region a fundamental priority, along with revision of key laws and protected area management plans to update these in line with the needs of a petroleum sector. The program has been extremely successful at unifying and catalyzing government resources and commitment to progressive reform of environmental management.

In 2012, some of these promises were carried out, such as creation of an atlas that spatially depicts regional social and environmental sensitivities to petroleum development, and conspicuous rehabilitation of disturbed areas during exploration. However, actions on the major obligations of institutional and legal reform have occurred at an excruciatingly slow pace. Critics fear that contracts are being signed and irreversible damage taking place in an unregulated environment, while government environmental authorities have already taken nearly four years after the NOGP's official decree to enact reform. Waiting for reform for one more year in this context could be detrimental. Once recommendations come out of the SEA process, months or even years could elapse before environmental regulations and new legislation are enacted. The Petroleum Bills introduced before parliament make substantial references to the National Environmental Act for guidance on environmental and social impact issues, yet that piece of legislation, as previously stated, lacks adapted rules for the petroleum sector. Furthermore, the Petroleum Bills fail to force companies to adhere to the world's highest and best practices, to require use of state-of-the-art technology, and to make health, safety, and environment (HSE) concerns companies' foremost priority.

6. RECOMMENDATIONS AND CONCLUSION

External Support

The European Union (EU), US, and OPEC countries can:

- Actively input revenue transparency in the extractive industries into new legislation to be developed in coming months.
- Discuss disclosure of non-financial information.
  - Review existing non-financial reporting standards to assess how they could best be adapted to the European context and be made compulsory for European companies.
  - Develop a monitoring standard for corporate social responsibility (CSR) activities, including measurement criteria and tools, to ensure positive social and environmental impacts.
- Influence oil companies through banks and funds that finance them.
  - Support better monitoring and reporting of compliance with existing sustainable lending standards, such as the Equator Principles (for banks) and the Principles of Responsible Investment (for funds).
  - Encourage pension funds from states to apply social and environmental screening of their investments in oil companies, modeled on the Council on Ethics of the Norwegian pension fund.
- Encourage the investment bank to provide loans to African oil-producing countries to enhance economic diversification and development, for example to:

- Develop modern refineries, liquid natural gas (LNG) projects, and distribution networks for petroleum and gas to improve domestic energy supply.
- Set up health and education projects in oil-producing countries.
- Guarantee micro-lending initiatives in enable local communities to better cope with the negative impacts of oil companies, and to benefit from economic opportunities such as supply of food to oil operations (as piloted by British Petroleum [BP] and Chevron in Angola).

Technology Development and Support

Oil companies could promote development and diffusion of cost-effective, locally usable technologies by:

- Encouraging European oil companies, government agencies, and higher education and research institutions to develop effective technologies in oil fingerprinting to help reduce oil theft and trace sources of pollution, and stop imports of certain oil products (e.g., that originate from areas with poor human rights or environmental records) (The technology may be developed with a view to explore regulatory measures to ensure legality of oil imports.);
- Reducing gas flaring, including the technology to turn gas into LNG and make it available at affordable prices to local consumers in oil-producing countries, which could be developed, financed, and promoted through the Global Gas Flaring Reduction Partnership; and
- Monitoring and cleaning up oil spills—including mobile phone-based technology to report oil spills, and technology that can be used by local communities to deal with minor but numerous spills.

Development Assistance

OPEC and other unions could provide development assistance to:

- Set up independent oil spill response teams and clean up mechanisms in oil-producing countries to delink the problem and its remediation from the political context and financial constraints.
- Channel education funding in support of skills and capacity building with a view to economic diversification, in addition to enabling members of oil-producing communities to benefit from direct and indirect employment opportunities provided by the oil sector, to the extent that these are available.
- Strengthen local governance through improved administration and by promoting appropriate local elections and decentralization, as well as by building capacity of local communities to understand and promote their rights.
- Undertake independent scientific surveys of oil-producing regions to establish baseline data, engaging national and local governments, international and national researchers, and national civil society groups in the research process.

Revenue and Production Transparency

International oil companies and their partner governments and companies in the oil-producing countries could:

- Implement country-by-country reporting to make the accounts of multi-national companies more transparent to help tackle tax avoidance (transfer pricing), improve democratic accountability, curb crime, and remove large and destabilizing risks from the global financial markets.
- Continue and increase support for the Extractive Industries Transparency Initiative (EITI) as an easily applicable mechanism necessitating governments and ministries to "get their numbers right" by comparing oil company payments to government receipts.

- Publish oil contracts. Oil is a national resource for the public good and therefore any contracts should be published in the public interest.
- Make sure that audits (fiscal and cost) occur at every stage of the process (including at exploration and development) to facilitate good bookkeeping, as well as audits down the line when exploration and especially development costs incurred by oil companies are often offset against oil profits during the production phase. External parties (donors) could fund audits during these early stages of exploration/development.
- Commission audits through international leading auditors, given that the oil industry is a highly specialized and global industry.
- Encourage governments to publish and report on audits, including follow-up activities and action points for the various ministries involved. Support to government departments involved at this stage may be suitable via capacity-building and technical support if needed.
- Encourage governments to not only publish data (e.g., EITI data, budgets, audits, etc.) but to publish the data in a way that is accessible and comparable (e.g., people's budgets); the method of accounting should be similar (cash or accrued) and the period of accounting should be the same (this may differ depending on financial year versus calendar year, for example).

Producer-Country Measures

Producer-country governments (also under pressure of international and domestic CSOs) could:

- Clarify joint-venture legislation and production sharing agreements to introduce environmental benchmarks in future agreements for concessions and increase transparency and accountability of oil operators.
- Streamline management structures and competencies in government agencies dealing with oil industry (both exploitation and environmental aspects), including by strengthening the role and human resource capacities of environmental and health departments at national and provincial levels.
- Support domestic use of gas for energy generation by reducing market distortions that render alternative solutions for addressing gas flaring non cost-effective, and by supporting development of national infrastructure for local energy production and use.

Building Partnerships

All stakeholders could foster greater engagement between oil companies and local communities in the areas where they operate.

Equity

Equitable distribution of costs and benefits should occur (e.g., within and among communities, between communities and developers, and across different economic interests and generations).

Measures against Economic Vitality

- Attractive business climate for all investors (e.g., clarity and certainty of regulations, access to current geoscience data);
- Local retention of benefits;
- Balance of traditional and non-traditional (i.e., wage) economies;
- Economic diversification (i.e., not dependent on one sector); and
- Capacity building for people (e.g., through education, literacy programs, high school upgrading, and training and opportunities for employment).

Conclusion

Negative environmental and health impacts of the oil industry are a major concern in oil-rich countries. Information on oil spills remains sketchy. While larger spills are more likely to be reported (albeit at times with delays), problems created by smaller, but more common spills are easier to conceal and thus tend to be underestimated. In addition to direct health and environmental effects, impacts on livelihoods pose a particular threat in African countries where local communities largely depend on natural resources for agriculture and fisheries, or where wildlife tourism is an important part of the economy.

Gas flaring also continues, in particular in Nigeria, although alternative technology is available and widely used in other countries. Cost-effective solutions are required not only to prevent health impacts and greenhouse gas emissions, but also to utilize the valuable resource in affordable energy for local communities as a contribution to poverty alleviation in oil-producing countries.

While oil companies are implementing some measures to address these impacts, efforts remain insufficient. CSR activities are piecemeal and short term, environmental impact statements (EIA) are insufficiently robust, and requirements for accountability and transparency are either not available or not enforced.

Community engagement also remains challenging, giving rise to social tensions and even unrest. Nigeria can provide useful lessons in this regard, and current engagement strategies worth monitoring to see whether they can provide a model for other producers.

In oil-producing countries, the main limitation is often not absence of regulations, but lack of political will and capacity to implement and enforce regulations. Thus, any solution will ultimately have to deal with issues of governance, including increased revenue transparency, more equitable and effective revenue sharing and use, a better balance of power among ministries, and greater citizens' participation.

The EU, as a major importer of SSA oil and host of companies investing in SSA, has both the responsibility and the opportunity to promote greater sustainability and equity in the sector.

Engagement with "new" producers will be particularly important to learn from experiences in other countries and lay the foundation for contribution of oil to national development. Current efforts to promote greater revenue transparency are important steps that must go hand in hand with a push for revenue management and greater emphasis on preventing trade in oil sourced illegally or from conflict areas.

Based on the preceding analysis, a number of recommendations are offered to induce oil companies' behavior toward more sustainable practices through regulations in the companies' host countries, promote technology solutions, target EU development assistance, enhance transparency of oil operations, strengthen producer country measures, and build partnerships between stakeholders. Different actors will be more suited than others at these various points of intervention. Capacity and ability of actors, as well as their responsiveness and the sustainability of their actions determine impact.

7. CASE STUDIES

Chad: Failure of a "Best Practice" Framework

The weakness of a technocratic approach to oil management is well illustrated by the experience of Chad, which entered a phase of intensive development of its oil resources in the late 1990s. In partnership with the international community, led by the World Bank, significant assistance, both financial and technical, was offered for construction of a pipeline to Cameroon, from where Chad's oil could reach a world market, in return for elaboration of a stringent regulatory framework that seemed to "guarantee an effective fight against poverty." This included transparent handling of oil revenues and commitment of a significant percentage of these to poverty reduction. Just 15% was intended to go to the general government budget, with 85% set aside for measures intended to reduce poverty. Of this, 10% was earmarked to go to a "future generations" fund, 5% to the communities of the oil-producing region, with the remainder reserved for priority sectors including infrastructure development, health, and education. The Chadian framework also incorporated an oversight committee that brought together the government and civil society to monitor the oil sector, the *Collège de Contrôle et de Surveillance des Resources Pétrolières* (CCSRP). Its principal objective was to ensure use of oil revenues to fight poverty. Made up of nine members, including four civil society representatives, the CCSRP was given broad powers, enshrined in law, to monitor production, budgeting, and spending.

Production started in late 2003, after investment of more than $4 billion in development of the oil fields and pipeline. Yet, despite close collaboration between the government and oil companies, and the best available technical expertise from the World Bank, the framework has not proved effective. The government has repeatedly sought to renegotiate the terms of revenue-sharing agreements, bringing a greater percentage under its direct control, notably to increase spending on the military and security services. Chad's relationship with the World Bank broke down to the point where, in September 2008, the government repaid its remaining debt to the bank and ended its involvement with the oil sector. In the words of one analyst, "the World Bank's position became untenable in the face of the evidence that the model it had designed had collapsed." Likewise, the CCSRP has not been able to play the role that civil society had hoped, undermined by political interference, budget constraints, and lack of access to sufficient information. Despite some successes in transparency of revenue—financial statements have been regularly produced by the CCSRP and oil companies—the government has proven able to direct spending as it wished, notably in the security sector. Development outcomes have not significantly improved, despite billions of dollars in additional revenue, leaving Chad fifth from bottom in the latest United Nations Development Program (UNDP) human development index. The key lesson from the Chadian experience seems to be that externally sponsored regulatory frameworks, regardless of how robust they seem on paper, are not enough to ensure that oil revenues contribute to poverty reduction or improvements in government. Local political imperatives win out.

Transparency in Ghana and Alaska

The Public Interest and Accountability Committee (PIAC) was established by the Ghanaian Petroleum Management Act to monitor compliance with the law, to act as a forum for public debate on oil issues, and to undertake regular and independent assessment of management and spending of revenues. Its membership represents a wide range of civil society groups and actors, from traditional rulers to trade unions, think-tanks, NGOs, and religious groups. It began work in September 2011 and has already published its first assessment report.

Ghana offers a model for Uganda to consider. In assessing progress on oil management and encouraging public engagement in informed debate, it is both the source and the conduit for useful, reliable information about the oil sector, able to cut through rumor and speculation. Significantly, though the PIAC is mandated by law (important to give it sufficient weight to offer objective views, even if they are controversial or politically unpopular), it does not have any coercive or enforcement capacity. It can neither compel witnesses nor prescribe punishment for any transgression. Nor does it have any formal role in the legislative process.

Thus, the PIAC should be able to stand apart from partisan debate, free from party-political influence. Though there have reportedly been some tensions with government—the PIAC has not yet been given the financial or material support mandated by law—and parliamentarians have been nervous that their role was being usurped, the broad base of the committee provides it with the opportunity to build a relationship with all Ghanaian stakeholders, from local communities to national government.

Ghana also offers an interesting model for how mechanisms for consultation and transparency could function at a local level. The PIAC has already held public consultations in the oil-producing western region of the country, an important step in ensuring local voices and concerns are adequately represented in the national debate.

Alaska's Prince William Sound Regional Citizens' Advisory Council offers another model. The council was established after a major environmental disaster, the 1989 Exxon Valdez oil spill, which spread 11 million gallons of crude oil along more than a thousand miles of coast and exerted enormously damaging impacts on local ecosystems and livelihoods. Subsequent investigations revealed that much of the damage could have been prevented by better planning and responses from both government and industry. A permanent, industry-funded citizens' council was founded to ensure open lines of communication between local communities and industry, and to oversee both the oil transportation industry and its government regulators. This council includes representatives from communities and businesses. The council was established both by law (the Oil Pollution Act of 1990) and through a contract directly with the oil production company. Under the terms of this contract, the company funds the council and guarantees access to facilities.

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LECTURE 2: CONFLICTS AND SOCIAL IMPACTS ASSOCIATED WITH OIL AND GAS DEVELOPMENTS

SYLLABUS

Teaching Aims

(i) To examine the social and health impacts of the petroleum industry.

(ii) To asses factors that influence social and health impacts in the petroleum industry.

Learning Outcomes

(i) Recognize the positive and negative social (secondary) and health impacts of the petroleum industry.

(ii) Explain the key factors that influence social and health impacts in the petroleum industry.

(iii) Describe the roles of different actors in addressing the negative social and health impacts of petroleum industry.

Outline of Lecture Content

Topic and Subtopic	Suggested Approach, Methods & Equipment
1. Introduction	Mini lecture
2. Causes/Drivers of Socioeconomic Conflicts	Case studies in groups followed by presentations in plenary
3. Key social issues considered in planning petroleum projects	• Q&A • Lecture based on participants' knowledge and experience • A focused group discussion on the rights of indigenous and vulnerable populations
4. Impact on Environment and Socioeconomic Conflict	Discussions based on video documentaries
5. Macroeconomic and Fiscal Policies	Mini lecture, Q&A and discussion
6. Models/Initiatives that can be Used to Preempt and/or Manage Socioeconomic Conflicts In Petroleum Industry	Mini lecture, Q&A and discussion
7. Key Social Impacts in the Petroleum Industry	Mini lecture, Q&A and discussion
8. Factors that May Lead to Social Impacts	• Q&A based on participants' knowledge and experience • Discussion with field personnel during a field trip to the Albertine Graben on how these factors have led to social impacts • Gabon case study
9. Understanding the Tradeoffs	• Lecture based on Q&A • Case study (Muskeg River Mine project), practical examples on how this has been done in the Albertine Graben
10. Management of Social Issues	Lecture

Topic and Subtopic	Suggested Approach, Methods & Equipment
11. Positives from Addressing Social Issues: Case Study of Texas	Q&A, lecture, practical example from the Albertine Graben on positives arising out of addressed social issues, especially regarding health, education, and roads
12. Case Study of Nigerian (Negative Social Impacts) Study	
13. Conflicts	

DETAILED NOTES

1. INTRODUCTION

This lesson focuses on a critical challenge that has frequently bedeviled developing countries with abundant natural resources such as rich petroleum deposits, yet facing high poverty levels, a growing population with high expectations, a low revenue-base, and a sluggish economy with weak institutions. What such a country normally needs is disciplined exploitation of resources to attain a quick and simple avenue to secure revenues that can be used to mitigate poverty and modernize infrastructure. More often, the country is enveloped by resource-related conflict, and this is a reflection of governance challenges facing the natural resource sector.

2. CAUSES/DRIVERS OF SOCIOECONOMIC CONFLICTS

The development approach for petroleum or hydrocarbons is premised on the notion that natural resources should contribute toward the national development agenda and that natural resources should be developed rather than exploited. Exploitation creates images of wasting an asset, while development suggests more care for longer-term opportunities. In developing hydrocarbons, it is important to deliberately take account of the two key areas of direct linkages that are the effect of hydrocarbons on national finances and potential tensions regarding the environment. The promise of large revenues can lead to distortions in expenditure management, non-transparent agreements, and macroeconomic instability. Likewise, linkage of carbon mining and oilfield operations to the environment is problematic, mainly from the perspective of local capacity to effectively monitor operations at a large, complex site.

Because of the diverse uses of petroleum and their direct links to economic and social wellbeing, demand for these commodities continues to grow as incomes rise and populations expand in most developing countries.

The main causes or drivers of conflicts related to development of hydrocarbons include the following:

- **Poor Engagement of Communities and Stakeholders:** Where communities and stakeholders are poorly engaged, marginalized, or excluded from the dialogue in the development process, they are almost certain to begin to oppose the development. As the conflict escalates, use of strategies of violence as a coercive measure may be used against the oil company or others within the community, and as a means for addressing old grievances and mounting opposition against the government, are likely.

- **Inadequate Benefit-Sharing:** If benefits are distributed in a manner that appears unfair as compared to distribution of costs, risks, and responsibilities, those disenfranchised or bearing risks and responsibilities without fair compensation are likely to oppose the development, and possibly rebel.

- **Excessive Impact on the Economy, Society, and the Environment:** Notwithstanding the promise of prosperity often associated with petroleum, impacts on the local economy and macroeconomic conditions of the nation as a whole can be quite negative; in circumstances where governing institutions are weak or underdeveloped, consequences of the resource curse are often magnified. Furthermore, while social and environmental assessments and management procedures in the petroleum sector are well developed, impacts on communities and the environment continue to be a powerful conflict driver.

- **Mismanagement of Funds and Financing Conflict:** Corruption and diversion of funds to satisfy individual gains at the expense of national and community interests can easily contribute to conflict. Too often, the vast revenues from the natural resource have been diverted away from the public interest to satisfy personal gains and, in some cases, to finance armies and violent conflict.

- **Inadequate Institutional and Legal Framework:** Mismanagement of funds is symptomatic of inadequate broader institutional and legal capacities to manage development of the natural resource for the benefit of the country as a whole.
- **Unwillingness to Address the Natural Resources Question in Peace Agreements:** Where natural resources have been an underlying cause of war, they can reignite conflict if the relevant issues are not addressed in the peace process. Issues of ownership, wealth sharing, and distribution are often important, and significantly affect capacity to achieve post-conflict stability.

Regarding political conflicts, a natural resource such as petroleum might lead to or aggravate conflict, depending on the extent to which it can be easily looted and transported ("lootability") and the degree to which access to these resources can be obstructed to prevent a government or political faction from benefiting financially from their presence ("obstructability"). A resource's "lootability" and "obstructability" are important keys to understanding not only why a conflict developed, but also to understanding how conflict is maintained. For example, a "lootable" resource can be used by opposition groups to generate revenue and support their movements, while access to an "obstructable" resource can be denied to government forces, stifling their ability to raise revenues to counter opposition movements or limiting the government's ability to wage war (Foundation for Environmental Security and Sustainability [FESS], 2006).

3. KEY SOCIAL ISSUES CONSIDERED IN PLANNING PETROLEUM PROJECTS

Conflict and Governance

Existence of socioeconomic conflicts stemming from petroleum development is often an indictment of the governance and institutional framework in the affected country. Governance refers to the manner in which power is exercised in management of a country's economic and social resources for development. The World Bank considers three dimensions of governance: (1) the nature of political regimes, (2) exercise of authority in management of social and economic resources, and (3) capacity of government to design and implement policy and to (responsibly) discharge its functions.

Some have noted, however, that in developing countries ruled by illiberal regimes, there are often restricted avenues through which governments can be held accountable for its actions. In many countries, civil society is weak and poorly organized. The relative lack of NGOs with capacity to engage and influence policy decisions is a clear liability in seeking to ensure transparency in use of natural resource-related revenues.

Yet this institutional gap also presents an opportunity for the future, especially in light of the continuing emergence of NGOs in the developing world. As an example, in Chad, NGOs were able to participate throughout the development of the Petroleum Revenue Management Plan for the Chad-Cameroon Pipeline Project, as well as during construction of the pipeline. Further, at the international level, the Publish What You Pay campaign helps citizens of resource-rich developing countries hold their governments accountable for management of revenues from the oil, gas, and mining industries.

In other instances, governments themselves—or key officials within governments—may be willing to address important development problems but may lack the political base, financial wherewithal, or technical capacity to make the most of existing petroleum reserves. This may relate to fundamental problems of governance (e.g., overly centralized decision making or inequitable treatment of ethnic minorities) not directly related to petroleum issues, but which intersect with them in ways likely to play a role in oil- and gas-related conflict. Policies aimed at avoiding resource-related conflict must encourage and/or assist governments in developing institutional capacities that can overcome some of these imbalances.

The Foundation for Environmental Security and Sustainability (2006) accordingly proposes the following considerations:

- Strengthen host country NGOs so that they are supported to focus on issues such as good governance, community participation, or the environment, and can play a key role in promoting transparency, environmental best practices, and socially responsible development.
- Problems associated with oil wealth that can lead to or exacerbate conflict must be addressed by a wide array of social and civic groups. Assistance for local NGOs or other independent host-country groups should be combined with other initiatives from the international community that aim to encourage and facilitate an open dialogue at all levels of society.
- In many developing countries, environment and health ministries are understaffed and notably weak in relation to other elements of the state, such as finance and interior ministries. The strengthening of environment and health ministries, and related government agencies that advocate regulations to protect the public interest, can help address citizen concerns about the impact of petroleum extraction, and therefore reduce prospects for conflict.

Sustainable Development

Nations have focused on economic growth without considering the quality of that growth on people and environment. This underlies the new approach adopted by the United Nations (UN) through what the UN has dubbed *inclusive and sustainable development.*

The concept of *sustainable* implies that development gains can be sustained to ensure that both current and future generations benefit. Sustainable development is accordingly based on the three pillars of economic, social, and environmental sustainability. Thus, greater sustainability means that development must respect limits set by the natural environment, including its planetary boundaries. This also implies that solutions to poverty should be socially and economically sustainable.

The concept of *development* recognizes that economic growth is a necessary but insufficient condition to raise living standards. Development highlights the need to address issues that go beyond the narrow economic sphere, such as governance, institutions, security, and other aspects of wellbeing. In fact, inclusive and sustainable development can be achieved only through economic and social transformation. Thus, a defining feature of the term "inclusive and sustainable development" is that it explicitly combines concerns to reduce poverty and inequality with emphasis on need to do so in a sustainable manner.

While the concept of inclusive development is in line with the human development approach, the latter tends to be associated with outcomes, while inclusive development tries to focus on process. This opens the possibility of devising both process (e.g., inclusive growth) and outcome goals (e.g., current Sustainable Development Goals [SDG]). Inclusive and sustainable development should be at the heart of any new global development framework. Its dimensions underline the importance of its three key features—quality of development and not just growth, spread of development by reducing inequality, and need to confront scarcities to ensure that development has a long-term perspective.

Revenue Management

Use of project revenues in developing countries is frequently a topic of concern not only for NGOs and social advocacy groups, but for many lenders.

Indigenous and Vulnerable Populations

A discussion of rights of indigenous and vulnerable populations is included in the International Labor Organization's Convention No. 169 concerning Indigenous and Tribal People's in Independent Countries. The World Bank also has procedures related to projects affecting indigenous and vulnerable populations. (These were applied in the resettlement of communities affected by the Bujagali Hydro-power project in Uganda.) The example of the Batwa Resettlement near Bwindi provides insights into the challenges of resettlement in Uganda.

4. IMPACT ON ENVIRONMENT AND SOCIOECONOMIC CONFLICT

This lesson unit highlights how operations in the energy sector impact the environment, and ultimately the community. The realization is that adverse impacts on environment affect livelihoods, and this may extend to quality of living and access to social services.

In considering development of natural resources, such as petroleum, it is important to realize that the resources are embedded in a space where actions by one individual or group generates effects far beyond localities and national jurisdictions.

Generally, impacts of petroleum development can be highlighted (Baumüller, Donnelly, Vines, and Weimer, 2011) as follows:

- The process of resource extraction is ordinarily polluting and detrimental to the environment in the resource-rich country. The extent of pollution caused by extracting resources depends on the quality of technological equipment used for the extraction. In Nigeria, conflict over environmental degradation and human rights led to protests in the early 1990s that culminated in the execution of Ken Saro-Wiwa in 1995.
- In SSA are environmental-related conflicts that play out through ethnic identity, land tenure issues, and competition for resources at the community level.
- Also, consequences attributed to oil spills and gas flaring have led to collapse of local fishing and farming, loss of habitat and biodiversity, acid rain damage, and health impacts of air, noise, and light pollution. Damage in the Niger Delta from petroleum operations is chronic and cumulative, and has acted synergistically with other sources of environmental stress to result in a severely impaired coastal ecosystem and compromised livelihoods and health of the region's impoverished residents,
- Numerous spills are not reported in Nigeria. Reports by the Nigerian authorities indicate that 9,107 oil spill incidences occurred between 1976 and 2005, resulting in just over 3 million barrels of oil spilled into the environment (Egberongbe, 2006). Angola rarely reports any spills.
- Gas flaring (burning of waste gas) continues to be common practice in Africa. Widespread use of the "open pipe flare" method in Nigeria, almost obsolete outside the country, compounds the problem. The quantity of gas flared in Nigeria is unclear, with estimates ranging from 20% of produced associated gas to 76%; this compares unfavorably with a worldwide average of 4.8% (Donwa et al., 2015). This affects the health of people and is a notable source of greenhouse emissions.
- Most oil companies operating in SSA have programs for engagements and partnerships with the local community. In Uganda, Tullow has even appointed community liaison officers.

This lesson unit focuses participants on the puzzle of countries richly endowed with natural resources, yet mired in poverty due to inability to properly manage and utilize the resources. Participants are expected to conceptualize this paradox and explore how countries can overcome it.

What Is the Resource Curse?

The resource curse refers to the inverse relationship between development and abundance of non-renewable natural/extractive resources such as petroleum and other minerals in a given country. In countries with abundant natural resources like oil, natural gas, minerals, wildlife, and other resources, the level of socioeconomic development does not reflect the endowment in resources, and citizenry are denied opportunity to enjoy benefits of those resources. This state of affairs is often attributable to inept and corrupt government institutions. Many have asserted that petroleum, in particular, bodes trouble—waste, corruption, consumption, debt overhang, deterioration, collapse of public services, wars, and other forms of conflicts. This existence of wealth or plenty against poverty is the "resource paradox."

Drivers of Resource Curse

Despite introduction by petroleum of substantial resources to the economy (Sturm, Gurtner, and Alegre, 2009, Box 1), some have observed that resource-abundant countries tend to grow at a slower rate than countries without natural resources, dubbed the resource curse, and this is attributable to four main causes:

- The Dutch Disease hypothesis which stems from two influences: first, appreciation of a country's real exchange rate caused by sharp rise in exports; and second, tendency of a booming resource sector to pull capital and labor away from a country's manufacturing and agricultural sectors, which inflates production costs in these sectors. Effects of these influences are a drop in exports of agricultural and manufactured goods, and increase in cost of non-tradable goods.
- Resource abundance may also discourage the country to invest in human resources and to accumulate private capital. Moreover, concentration of resource revenues in the public sector may lead to circumvention of tough decisions on economic reforms. Ultimately, this adversely affects investment efficiency and diversification, magnifies economic distortions, and derails economic development.
- High volatility of resource revenues associated with the dynamics of petroleum prices is a source of increasing investor uncertainty. This volatility not only constrains execution of a balanced fiscal policy but hinders economic growth. This also links the larger volatility of revenue incomes to inability of governments to properly manage public surpluses, implying for example, a tendency to conduct pro-cyclical fiscal policies and unproductive use of funds.
- Natural resource rents have also caused political instability and conflict, corruption, weak institutions, unequal distribution of wealth, and policy failure—especially in factional political states associated with heterogeneous societies.
- Exploitation of natural resources also imposes ecological challenges because this essentially entails activities that often adversely disrupt the natural environment, imposing a socioeconomic burden that waters down benefits derived from the natural resource.

All these factors must be managed if a country is to overcome the resource curse.

5. MACROECONOMIC AND FISCAL POLICIES

This lesson unit focuses participants on whether targeted macroeconomic and fiscal policies are in place to protect the environment and biodiversity, and whether the government commits to expend resources to address damage to these.

The greatest challenge to the petroleum industry is that developing countries are primarily the source of raw materials such as crude oil, which are taken to developed countries for processing and a lion's share of consumption. Exploration and development of petroleum fields has led to opening up of virgin lands and untouched environments. Whereas this can certainly be a source of development with proper stewardship and management by the political leadership, improperly managed exploitation can lead to social conflict, nourish corruption, disrupt people's lives through displacement from their homes and lands, destroy the environment via pollution of water bodies, cause irreversible biodiversity loss, and destroy people's health. Unfortunately, examples are evident in the developing world of extractive industries causing human suffering and damaging the environment, such as in the Delta region of Nigeria and the diamond fields in Zimbabwe, where clear macroeconomic and fiscal policies, and incentives dedicated to supporting protection of the environment are absent.

Local Content

Whereas most oil-producing countries have statutory ceiling on local content, not many countries have a formal local content operating model. Local content operating models focus on identifying opportunities for expansion of local content at the earliest possible stage in the extractive industry's activities. Local content often is mandated as part of procurement and employment strategies, and is a critical element of operators' contracts with their international suppliers. Industry also seeks to engage with in-country stakeholders to develop country-specific plans for local content development. This helps manage expectations regarding opportunities that would become available, develop practical and realistic plans, and gain support for collaborative relationships to implement such plans. Local content country plans normally include appraisal, development, and registration of potential local suppliers; identification of potential partners among international companies; and establishment of enterprise development initiatives.

Local policy content can be usefully complemented by adequate levels of public funding of local services and infrastructure projects in the areas of natural resource development. This also suggests need for attention to inter-government fiscal arrangements that would provide adequate funding for local governments in extractives industry areas.

Revenue Management

This lesson unit focuses participants on the challenging responsibility of most oil-producing developing countries regarding revenue collection and management. The process incorporates measures that would ensure proper appropriation and accountability, and preempt revenue leakages.

Coexistence of resource riches and poor economic performance (commonly dubbed the "paradox of plenty" or "resource curse") is not inevitable. This unwelcome scenario largely stems from poor policy choices and corruption that have exacerbated the cycles of poverty and conflict.

Countries that have instituted prudent and transparent management practices through proper stewardship of revenue from the oil, gas, and mining industries have lifted their people out of poverty and attained sustainable development. These countries have defied the resource curse, and their industries have generated jobs directly and indirectly, transferred technologies and knowledge, and produced significant income. These benefits also have provided governments with a financial base for infrastructure development and social service delivery. The petroleum sector particularly is known for generating high economic rent, and the government's share of this rent can be very large in times of high oil prices.

Oil revenue, however, has some features that challenge policymakers and often account for the common inability to conduct proper management. These features include volatility, uncertainty, exhaustibility, and origination of the revenue largely from abroad.

Proposed Revenue Management Standards

The two Bretton Woods institutions (the World Bank and the International Monetary Fund [IMF]) have been working closely with governments to support transparent, sustainable management of their hydrocarbon resources to maximize development gains and reduce poverty. The guidelines are as follows:

- Contractual arrangements between government and public or private entities, including resource companies and concession operators, should be clear and publicly accessible.
- Government liability and asset management, including granting of rights to use or exploit public assets, should have an explicit legal basis.
- Receipts from all major revenue sources, including resource-related activities and foreign assistance, should be separately identified in the annual budget presentation.
- The government should publish a periodic report of long-term public finances.
- Purchases and sale of public assets should be undertaken in an open manner, and major transactions should be separately identified.

6. MODELS/INITIATIVES THAT CAN BE USED TO PRE-EMPT AND/OR MANAGE SOCIOECONOMIC CONFLICTS IN PETROLEUM INDUSTRY

Introduction

This lesson unit explores measures that can be adopted to mitigate risks of environmental damage and conflict in oil development. Participants will be encouraged to think of appropriate measures or solutions to challenges identified during the lesson. Discover if participants can develop ideas useful for converting challenges into opportunities to turn around poor countries rich in resources.

A number of initiatives to improve revenue management and pre-empt resource conflicts have emerged, including the following:

Natural Resource Charter

The Natural Resource Charter is a set of principles for governments and societies on how to best manage opportunities created by natural resources in development. An independent group of experts in economically sustainable resource extraction drafted it. The charter comprises 12 precepts, or principles, which encapsulate choices and suggested strategies that governments might pursue to increase prospects of sustained economic development from natural resource exploitation (see www.naturalresourcecharter.org and Figure 2.2 below).

Extractive Industry Transparency Initiative

This is a global standard for increasing transparency of revenues from oil, gas, and mining. EITI produces regular publications of material related to oil, gas, and mining payments by companies to governments and all material revenues received by governments from oil, gas, and mining companies.

"In 2008, the World Bank launched the Extractive Industries Transparency Initiative Plus (EITI++), which "seeks to develop national capability to handle the boom in commodity prices, and channel the growing revenue streams into fighting poverty, hunger, malnutrition, illiteracy, and disease…." EITI++ complements the EITI by offering capacity building and technical assistance to improve management of resource-related wealth. It aims to improve the quality of contracts for countries, monitoring operations, and collection of taxes and royalties. It will also improve economic decisions on resource extraction, management of price volatility, and investment of revenues effectively for national development" (Baumuller, et al., 2011).

Other initiatives that will improve management of the environment and social impacts of petroleum development include:

Source: Baumuller, et al., 2011.

- "The World Bank's Global Gas Flaring Reduction Partnership (GGFR) provides a platform for oil producers, importers, and oil companies to promote joint efforts to increase use of natural gas associated with oil production and thus reduce flaring and venting."
- "The United Nations Global Compact provides organizations and businesses with a framework to align their operations and strategies with 10 principles in the areas of human rights, environment, labor, and anti-corruption."
- "The Organization for Economic Cooperation and Development (OECD) Guidelines for Multinational Enterprises set out voluntary principles and standards for responsible business conduct in areas such as environment, information disclosure, combating of bribery, and human rights."
- "The "Lugar-Cardin" Provision in the Dodd-Frank Act of 2010 (Wall Street Reform Act) requires all U.S.-listed/registered extractive industry companies to disclose payments to governments in Securities and Exchange Commission (SEC) filings starting in 2012/13 (Gary, 2010). This law is a

success for the Publish What You Pay coalition after a five-year effort. The legislation covers approximately 90 per cent of internationally operating oil companies—U.S. and foreign."

7. KEY SOCIAL IMPACTS IN THE PETROLEUM INDUSTRY

International Labor and Employment Issues

The most internationally recognized labor principles relating to private sector projects are expressed in the International Labor Organization's *Declaration of principles concerning multinational enterprises and social policy*. This declaration includes sections on rights of workers to form and join workers organizations, and receive information about health, safety, and rights of children-forced and child labor, among others. Human Rights: The UN Universal Declaration of Human Rights (UDHR) and over 80 other international conventions, declarations, resolutions, and international agreements relate to human rights and UN Guiding Principles on Business and Human Rights.

Negative Secondary Impacts from Petroleum Development

Petroleum exploration and production activities can exert a wide range of impacts on biodiversity, both positive and negative. These impacts, which can be defined as changes in quality and quantity of biodiversity in a physical environment, vary in scale and significance, depending on activities and environmental conditions.

Impacts on biodiversity can be broadly divided into two types: primary impacts and secondary or induced impacts. Our focus is largely on secondary or induced social impacts.

Secondary (Social) Impacts

Secondary impacts do not result directly from project activities, are usually triggered by operations, but may reach outside project or even concession boundaries and may begin before or extend beyond a project's life cycle. Although secondary impacts may be predicted via a thorough environmental and social impact analysis (ESIA) that includes attention to biodiversity issues, in some cases, potential for such impacts may not be identified or realized until much later in the project cycle, or even after the project has been decommissioned.

Social impacts tend to result from government and company decisions, and actions and practices of nearby communities or immigrants commonly referred to as the "boomers." Responsibility for predicting, preventing, and mitigating secondary impacts is not clear-cut. Some occur as a result of decisions and actions of organizations and individuals unrelated to the petroleum industry, although petroleum companies are largely held responsible for negative social impacts. These tend to be the most controversial and difficult to manage types of impacts from petroleum development.

8. FACTORS THAT MAY LEAD TO SOCIAL IMPACTS

The most common causes of social impacts relate to population changes in an area and new or additional economic activities resulting from large investments in potentially permanent infrastructure (roads, ports, and new towns) that may accompany a petroleum project or any other major industrial development.

Immigration and New Settlements

Petroleum operations usually require skilled labor and thus are magnets for people hoping to find employment with the company or its contractors. New projects also typically stimulate provisions of goods and services to the project and/or affected local communities. Creation of additional employment opportunities and attraction of more people to the area, even unfounded rumors that project activities will occur, may be sufficient to cause people to migrate to an area in search of employment. In some cases, in-migration is encouraged or even supported by local or national governments, rendering this a particularly sensitive political issue.

Gabon Case Study

In Gabon, Shell's operations have been the catalyst for establishment and development of Gamba, a town of currently about 6,000-7,000 people, many of whom work directly or indirectly for Shell. Presence of these workers, some of whom are second generation, has affected surrounding biodiversity through limited agricultural activities and hunting of bush meat (recognizing allowance of this within local law as long as it is for local consumption and not trade). Shell has no direct control over Gamba, a town with its own governance; but where Shell does have direct control, such as the Gamba terminal or the infield Rabi oilfield, it has imposed strict management controls, including controlling development, prohibiting hunting, limiting driving speeds and times, and managing emissions to minimize impacts on biodiversity.

Increased Demand for Housing and Social Services

Particularly within previously undeveloped areas, local populations need housing, food, and other goods and services. This increased demand exerts additional pressure on natural resources, including:

- Deforestation from clearing of land for agriculture, building housing and other infrastructure, and collection of wood for construction, cooking, and heating;
- Increased demands on water resources and generation of wastes and other pollution;
- Increased demand for public services such as schools, law enforcement, and health care, which reduces resources available to address biodiversity concerns; and
- Commercial and illegal logging, as well as extraction of non-timber forest products, such as fibers, medicinal plants, and wild food sources.

Who is at Risk?

Laying the Foundations

1. Principles of environmental and social rights,
2. Tools for fulfilling environmental and social rights,
3. Sources of standards,
4. Using tools successfully, and
5. Emerging issues.

International Environmental Law Principles

- Precautionary Principle;
- Prevention;
- Equity;
- Polluter Pays;
- Transparency, Information, Participation; and
- State Sovereignty.

Notes:

- Discuss each principle; encourage participants to define each principle.
- Discuss prevention, emphasizing that environmental damage cannot be made whole again.
- Draw participants out on why equity is important (i.e., who bears costs and who benefits?).

- Free, prior informed consent (FPIC) originally applied only to indigenous people but was not part of many performance standards, including those of International Council on Mining and Metals (ICMM) and International Finance Corporation (IFC).
- Implicit is not causing harm outside national boundaries.
- Polluter pays: internalize the externalities; financial assurance for environmental restoration.

How to Apply the Principles

1. Principles of environmental and social rights,
2. Tools for fulfilling environmental and social rights,
3. Sources of standards,
4. Using the tools successfully, and
5. Emerging issues.

Notes:

- Assessment, planning tools have been developed to apply these principles on the ground.
- A lot of future is left! How do we go about harnessing this opportunity? HOOK! Opportunity in Uganda, because much of the country is not yet fully explored. Chance to get it right, because of wide international experiences.

Understand the Risks

Cost-benefit analysis traditionally considers only costs and benefits internal to a project. Environmental and social impacts are externalities. Efforts to quantify environmental harm are controversial.

Environmental (and Social) Impact Assessment

1. Screening,
2. Scoping,
3. Prediction,
4. Mitigation,
5. Management and monitoring, and
6. Auditing.

Discussion Notes:

- Historically EIAs have not sufficiently emphasized the social. Can you separate environmental from social impacts?
- EIA is a tool for understanding the physical and social environment:
  - It is an iterative process to gain full understanding of potential negative and positive impacts and alternatives.
  - It provides a basis for management and mitigation.
  - Screening often results in categorization of the project, and from this a decision is made on whether or not a full EIA is to occur

- Scoping is the process of determining which are the most critical issues to study, and would involve community participation to some degree. At this early stage, an EIA can most strongly influence the outline proposal.
- Detailed prediction and mitigation studies follow scoping, and occur in parallel with feasibility studies.
- The main output report is called an Environmental Impact Statement, which conveys a detailed plan for managing and monitoring environmental impacts both during and after implementation.
- Finally, an audit of the EIA process occurs some time after implementation. The audit serves a useful feedback and learning function.

- If we study only specific risks at the time a project is proposed, is it possible we might be missing something?
- The environmental site assessment (ESA) was first enshrined in law with enactment of the National Environmental Protection Act (NEPA) in the United States in 1969 as a counterbalance to cost benefit analysis. It was then adopted in more than 25 countries in the 70s and 80's, and now is a legal requirement in almost every country in the world. It was subsequently adopted by regional organizations and environmental initiatives such as the Brundtland Commission in 1985 and the Rio Summit in 1992.

Public Participation

Central to Environmental and Social Impact Analysis (ESIA) process:

- Critical to project success,
- Often improves project,
- Must conduct stakeholder analysis to be effective, and
- Project proponent should pay for potentially impacted people to participate meaningfully.

Discussion Notes:

- "Agreed" means agreed among the project proponent, the potentially affected community, the government, and the funder.
- Conflict is much more common when consultation is not conducted thoroughly.
- EcuaCorriente, Chinese company Mirador Copper Mine, Ecuador is paying a high rate of compensation both to local communities and the central government; but because no consultation occurred, people do not accept the project.

Prediction

- Conduct assessments to set a baseline.
- Perform social and scientific studies.
- Identify potential impacts based on the characteristics of the site.
- Identify alternative approaches for the project.

Discussion Note:

- Oil spills exert vastly different impacts, depending on where they occur.

List of Likely Social Issues

- Contamination;
- Sometimes toxic or radioactive;
- Loss of drinking water;
- Groundwater impacts;
- Sedimentation, sometimes contaminated;
- Higher water levels;
- Flooding;
- Contamination, death of fish, damage to aquatic life food chain;
- Erosion;
- Loss of arable land;
- Changes to topography;
- Destruction of forest;
- Loss of animal species or habitat;
- Displaced communities;
- Loss of livelihoods, way of life;
- Damage to cultural sites;
- Disparate impacts on women;
- Climate impacts;
- Toxins in the dust, sometimes radioactive; and
- Conflict, violence.

Discussion Notes:

- Start by listing benefits.
- Some are planned and others are not.
- Who is directly impacted by many of these costs? And who gets most of the benefits?

Mitigation of Impacts

- Identify alterative operational and technological approaches
  - Placement of infrastructure,
  - Waste treatment and disposal,
  - Runoff control,
  - Dust suppression, and
  - Erosion control, etc.
- Closure – Reclamation, Restoration, Rehabilitation, Post-closure

Discussion Notes:

Boege and Franks, 2012:

- Mechanisms to foster compliance with contractual obligations, and
- Insurance and performance bonds.

Environmental Compensation

- Conservation of a similar area of land – no net loss;
- Biodiversity offsets;
- Ecosystem services, especially hydrology, livelihood; and
- Complex valuation methodologies.

Discussion Notes:

- Compensatory offsets – sometimes offsets can be more valuable to the local population than what was lost; offsets often cheaper than restoration.
- Preserve a "similar piece of land."
  - 1:1 will not work (e.g., if only replace land where road is built, will miss the land lost by the new development that will follow, with subsequent destruction of the forest by the new inhabitants.
  - 3:1 in U.Ss CWA for wetlands; international standard is 10:1 for high-quality sites.

Compensation for Communities

- Traditional village = tin roof tenement?
- Seedlings = mature fruit trees?
- Tree planting seedlings?
- Boda-bodas?

Discussion Notes:

- Value of land = do financial processes always reflect the value of the land?
- People fight wars over this,
- Mechanisms controversial,
- No agreed standards,
- Context-specific, and
- IFC defines it as the market value of what is lost plus transaction costs… takes years.

Environmental/Social Action/Management Plan

The guide to implement the approach identified by the prediction and mitigation phase of the EIA:

- Following mitigation measures, and
- Carrying out compensation measures, etc.

Compliance Monitoring

Translating the rules to reality:

- Can be costly.
- Is highly technical.
- Informed public can help.

Discussion Notes:

- Are there any examples of thorough and effective monitoring by the government in Uganda?
- In El Salvador environmental observatory – local citizens alert for environmental threats.

Sharing the Benefits

Discussion Notes:

- Who?
- How much?
- Administered by government or by company?
- Enshrined in law or agreed with affected community? Good neighbor agreements.

9. UNDERSTANDING THE TRADEOFFS

As with any form of development, when a petroleum operation enters an area, there will be inevitable trade-offs between long- and short-term costs or benefits, and conservation and economic development priorities. It is beyond the ability of a company alone to fully address or prevent secondary impacts or make decisions about how to balance those trade-offs to achieve the most sustainable development possible for the area. Because secondary impacts typically arise from complex interactions among social, economic, and environmental factors and players, these can be difficult for a company to fully predict, and equally difficult or impossible for a company to effectively manage alone.

Anticipating and managing secondary impacts is further complicated by the possibility of impacts from activities not associated with the project, thus adding to the severity or intensity of secondary impacts. Secondary impacts will sometimes result from company activities that contribute positively to economic development, such as road-building or local employment. Tension can be significant between conservation and development goals in an area, and a company may find itself caught in the middle of that debate. For example, a company's commitment to contribute to local economic development and skills via training and hiring of local labor and suppliers may encourage immigration to an area, leading to secondary impacts from population growth. Alternatively, a road that local communities or government agencies support because it will increase economic activity in an area may be strongly opposed by conservation organizations concerned that the road will open access to a pristine ecosystem.

Group Discussion/Assignment: Identifying Social Impacts of the Petroleum Industry in Uganda

1. Audit the upstream, midstream policy and legal framework, and Public Finance Management Act (2015), and identify environmental and social impact gaps.
2. Outline the social impacts associated with petroleum developments.
3. Identify key actors and their responsibilities in addressing social impacts.
4. Develop strategies to address those impacts.

Case Study: Avoiding and Managing Secondary Interests: Shell's Muskeg River Mine Project

In Northern Alberta, Canada, Shell has made local economic development a focus of its strategy at the Muskeg River Mine Project, part of the wider Athabasca Oil Sands Development. About 55,000 people live near the project, 15% of whom are aboriginal. An extensive stakeholder consultation and engagement process revealed that economic development and employment were two of the biggest concerns for local people. The company has taken a number of proactive steps to increase local employment and supply chain opportunities, and thus limit need for in-migration or unsustainable economic development that might lead to secondary impacts in the area. Shell's local employment strategy has included development of a regional business strategy, baseline capability studies, and a long-term commitment to building local capacity through programs such as apprentice schemes for young people. The company has said that it will not compromise its competitive or HSE standards but that it is committed to investing in efforts to bring local contractors up to those standards. Long-term sustainable economic opportunities are a key focus of the program, to avoid local suppliers becoming dependent on the operation. So far, the response among local people has been mostly positive, and more than US $110 million in contracts has gone to businesses in the local region.

10. MANAGEMENT OF SOCIAL ISSUES

The International Finance Cooperation (Campbell, 1998) has defined "Public consultation" as follows:

> "Public Consultation… is a tool for managing a two-way communication between the project sponsor and the public. Its goal is to improve decision-making and build understanding by actively involving individuals, groups and organizations with a stake in the project. This involvement will increase a project's long-term viability and enhance its benefits to locally affected people and other stakeholders."

Consultations

Increasing emphasis has been placed on early and continuing consultation with potentially affected stakeholders during the life cycle of a project in as transparent a manner as possible. Consultation is now a major component of most major development projects, and is mandated as part of the environmental planning process by many lenders and governments. It is the principal method to engage stakeholders, form partnerships, and develop trust and respect within affected communities. Open and frank discussion is required for successful consultation.

Dealing with Resource Boomers

People who have settled in an area either for employment on a project or to provide additional services usually remain after their jobs are finished, and often well after the operation has ended and leaves the area. When economic activity generated by a company disappears, people often depend even more on natural resource extraction, such as increased clearing of land for agricultural activities, timber, and hunting. For example, at the peak of project labor demand, during the construction phase, thousands of workers may be needed. However, this need for labor rapidly diminishes in the operational phase, leaving many people who moved to the area without a ready source of income. This calls for stakeholders to plan for life after the project. Diversification of the economy is one alternative.

Role of Development Partners

Development of major petroleum projects involves a partnership of multiple entities. This may create challenges associated with management of social issues.

Project Partners Include:

- Foreign governments;
- State-owned and operated petroleum companies; and

- Other privately and publicly held national and international petroleum companies (Tullow PLC, China National Offshore Oil Corporation [CNOOC], and Total, for example).

In these partnerships, negotiation and achievement of common ground related to implementation of social issues are important. Issues for consideration include:

- Alignment of partner social policies and plans;
- Approaches to resolving differences in applicability/types of commitments;
- Evaluation of historical and cultural approaches/actions;
- Assessment of human resources and capabilities of participating partners/governments;
- Identification of risks associated with assignment of project development-operatorship to partners; and
- Possible inclusion of descriptions of social issues and goals in construction scope of work and other technical bids, including perhaps a description of social management issues that might affect project bid costs, such as:
  - Reporting requirements;
  - A requirement for intensive local hiring practices; and
  - In cases where a contractor may have multiple options (e.g., housing workers in camps versus field camps), evaluations of costs of all options should occur because one may exert more significant effects on local communities. To the extent these options might necessitate adverse costs to implement, mitigation measures should be considered as part of the overall evaluation.

Local Communities

Local communities may be affected either directly or indirectly by project activities, and may have a particular interest in project planning and implementation. In some cases, regulations may determine how the company will interact with local communities. Early and continuing interaction with local communities is important to identify and address their concerns and needs, and manage expectations and project commitments. Communities in the project area may have differing characteristics, objectives, and requirements that must be considered. Community support is critical to success. Typically, it is important for communities to give free, prior, informed consent (FPIC).

The Role of Governments

Most projects involve some type of government regulatory review and oversight. The nature of this interaction will vary considerably depending on the type of project and applicable regulatory framework. Regulatory requirements relating to consultation, and social and economic impacts of projects differ substantially in different countries because of variations in:

- Legal bases;
- Implementing regulations;
- Oversight institutions;
- Enforcement standards; and
- Land ownership and acquisition.

International oil and projects must consider applicable laws and regulations of both the host and home countries because some policies and practices of national and local governments do not align. Government policies and practices may sometimes limit ability of companies to implement social policies. Government policies not directly applicable to a project may influence the manner in which a company addresses mitigation of social impacts. For example, governments may have preexisting policies encouraging settlement of rural and previously inaccessible areas. When petroleum projects are developed in these areas, governments may require companies to construct permanent roads to encourage people to settle there, creating project-induced spinoffs. Additionally, government and lender requirements may not align. Such differences might be addressed early in the project planning phase.

The Role of Indigenous and Native Peoples Authorities

In some countries, recognized native governments and land holding indigenous groups have developed regulatory and consultative procedures to address social impacts (notably, the indigenous debate is ongoing in Uganda). In other cases, national laws or regulations may exist, but are not implemented, especially by local governments in remote locations.

In either case, lenders such as the World Bank may give special consideration to these groups. Some national governments take exception to practices that afford special recognition and treatment of indigenous/vulnerable peoples and or ethnic/religious groups. That a group may be given special consideration as an indigenous vulnerable group by lenders (such as the World Bank) is often a source of government concern. This can create a perception that all citizens are not treated equally, and perhaps even violate the country's own laws and declaration of human rights.

Many companies are now developing projects in areas where they have not worked before. As a result, a plan for understanding the social environment of the project and transparent consultation to align various interests is necessary.

Role of Lending Agencies

Lending agencies may participate with governments and/or companies in projects, and will have their own objectives and requirements relating to assessment and management of social issues. In recent years, social issues have become a high priority for them. For example, the primary goal of the World Bank is alleviation of poverty. Both the World Bank and the IFC have had mandatory environmental and social "do not harm" policies in place since the early 1980s. The World Bank has developed extensive policy directives, guidance documents, reports, and publications related to social and environmental assessment as part of the project developing process. Where mandatory requirements apply, compliance with these is required at all stages of the project life-cycle.

Role of Nongovernmental Organizations

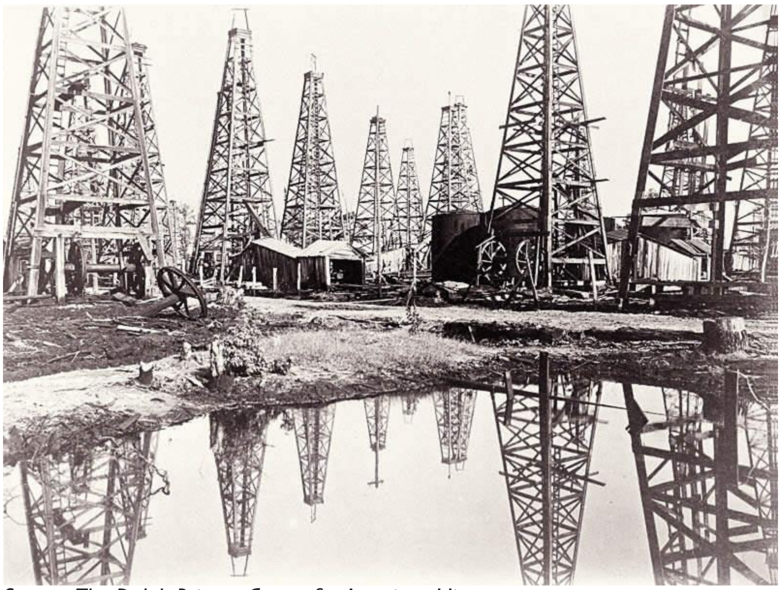
Directly or indirectly, NGOs may seek to influence project development through public information campaigns and direct interactions with policy makers, other stakeholders, and companies. NGOs offer a range of expertise in identifying, evaluating, and addressing social issues. Therefore, opportunities for positive interactions and partnerships between companies and NGOs are plentiful. Regarding Uganda, several multi-skilled and specialist NGOs are currently working under the Civil Society Coalition on Oil and Gas (CSCO) network to promote good governance in the extractive industries sector.

11. POSITIVES FROM ADDRESSING SOCIAL ISSUES: CASE STUDY OF TEXAS

Boomtowns

The spectacular fortunes made in the oil business drew thousands of people to the Texas oil fields and nearby towns called boomtowns because they grew along with economic booms. The towns were crowded, dirty, and rough places.

FIGURE 2.1: TEXAS OIL INDUSTRY IN 1901



Source: The Dolph Briscoe Center for American History

Texans arrived at these towns seeking work in the oil industry. Oil field workers lived in tents or wooden shacks. The dirt streets of the town became rivers of mud when it rained. Above all, boomtowns were busy places where people were trying to make money.

The Automobile and Petrochemical Industries

Oil companies grew at a time when electricity was rapidly replacing kerosene for lighting homes. Fortunately for oil producers, new uses for petroleum were being discovered.

At the time, oil was cheaper than coal, and it quickly replaced coal as fuel for steam engines. Use of automobiles with internal combustion engines was also increasing. These engines use gasoline, and oil by-products.

Scientists continued to develop new uses for petroleum. Petrochemicals made from petroleum became an important part of the Texas economy. Petrochemical products include synthetic rubber, plastics, and carbon black, which is used to make ink, tires, and other products.

Social Effects of the Oil Boom

The oil boom attracted many young farm workers to jobs in the oil fields. Most drilling and production jobs were reserved for white workers. Despite facing discrimination in the oil fields, African American and Mexican American workers found jobs as teamsters, and hauled goods to and from the oil fields. Many oil workers travelled from town to town as they followed new oil strikes

Effects of the Oil Boom

The oil boom affected Texas politics and the environment. State officials began to pass restrictions designed to control parts of the oil industry. The legislature passed laws regarding abandoned wells and protection of groundwater from oil pollution. Twenty years later, the legislature made it illegal to waste oil and natural gas.

In 1917, the legislature gave the Texas Railroad Commission, an agency originally created to regulate the railroads, authority to enforce laws concerning the petroleum industry. The commission set standards for spacing between wells and for pipeline transport of petroleum. These rules helped prevent over drilling.

The state government also began collecting taxes on oil production in 1905, taking in more than $101,000 in taxes that year. By 1919, taxes collected from oil production rose to more than $1 million. This money helped fund the state government and education programs for Texas children. Higher education in Texas also benefitted from the State's oil production.

Impact on Education

In 1876, Texas also set aside 1 million acres of land in West Texas for the Permanent University Fund. Texas universities received money from sale or use of this land. Santa Rita #1 oil well struck oil in 1923, and the income went into the Permanent University Fund of the Texas A&M University and the University of Texas systems who continue to share the money in this fund.

Texas also benefitted from oil producer's philanthropy—contributions of money or gifts. Hugh Roy Cullen gave large gifts to the University of Houston and the Texas Medical Center.

Other oil producers gave generously to the arts in Texas. John and Dominique de Menil established a collection of more than 10,000 works of art for public display.

Oil producers have provided many jobs and spurred related industries in Texas.

12. CASE STUDY OF NIGERIAN (NEGATIVE SOCIAL IMPACTS) SUBSIDIES

Nigeria exemplifies a model of a nation plagued with the Resource Curse. The multifarious actors in its petroleum industry pursue self-interested incentives that diverge from the public interest, supporting the finding that development is more a political rather than a technocratic process (Brown, 2009). Given these multiple actors and their conflicting interests, reforms and policies will likely succeed if engagement is embedded in the political economy of the country (Brown, 2009). Structuring reforms that recognize the actors, and their incentives, linkages, and influences, could help Nigeria and many other resource-cursed nations' progress toward improved, transparent, accountable, and efficient production, management, and distribution of natural resource wealth.

The political economy approach therefore offers a new strategy that can provide some hope. Brown (2009), however, warns that ability to analyze actors, and their incentives, linkages, and so on, does not necessarily result in clear recommendations or successful reforms if not properly conducted.

Participants will watch a Nigerian documentary on oil subsidies and follow it up with a practical handout exercise of identifying key actors and factors that influence policy making in Nigeria's petroleum industry. This is designed to enable them to identify overlapping issues and genesis of social impacts in the petroleum industry. These issues are centered around:

- Poor legislative infrastructure;
- Overbearing influence of the Nigerian National Petroleum Corporation (NNPC);
- Lack of accountability and transparency;
- Unenforceability of laws;
- Subsidy on imported refined products; and
- Resource control: demands of the Niger Delta community-based organizations (CBOs), ex-militants, resource nationalism, illegal exploitation of oil, etc.

Sources of Rules

1. Principles of environmental and social rights;
2. Tools for fulfilling environmental and social rights;
3. Applicable standards;
4. Using the tools successfully; and
5. Emerging issues.

Instruments for Enforcing Environmental and Social Protections

- Contract provisions with the Model Production Sharing Agreements (PSA) (2012 of Uganda);
- National laws (upstream, midstream laws now in place)—e.g., water laws protect basic human needs; ownership;
- Constitutional provisions;
- Lender standards: IFC-Performance Standards (PS), Environmental Protections (EP);
- Associations of companies: International Council on Mining and Metals (ICMM), International Petroleum Industry Environmental and Conservation Association (IPIECA);
- International laws/agreements; and
- Laws and standards of the country where the company is based.

Discussion Notes:

- Even China has adopted the EPs (Ministry of Commerce and Environment. 2013. Guidelines for Environmental Protection in Foreign Investment and Cooperation. February); export credit bank (first Chinese Bank).
- International laws and standards—can you list them?
  - Extractive Industries Transparency Initiative (EITI);
  - United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP);
  - Arhus Convention on Public Participation;
  - Equator Principles;
  - Economic Community of West African States (ECOWAS) Directive on Harmonization of Principles and Policies in the Mining Sector; and
  - … any from your region?
- Lender standards are generally higher than national standards (e.g., IFC PS requires compensation for landowners regardless of whether they have legal title).
- Generally conduct annual visits—ask to meet them.
- PS is a voluntary framework for banks to manage environmental and social risks in project finance, based on IFC's Performance Standards and World Bank Group Environmental, Health and Safety Guidelines first announced in June 2003 with 10 banks. Relaunched as EP2 in July 2006, in line with the new IFC E&S Performance Standards. Currently, more than 65 financial institutions "Equator Principles Financial Institutions" arranging around 90% of global project finance. All projects undergo categorization and social and environmental review. Projects often have a mix of sources of finance so more than one set of standards may apply.
- These are ever progressing.

Who is Responsible for Applying Environmental and Social Safeguards?

- Government;
- Company;
- Community;

- Checks and balances critical! Need effective monitoring but also strong judiciary and legislature; and
- These are inter-ministerial concerns: authorizing environment.

Discussion Note:

Natural resources governance should be intersectoral, not based on sector leadership—should include strong, and multiple levels of government, and multiple actors (including those impacted).

Rules Used Successfully

- Principles of environmental and social rights;
- Tools for fulfilling environmental and social rights;
- Sources of standards;
- Using the tools successfully; and
- Emerging issues.

Tools Used Successfully

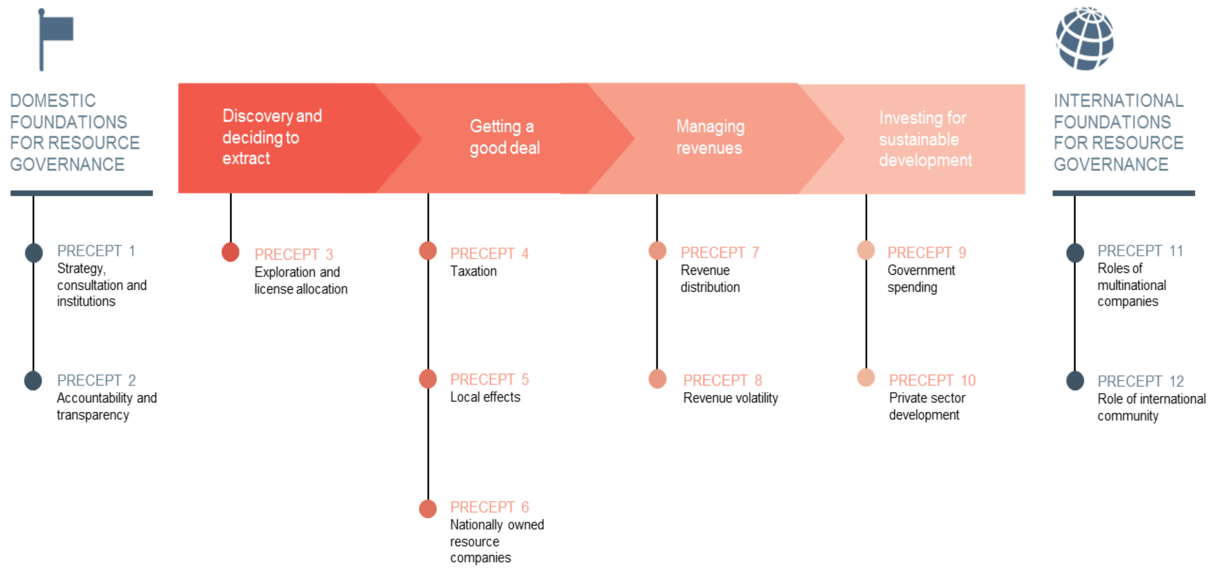
- Leading oil companies have pledged to avoid operating in natural World Heritage Sites.
- Multi-sectoral decision making: HidroAysén mega-dam project in 2014.
- El Salvador froze issuance of all mining licenses to conduct environmental study in 2008.

Case Study

The Chilean Ministries of Environment, Indigenous People stopped a project that would have required three hydro dams in Patagonia and transmission lines across the Andes for mines on indigenous lands.

When should Environmental and Social Impacts be Considered?

FIGURE 2.2: DOMESTIC FOUNDATIONS FOR RESOURCE GOVERNANCE



Source: Natural Resource Governance Institute, 2014

Natural Resource Charter Precepts Discussion

Source: Natural Resource Governance Institute, 2014.

- Precept 1: Long–term strategy, especially important for environmental and social considerations.

  Long-term strategy: Identify critical areas and endangered species; make provision for setting aside areas considered too valuable to harm; maintain clear legal framework and competent institutions.

- Precept 2: Accountable to an informed public—disclose information related to environmental and social issues, and ensure legislative oversight of enforcement with strong judiciary.
- Precept 3: Exploration and production and rights allocation—consider trans-boundary environmental impacts, and establish property rights.
- Precept 9: Public spending—think about environmental and social impacts of large public investment infrastructure projects, and do not move faster than protections, etc.
- Precept 10: Government should facilitate private-sector investments, diversify the economy, and maintain stable environment, including framework to support local content.
- Precept 11: Companies should commit to highest standards.
- Precept 12: Role of international actors—how they can raise the bar.

Discussion/Group Work:

- Are minimization, mitigation, and compensation always enough?
- Is a "social license" really meaningful if it is only question of which project, rather than whether there should be a project?

Strategic Environmental (and Social) Impact Assessment

It is important to take a comprehensive view of resources and look at project-specific impacts.

Discussion Notes:

- Other procedural steps give a more equal chance to consider whether, and how, to proceed, and not just to adjust a project at the margins.
- Death by a 1,000 papercuts.
- Is there a philosophical question of the value of some environmental and social impacts (whether they are tradable/have an objectively determinable price)?

Environmental and Social Reasons Not to Develop a Deposit?

- Primary forests;
- Biodiversity hotspots (i.e., those listed by International Union for Conservation Network [IUCN]);
- Water-producing regions/tops of watersheds;
- World Heritage Sites – natural and cultural sites;
- Indigenous lands; and
- Conflict zones.

Other Key Policy Options and Recommendations for Consideration

- Active and informed citizen participation;
- Transparency and accountability for revenue transfers from national to subnational governments;
- Integrating companies into public planning;
- Revenue mapping and forecasting;
- Local involvement in supply of goods, services, and workers for companies;
- Smoothing expenditures and generating sustainable returns;
- National regulations for improved state and local government action; and
- Consulting and involving local communities in the Albertine Graben.

Recommended Case Study: the Ogoni People in Nigeria

Source: United Nations Department of Economic and Social Affairs, 2007

Introduction

"Crude oil has more profoundly impacted world civilization than any single natural resource in recorded history. Oil has become a very decisive element in defining the politics, rhetoric, and diplomacy of states. This fact is adumbrated in a public lecture entitled "Oil in World Politics" delivered by a former Secretary of OPEC, the late Chief M.O. Feyide, when he asserted that "All over the world, the lives of people are affected and the destiny of nations is determined by the result of oil explorations. Oil keeps the factors of the industrialized countries working and provides the revenues, which enable oil exporters to execute ambitious national and economic development plans. The march of progress would be retarded and life itself would be unbearable if the world is deprived of oil. That is why oil has become the concern of governments, a vital ingredient of their politics, and a crucial factor in the political and diplomatic strategies" (Feyide, 1986). Yet behind this deification of oil, nothing is said about its impact on the environment."

"Nigeria joined the league of oil-producing nations on August 3, 1956, when oil was discovered in commercial quantities and today ranks as the leading oil and gas producer in Africa and the sixth largest oil exporter in the world. Nigeria is also Africa's most populous nation with 140 million people, as announced for the recently conducted National Census in 2006. As oil was struck in commercial quantities in Nigeria, it also signaled the beginning of a profound transformation of Nigeria's political and economic landscape. Since the 1970s, oil has accounted for 80% of the Nigerian government's revenue and 95% of the country's export earnings. Interestingly, all of Nigeria's oil and gas resources come from its Niger Delta region occupied by a mosaic of indigenous nationalities."

"The Niger Delta sustains the largest wetland in Africa and one of the largest wetlands in the world, (Human Rights Watch, 1999). The Niger Delta encompasses a total landmass of approximately 70,000 square kilometers with the third largest mangrove forest in the world, a most extensive fresh water swamp, coastal ridges, fertile dry land forest, and tropical rainforest characterized by great biological diversity. Seasonal flooding and sediment deposits over thousands of years have made the land fertile. The innumerable creeks and streams have in the past, provided habitat for an abundance of fish and marine wildlife. Today the Niger Delta is home to approximately 20 million people grouped into several distinct nations and ethnic groups, among which is the Ogoni."

Background

Source: Pyagbara, 2007

"The Ogoni people are a distinct indigenous minority nationality living within an area of 404 square miles (about 100,000 square kilometers) on the southeastern fringe of the Niger Delta River in what is geo-politically referred to today as the South-South of Nigeria (Wiwa, 1993)."

"As an indigenous people, the Ogoni had a well-established social system that placed great value on the environment before the advent of British colonial rule. Living on a fertile alluvial soil and blessed with a necklace of rivers and creeks, the Ogoni people seized the opportunity presented by these resources to become great fisher folks and farmers, producing not only for their own subsistence but also for their neighbors in the Niger Delta. Their land was appropriately referred to as the "Food basket of the Niger Delta." They created a system of agriculture, and their traditional means of livelihood ensured sustainable management and sustainable exploitation of natural resources. Socio-culturally, the Ogoni people live in closely knit communities and were more endogenous."

"The Ogoni people have a tradition and custom deeply rooted in nature, and this helped them protect and preserve the environment for generations. They view the land on which they live and the rivers that surround them not just as natural resources for exploitation but as a setting with deep spiritual significance. "Land is viewed as the abode of our ancestors from where they oversee our lives; it is also a god and we revere it as such (Institute of Human Rights and Humanitarian Law, 2000). This respect and reverence for land also means that forests are not merely a collection of trees and the abode of animals but also, and more intrinsically, a sacred possession. Therefore, trees in the forests cannot be cut indiscriminately without regard to their sacrosanctity and their influence on the wellbeing of the entire community. Some animals are not to be killed because they are said to be totems—animations of the spirit of somebody—and if one kills them, something disastrous will occur."

"Similarly, rivers and streams apart from serving as sources of water for life are also intricately bound up with the life of the community, and are not to be desecrated by oil pollution, etc. Thus, the Ogoni people believe in a dynamic interaction among men and women, animals, plants, and so on."

"The Ogoni people understood natural rights over the years, and believed that every person has to take action to protect those natural rights—rights to lands, rights to nature, etc. Grave consequences follow any erring human conduct or action desecrating the environment, and failure by the custodial community to take action to protect the environment from desecration attracts the wrath of the gods, which afflict the community with disaster. The pre-colonial social system therefore ensured sustainable exploitation of natural resource and protection of biodiversity. Most of these practices still exist, and this explains why the Ogoni people are unanimous about decisions regarding their environment. To them, their lives are intrinsically bound with survival of the environment. This also explains why the Movement for the Survival of the Ogoni People (MOSOP) recorded a phenomenal success in mobilizing the Ogoni people to stand up against denigration of their environment in the early 1990s."

Oil Discovery, Oil Pollution, and Ogoni

Source: Pyagbara, 2007

"Oil was discovered in the Ogoni territory in early 1957 when Shell found oil in the Ogoni community of K-Dere popularly and mistakenly called the Bomu Oil fields (Pyagbara, 2005). Subsequently, Shell made more discoveries in other Ogoni communities including Ebubu, Yorla, Bodo West, and Korokoro. Shell Petroleum Development Company is the sole player in the oil extractive industry in Ogoni, having secured the Oil Mining License (OML) covering the entire Ogoniland."

"At last count, Ogoni has five major oil fields with 110 oil wells, hooked up to five flow stations at Bomu, Korokoro, Yorla, Bodo West, and Ebubu by a necklace of interconnecting pipelines that criss-cross Ogoni villages. Gas has been flared for 24 hours a day for 40 years in close proximity to human habitation at 19 oil locations within a 404-square-mile area with population density of 1250 per square mile—this without due regard for negative impacts of such activities on people and the environment. Until now, no EIA study in Ogoni has occurred."

"Unfortunately, the history of oil exploitation in Ogoni is like the history of oil pollution, as commencement of oil exploration and exploitation was followed almost immediately by the three major causes of oil pollution: the seismic survey, gas flaring, and oil spills."

What is Pollution?

Source: Pyagbara, 2007

The word "pollution" has various meanings. However, under Nigerian law, Section 41 of the Federal Environmental Protection Agency Act Cap. F10 Laws of the Federation 2002 defines pollution as

"Man-made or man aided alterations of chemical, physical or biological quality of the environment to the extent that is detrimental to that environment or beyond acceptable limits."

Regarding oil pollution specifically, "oil pollution occurs when the above happens as a result of, or in the course of the extraction, storage or transportation of petroleum oil. It can be seen as the release of contaminants or pollutants associated with the extraction of crude oil into the environment."

Sources of Oil Pollution.

Source: Pyagbara, 2007

In Ogoni, three main sources of oil pollution have been identified:

- Oil spills,
- Gas flares, and
- Effluent and waste discharges.

Oil Spills

Source: Pyagbara, 2007

"In Ogoni, between 1993 and mid- 2007, 35 incidences of oil spills were recorded. This is aside from the unnoticed slicks and unreported cases of oil spills. Major causes of the spills in Ogoni include pipelines and flow lines leakage/blowouts, blowouts from well-heads due to poor maintenance, and damage and spills from flow stations."

"As stated earlier, oil spills involve release of dangerous hydrocarbons such as benzene and polynuclear aromatic hydrocarbons into soil and water sources. These spillages affect vast stretches of land and waterways, thus polluting not only crops but also marine life and the sources of water for domestic uses. Mangrove forests are particularly vulnerable to oil spills because soils soak up the oil like sponges and re-release it every rainy season. Moreover, oil prevents lenticels of the mangrove from absorbing oxygen, and hence oxygen starvation results. The mangrove withers and dies in large numbers due to oil spills."

"As a spill occurs, it spreads onto farmlands and waterbodies. The toxic crude seeps into the grounds and is taken up by the roots of plants. Recent studies have shown that oil spills lower soil fertility and cause poor growth of plants."

Gas Flares

Source: Pyagbara, 2007

"Oil production involves burning of hydrocarbon gases. Flaring off of natural or associated gas is a by-product of drilling of crude oil from reservoirs in which oil and gas are mixed. One hundred percent of the gases were being flared, resulting in pollution of the area. This rendered the Ogoni area one of the most polluted areas in the world. In the Ogoni area, the impact of gas flares on local ecology and climate, as well as peoples' health and property, is evident."

"The flares release into the atmosphere dangerous hydrocarbons, mostly methane and others that include sulfurous oxides and the oxides of nitrogen. The flares raise the temperature of the surrounding environment to temperatures beyond normal of 13-14,000 degrees Celsius and cause noise pollution around the vicinity of the flares. The result of this unchecked emission of gases has been release of 35 million tons of carbon dioxide and 12 million tons of methane, which means that the Nigerian oilfields contribute more to global warming than all the rest of the world (Institute of Human Rights and Humanitarian Law, 2000)."

"Another problem associated with gas flaring is light pollution. Light pollution subjects the living organism around the vicinity of the flare to 24-hour daylight. This affects diurnality and night-time patterns in animals. The flares drive away game, affect reproduction of fish, and send fish to deep sea areas. Gases released during gas-flaring mix with moisture and other forms of precipitation in the atmosphere to form acid rain."

Effluent and Waste Discharges

Source: Pyagbara, 2007

"Another source of oil-related pollution is discharge of effluents into the surrounding environment, sometimes into water, by oil companies. For instance, during exploration or seismic surveys by oil companies, drill cuttings, drilling mud, and fluids are used for stimulating production. Moreover, chemicals are used during seismic activities. The major constituents of drill cuttings such as baryotes and bentonitic clays, when dumped on the ground, prevent local plant growth until natural processes develop new topsoil. In the water, these materials are dispersed and sink, and may kill local bottom living plants and animals by burying them (African Network for Environmental and Economic Justice, 2004). In addition to pollutants introduced into the environment from exploration and exploitation operations, refinery wastes also have characteristics of potential land, water, and air pollutants. Disposal of wastes into the sea from oil facilities directly affects fish stocks."

Impacts of Oil Pollution on the Environment and Wellbeing of the Ogoni People

Source: Pyagbara, 2007

Oil pollution has impacted the Ogoni community in several ways grouped into three interrelated impacts as follows:

- Adverse impacts on biodiversity,
- Socioeconomic impacts, and
- Physico-health impacts.

Impacts on Ogoni Biodiversity

Source: Pyagbara, 2007

"The most profound and adverse impact of oil pollution in Ogoni, with far-reaching implications for all other aspects of Ogoni traditional lifestyles and livelihoods, has been total loss of biodiversity and destruction of habitats largely due to soil degradation—complete destruction of ecosystems. Mangrove forests have fallen to the toxicity of oil spills and are being replaced by noxious nypa palms; the rainforest has fallen to the axe of oil companies; wildlife and game have been driven away; and farmlands have been rendered infertile with gross violation of the right to adequate food. During oil spills, the process of photosynthesis, which enhances plant diversity, is impaired as spilled crude with its high absorbance property spreads on surfaces of leaves, and the leaves find it difficult to photosynthesize and thus die, leading to biodiversity loss. The toxic crude also affects underground herbs and shrubs, while microbial organisms that form important groups in the food web are also destroyed."

Socioeconomic Impacts

These adverse impacts include:

Nutritional Styles and Food Shortage

Source: Pyagbara, 2007

"One fallout of oil pollution in the Ogoni area is destruction of the traditional local economic support system of fishing and farming. The combination of effects of oil spills and acid rain resulting from gas flaring has degraded soil, thus drastically lowering crop yields and harvests. Fish are driven away from in-shore or shallow waters into deep-sea as a result of flaring—ultimately resulting in poor fish catch (as most fish have been driven into deep waters and the Ogoni people do not have the fishing gadgets to conduct deep-sea fishing). Overall impacts of these developments are food shortage and impaired ability of most families to feed themselves. As a result, Ogoni—once the food basket of the Niger Delta—now fully depends on imported food such as the popular icefish, which has now replaced the traditional fish on the Ogoni menu."

"Thus, oil pollution has impinged on the right to food of the Ogoni people. The African Commission (Decision 155/96, para 66 involving The Social and Economic Rights Action Center and the Center for Economic and Social Rights versus the Federal Republic of Nigeria) stated that the government's treatment of the Ogoni has violated all three minimum duties of the right to food by allowing private oil companies to destroy food sources. Thus, the government fell short of what is expected under the provisions of the African Charter and international human rights standards, and hence, is in violation of the right to food of the Ogoni."

Destruction of Traditional Means of Livelihood

Source: Pyagbara, 2007

"Another implication of oil pollution is that, having destroyed biodiversity, it has also rendered the agricultural sector (the largest employer of labor in Ogoni) unprofitable. Hence, most of the youth and women have become jobless because their local economic support system of fishing and farming is no longer sustainable."

"An example is the mangrove-abundant Ogoni community of Bodo, where livelihoods of local people had been sustained by living in the midst of a once healthy and productive mangrove forest, and fishing and farming. They gathered mangrove wood for building and for local energy and fuel. However, incessant oil spill incidences coated the breathing roots of this plant with oil, killing off parts of the mangrove forest and animals and marine life depending on it. This mangrove forest, which served as habitats for fish and mollusks, as well as a source of raw materials for communities in Ogoni, has been lost to the ravages of oil pollution. The land, the sea, and the environment can no longer support subsistence of this local Ogoni community, as had been the case for thousands of years."

Migration and the Rise of Environmental Refugees

Source: Pyagbara, 2007

"Socio-culturally, the Ogoni people live in closely knit communities and are more endogenous. The Ogoni people were not used to mass outflows/movement from their territory, as their subsistence economy provided them with their basic needs. To the average Ogoni, movement from the area, considered a place of abundance, into alien lands meant subservience, poverty in the new area, and loss of pride and self-esteem. This indeed was the situation before economic consideration led to intervention of oil exploration and exploitation by Shell Petroleum Development Company (SPDC), which resulted in a complete change in the socio-economic landscape of Ogoni. Oil pollution has resulted in destruction of the Ogoni environment, rendering land unsuitable for the traditional economic livelihood patterns that once thrived in the area. As a result, many Ogoni women and youth emigrated out of the area into cities, especially to Port Harcourt where they have become environmental refugees (Pyagbara, 2004), and because of their poor economic status, have had to take up accommodation in shanties, slums, and waterfronts with the attendant risks (especially violations of rights protection). In recent times, these slums have been undergoing demolitions by government."

Impact on Cultural Values and Spirituality

Source: Pyagbara, 2007

"Oil spills and gas flares know no boundaries, so these also have exerted adverse impacts on cultural values and social harmony. One of the most telling effects of oil pollution on the Ogoni community has been death and possible extinction of medicinal plants and herbs central to Ogoni traditional medicine, and with deep spiritual significance to the community. This degradation resulted from presence of most of these herbs and plants in sacred grooves, shrines, and forests destroyed by oil exploitation and the toxicity of oil pollution."

"Interesting in this regard is that Nigerian law precludes a licensee of an oil mining lease from exercising that mining lease where, inter alia, the land is a sacred forest (Paragraph 17 of the Petroleum Drilling and Production Regulations Cap P10 Laws of the Federation 2002). However, some oil companies routinely flout this with impunity."

Impact on Traditional Institutions of Authority and Social Harmony

Source: Pyagbara, 2007

"Customs and traditions of a communal lifestyle of the Ogoni people have been largely replaced by a rugged individualism fostered by the effects of oil pollution. This has been particularly evident in loss of respect for Ogoni elders. By Ogoni tradition, elders have authority to act as custodians of the community and its protectors in times of stress and inconvenience, such as during oil spills and other environmental incidents. The traditional system ensured that no single individual had the right to take what belongs to the community for himself or herself. However, with arrival of the oil companies, a new level of relationship evolved between the oil companies and the elders. Led by the traditional rulers, elders now regard their community people as subjects and themselves as "big men" because of the largesse and special treatment accorded to them by oil companies (as individuals rather than representatives of the communities), thus alienating them from the people. The result is that in times of distress or oil pollution (oil spills and fire conflagrations), most elders now think of themselves first and collect monies and other compensation from the oil companies, or they form companies in order to front themselves for contracts to conduct "cleanup exercises," which are actually euphemisms for "coverups." Rather than acting as protectors of the people, most elders are now seen as collaborators with the oil companies, thereby eroding community respect for their status, and resulting in conflict between them and the youth. In this way, the previous social harmony has been broken and discord has ensued."

Physico-health Impacts of Oil Pollution

Destruction of Zinc Roof

Source: Pyagbara, 2007

"One of the increasing socioeconomic costs to most Ogoni communities resulting from oil pollution is rapidity of corrosion of zinc roofs. Houses with zinc roofs close to the location of flare stacks become corroded within two years. In other areas, zinc roofs last for at least 10 years. This common trend also occurs in other parts of the Niger Delta where oil extraction proceeds (Clark et al., 2000). This zinc corrosion has added another dimension to the increasing socio-economic costs to the Ogoni people. It is common knowledge that acid rain oxidizes zinc to form zinc oxides. This has led Ogoni homeowners to resort to purchase of expensive asbestos with its obvious potential health hazards."

Effects of Oil Pollution on Health

Source: Pyagbara, 2007

"The most worrisome aspect of oil pollution in Ogoni is increasing occurrence of certain ailments previously unknown in the area. A correlation has been reported between exposure to oil pollution and development of health problems (Olusi. 1981). A recent research report released by a group of scientists from the Faculty of Pharmacy, University of Lagos, conveyed that results from water samples collected from the sea, river, bore holes, lagoons, and beaches in the Niger Delta region (especially in Delta and River States) indicated that more than 70% of the water in the Niger Delta contains a chemical called benzo(a)pyrene, at high concentration of 0.54 to 4 micrograms per liter—far above the World Health Organization (WHO) recommended health standard of 0.7 micrograms per liter for drinking water (*Nigerian Quarterly Journal of Hospital Medicine*. 2004. Volume 14. July-December). The report further asserted that if the level of harmful chemicals could be this high in ordinary water, sediments on which fish and other aquatic creatures feed are definitely higher in benzo(a)pyrene concentration, and people depending on these marine creatures for food thus ingest much higher levels of this cancerous chemical. This report is consistent with experiences among the Ogoni within the past 30 years who have witnessed an increase in occurrence of cancer and other respiratory problems traceable to oil pollution in the area. Other diseases include respiratory problems, skin ailments such as rash and dermatitis, eye problems, gastro-intestinal disorders, water-borne diseases, and nutritional problems associated with poor diet."

Effect on Groundwater

Source: Pyagbara, 2007

"A serious threat posed by oil-related pollution is impact on groundwater. When oil spills or when an effluent discharge or acid rain occurs, oil seeps into the ground and mixes with groundwater. Polluted groundwater requires many years to recover its original non-polluted condition. Yet this underground water moves into streams and wells that are the only sources of local water supply in the community, thus resulting in increased incidence of water-borne diseases. This has affected the traditional relationship of the Ogoni people with water, as a palpable fear grips the people that rather than the source of life, these water systems have become sources of misery, disease, and death."

Conclusion

Source: Pyagbara, 2007

"The externalities of oil extraction have resulted in profound adverse impacts on traditional lifestyles and livelihood patterns in the Ogoni community where unchecked oil exploration and exploitation have occurred for the past 40 years. The oil companies have not in any way helped matters, as they continue to flout environmental regulations in their areas of operations and pay less attention to environmental protection regimes that would have helped abate oil pollution. The government on its part has not shown any commitment to enforcing the minimal environmental laws which it created. A case in point is the government regulation that forbids exploitation of oil in sacred lands, which is routinely flouted without any government intervention on behalf of the community. To abate these adverse effects of oil pollution on the Ogoni community, oil companies and the government should show more commitment to application of abatement procedures and to environmentally sound and cleaner technologies for oil exploration and exploitation."

Recommendations

Source: Pyagbara, 2007

- "All draconian laws concerning oil, gas, and land-use that exclude indigenous peoples from participation in control and use of their resources should be abrogated or amended. The 1978 Land Use Act and the 1969 Petroleum Act (in Nigeria) should be repealed immediately, as recommended by the Committee on the Elimination of Racial Discrimination (CERD). The government should take urgent steps to restore the right of communities to some measure of control over their resources."
- "A multi-stakeholder approach to oil exploration and exploitation should be put in place involving the triad of government, oil companies, and host communities. The multi-stakeholder mechanism should address issues of biodiversity, conservation, and regeneration."
- "Oil and gas matters currently on the exclusive legislative list should be removed and placed on a concurrent list to enhance partnership and collaborative decision-making involving the oil companies, government, and host communities. This will provide more choices for the people."
- "The government of Nigeria should muster the political will to exact stricter respect for environmental laws and regulations by oil companies, and establish a penalty plan requiring oil companies whose activities cause excessive pollution or are ill-equipped to forfeit their licenses. "
- "Oil companies should be made to pay greater respect to implementation of judicial pronouncements on their activities. A case in point is the recent judgment by a Federal High Court in Nigeria that all oil companies in Nigeria should stop gas flaring."
- "An insurance fund against oil pollution should be established by the government and the oil companies. This fund would cover all socio-economic costs resulting from oil pollution."
- "A rapid oil spill response mechanism should be established by the government and oil companies, committed to response to communities in distress as a result of oil spills."
- "The government should require oil companies to provide all necessary social infrastructures before commencement of oil exploitation so their operations will not impact the immediate local population negatively."
- "The current compensation regime in Nigeria has to be reviewed for fairness and adequacy to meet emergency needs and concerns of those affected by pollution."
- "The water situation in Goony and the Niger Delta should be declared a national emergency requiring massive investment in provision of alternative water supplies."
- "As required by Article 8f of the Convention on Biological Diversity, the government and Shell Petroleum Development Corporation (SPDC) should embark on massive rehabilitation and restoration of the degraded Ogoni ecosystem, and promote recovery of threatened species. To this end, the Nigerian government, as a signatory to the Convention, should meet its obligation under the Convention by embarking on an environmental audit of Ogoniland, as recommended by the Secretary-General's Fact Finding team to Ogoni in 1996."
- "Multilateral donors and other development actors should design an operational policy guideline that could provide the basis for helping Nigeria and other countries integrate environmental concerns and indigenous rights in their national development policies."

13. CONFLICTS

Genesis of Conflict in Petroleum Development

Because of mismanagement of petroleum industries, relations with communities have often deteriorated into competition/conflict over space and resources among governments, international oil companies

(IOC), and local resource host communities. Most conflicts have involved a wide range of issues regarding surface uses and sub-surface access rights; land, subsoil, or territorial concerns over disturbances of existing livelihoods; concerns pertaining to governance; concerns about supply of crude petroleum and impacts on peoples' livelihoods; concerns regarding who is entitled to benefit; a sense of invasion; fears at the state level about running out of crude; peak theory debate; geo-political competition over finite hydrocarbon resources as finite resources; outright market competition (OPEC vs. gas frackers in the United States); and United States versus Russia regarding Ukrainian strategic location to European energy markets.

Information Symmetries: Power Difference

- Exploration;
- Concessions given without community knowledge, consultation, and participation;
- Limited knowledge of communities' rights and company obligations;
- Understanding the scientific perspective of oil exploration and development; and
- What happens to revenues collected for the crude.

Participation Issues

- FPIC – consultation/engagement,
- Who should participate?
- Conflicts over drawing boundaries
- Should participation be defined?
- Proximity to petroleum deposits,
- Drainage basin, and
- Territorial integrity between states and subnational political enclaves.

The Natural Resource Curse or the Paradox of Plenty

- Dutch Disease;
- Enclave economies;
- Underinvestment in education;
- Poor political institutions:
    - Disincentive to develop broad-based tax systems;
    - Cronyism/kleptocracy;
    - "Rent seeking"; and
    - Long-lived authoritarian regimes.
- Civil strife and war.

The Dutch Disease

The term was coined in 1977 by an economist to describe the decline of the manufacturing sector in the Netherlands after discovery of a large natural gas field in 1959 (*The Economist*. 1977, 82-83). The "Dutch Disease" refers to the apparent relationship between the increase in exploitation of natural resources and concurrent decline in a country's manufacturing sector, leading to a "two-speed" economy. The booming resource sector draws productive resources, particularly labor and capital, away from the rest of the economy, and the rest of economy (agriculture, service sector, manufacturing, retail, education, etc.) languishes, losing labor, capital, and income from lack of export income. The mechanism for this is increased income generated by sales of natural resources strengthening the nation's currency.

The Dutch Disease proceeded in the Netherlands in two stages:

- Stage 1: During the Dutch boom, appreciation of the Dutch currency, combined with enhanced competition for labor and capital, induced decline in the Dutch manufacturing sector and increase in Dutch unemployment (Gruen, 2011).
- Stage 2: Following exhaustion of the Dutch boom, in the post-boom economy, the real exchange rate returned to pre-boom levels but the manufacturing sector could not recover to its pre-boom levels of activity because of exit of some significant firms from the manufacturing sector and loss of specific skills in the manufacturing sector.

Thus, a short-lived boom such as exploitation of a natural gas field might cause longer term and possibly irreversible harm to an economy, leading to internal economic war.

TABLE 2.1: RECENT CIVIL WARS IN OIL- AND MINERAL-DEPENDENT STATES

Country	Duration
Algeria	1991-2002
Angola (UNITA)	1975-2002
Chad	1975-1982
Colombia	1984-present
Congo, Republic	1997-1999
Indonesia (Aceh)	1986-present
Iraq	1974-1975, 1985-1992, 2003-present
Liberia	1989-1995
Nigeria	1967-1970, 1980-1984
Papua New Guinea	1988-2003
Sierra Leone	1991-2002
Sudan	1983-present
Yemen	1986-1987, 1990-1994
	Source: Karl, 2008; Ross, 2008

Fighting for Oil: Energy Conflicts and Wars

At first glance, the fossil-fuel factor in the most recent outbreaks of tension and fighting in the Middle East may seem less evident. However, a closer look reveals that each of these conflicts is, at heart, an energy war and a struggle to control energy markets. The following is a list of most petroleum-resource-linked conflicts and wars over the last 100 years:

- 1872: Rockefeller took over 22 of his competitors (the Cleveland "Massacre") to increase Standard Oil share of market to 25%.
- 1924: Teapot Dome scandal—political manipulation in providing "friends" with the right to develop the U.S. Naval Oil Reserves resulted in resignations of the Secretary of the Interior (Albert Fall) and Secretary of the Navy (Edwin Denby).

- 1939–1945: World War II – control of oil supply from Baku and Middle East played a huge role in the events of the war and the ultimate victory of the Allies. Cutting off the oil supply considerably weakened Japan in the latter part of the war.
- 1956: Suez Crisis – Britain, France, and Israel attempted to regain control of Suez Canal.
- 1959: Natural gas discovered in Groningen Field, Netherlands. Origin of the Dutch Disease.
- 1967: Six-day War between Israel and the Arab world. Suez Canal closed.
- 1969: Qaddafi seizes power in Libya.
- 1969: Santa Barbara oil spill six miles offshore from Summerland, California. Induced major backlash against industry.

Assignment: Complete this history to 2010.[4]

The Iraq War

To claim the 2003 Iraq war was driven by oil may be an over-simplification. However, in so far as all wars are bankers' wars, and the U.S. dollar's global reserve status is underpinned by oil (and U.S. access thereto), oil is a significant factor in wars of the 21st century.

Oil Price Supply Shocks

Oil prices are volatile. Some firms use oil in their production processes, and others use end products made from oil. If oil prices rise unexpectedly, cost of production increases for these firms, while energy utilities that burn oil to generate electricity undergo cost increase as well, resulting in higher electricity prices. Rising oil prices lead to higher gasoline prices, increasing all transportation costs.

Oil-Production-Related Conflict and Price Supply Shocks

When firms face higher operating costs, they supply the same quantity at higher price, and the short-run aggregate supply (SRAS) curve shifts to the left. An unexpected event that causes this shift is known as a supply shock—if the event is oil-related, an oil price supply shock. Previous sources of oil price supply shocks have been:

- OPEC;
- Political events in an oil-producing country; and
- Natural disasters: Hurricanes (e.g., Katrina) or earthquakes.

OPEC

In 1972, the price of crude oil was about $3.00 per barrel. In 1973-1974, OPEC hiked the price of oil, and by the end of 1974, the price of oil had quadrupled to over $12.00 per barrel5—an oil price supply shock.

OPEC had taken shape between 1947 and 1973, as illustrated below.

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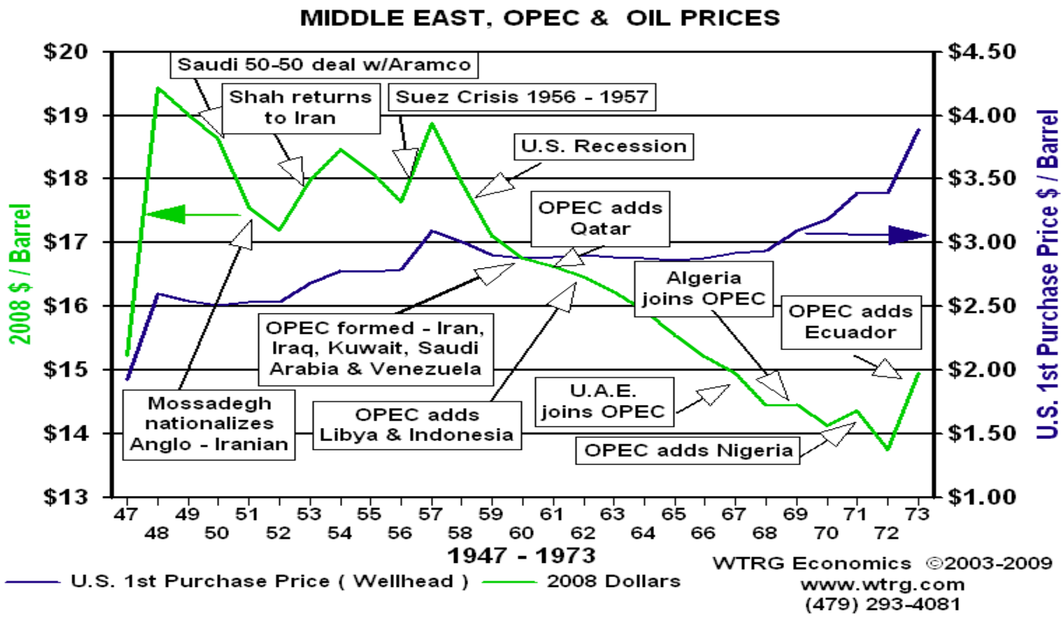
4 See complete history at www.geohelp.net/world.html

5 Available at: http://www.wtrg.com/prices.htm

FIGURE 2.3: OPEC FORMATION AND OIL PRICES FROM 1947-2008



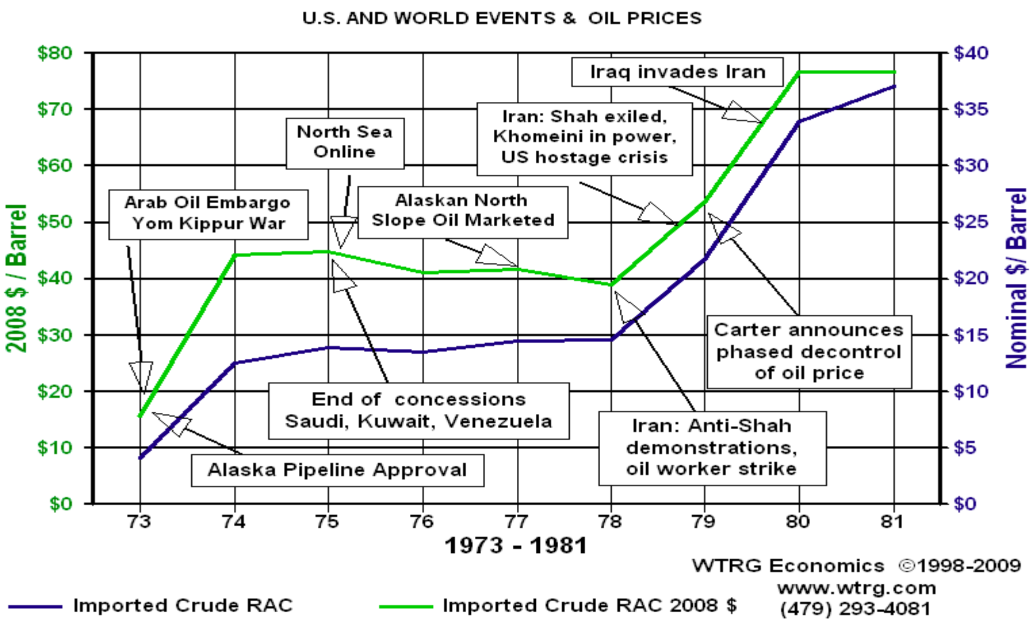
The 1979-1980 Iranian Revolution

The Iranian Revolution involved the overthrow of the Shah of Iran, which severely disrupted the flow of crude oil, causing the price of West Texas Intermediate (WTI) crude oil to increase 250% between 1978 and 1980. A two-speed economy developed in the United States, with oil-producing areas of Texas, Oklahoma, Louisiana, Colorado, Wyoming, and Alaska undergoing an economic boom and large population inflows.

Middle East Political Events between 1973 and 1981

Figure 2.4 shows political events between 1973 and 1981.

FIGURE 2.4: POLITICAL EVENTS BETWEEN 1973 AND 1981



2011 Libyan Political Upheaval and Oil Supply Shock

Before the political unrest in Libya, the price of WTI crude oil was $85.05 per barrel. During the unrest, the supply of Libyan oil was significantly reduced, causing the supply curve to shift to the left (supply during unrest), while concurrently, demand for oil rose because of fear of not enough oil. The fall in supply and the increase in demand pushed the price of oil to $95.58 per barrel. But extractive industries had continued to expand in developing economies.

Factors Causing Growth of the Petroleum Industry in Africa

- Price;
- Growing demand: China, India;
- Technology;
- Policy;
- National circumstances;
- More favorable investment climate;
- Lax environmental standards and/or implementation of standards/regulations;
- The governance question;
- International issues;
- International financial institutions (IFI) promoting petroleum development; and
- Rise of private-sector lending in IFIs.

Perceptions of Risk, Value, and Responsibility

What is manageable risk for companies is sheer uncertainty for communities. "Old mining"/"new mining." Different senses of "loss"—where a company may see an area for environmental remediation, a community may see permanent loss of a cultural landscape.

Direct Versus Indirect Responsibilities

"Aggravating" factors:

- Junior companies; and
- Distortion of key public institutions:
  - The media; and
  - The legal system.

Company strategy—conscious cultivation of support and difference. Important are local politics, prior conflicts, wider agendas, and local differences (example of preexisting conflicts and differences among tribes living in the Albertine Graben, Banyoro, Bakiga, Bagungu, Alur, Congo, etc.)

Case Study: The CAMISEA Pipeline

CAMISEA was the largest natural gas field in the Americas. Concessions and pipelines cut across the territories of some of the last non-contact peoples of South America. Much activism occurred in response to this one-time Shell project.

Case Study: Russia and Energy Nationalism

Source: Avni, n.d.

Resource nationalism essentially results from a tug of war among three basic human drives of greed, fear, and pride. Russian petroleum exports to Europe affect European-Russian geopolitical and economic relations. "Russia is very rich in natural resources, especially natural gas and oil. Between the 1960s and the 1980s, pipe infrastructure to supply those resources to Europe was built.

Production of those resources increased following the collapse of the Soviet Union. Boris Yeltsin, the Russian President at that time, privatized the country's assets to oligarchs who invested money in improving production technology. Increased production and world energy prices in the 1990s attracted European countries to the Russian energy market, and as their demand for Russian energy increased, so did their dependency on Russia" (Avni, n.d.). Table 2.2 lists natural gas and oil imports from Russia to Europe in 2004.

TABLE 2.2: NATURAL GAS AND OIL IMPORTS FROM RUSSIA TO EUROPE IN 2004

Natural Gas and Oil imports from Russia to Europe in 2004 (partial list)

Country	Quantity (billion cu. ft./yr.)	% of Domestic Consumption
Germany	1290	39%
Italy	855	31%
Turkey	506	65%
France	406	24%
Austria	212	69%
Poland	212	43%
Holland	94	6%
Greece	78	82%

*since 2004 the percentage of dependency on Russian energy increased dramatically
* Source- Bloomberg.

"In 1999, presidential elections took place in Russia. Vladimir Putin, Russia's fifth Prime Minister and a favored candidate by Boris Yeltsin, President of Russia at that time, won the election and took office. During his first term as president between 1999 and 2003, Putin was very interested to open the Russian energy market to Western energy companies and sign an energy partnership with the USA" (Avni, n.d.).

"In 2003, Putin won reelection and remained in office. When he started his second term, everything changed regarding foreign expectations in the Russian energy market. Putin ordered arrests of high officials at Yukos, Russia's largest oil company, with accusations of illegal taxing actions. In the West, the thought was that the real reason for these arrests was political" (Avni, n.d.).

Russia: Clipping the Wings of Yukos

"After the arrests, Putin nationalized Yukos and removed power over the company from the oligarchs. Now the government holds more than 50% of company shares, which means the government owns the company. Putin did this because he saw Russia's interests put aside, felt he had to respond to soaring energy prices, and concluded that Yeltsin's decision to privatize the country's assets had been wrong—coming to believe that government should be the main power, especially regarding energy resources" (Avni, n.d.).

Russia-Putin Greed

"After Putin's action involving Yukos, the Russian government was now the major player in the Russian energy market—owner of Russia's Gazprom (the largest natural gas company in the world) and now also Yukos, Russia largest oil company. In 2003, Gazprom decided to raise natural gas prices because of growing market demand" (Avni, n.d.).

The Russian-Ukraine Debacle

"Ukraine, which had been part of the Soviet Union, is a very important junction for Russian energy going to European countries. Gas and oil pipes pass through its territory" (Avni, n.d.). (see Figure 2.5 below, showing major European gas pipelines).

FIGURE 2.5: MAJOR EUROPEAN GAS PIPELINES

Source: The Economist, 2014

"Ukraine threatened Russia that if Gazprom would raise gas prices, it would shut down the Russian pipes that pass through its territory. But this Ukrainian threat pressured many European countries. It was wintertime, and most energy used in Europe came from Russia's natural gas. Austria, for example, was 100% dependent on Russian gas for heating, electricity generation, etc., and if the gas flow would stop, Austria's economy would be hurt badly and many of its citizens could freeze to death" (Avni, n.d.).

"Russia knew that many European countries, including Ukraine, depended on its natural gas, and Putin decided to teach Ukraine a lesson and shut down the gas production pipes. As a result, European countries prepared to use their energy reserves, but right before they did so, a freeze wave enveloped Europe. This caused seven European heads of state to demand that Ukraine apologize to Russia, and they flew to Moscow to beg Putin to open the gas production pipes to avoid disaster, and he agreed to do so" (Avni, n.d.).

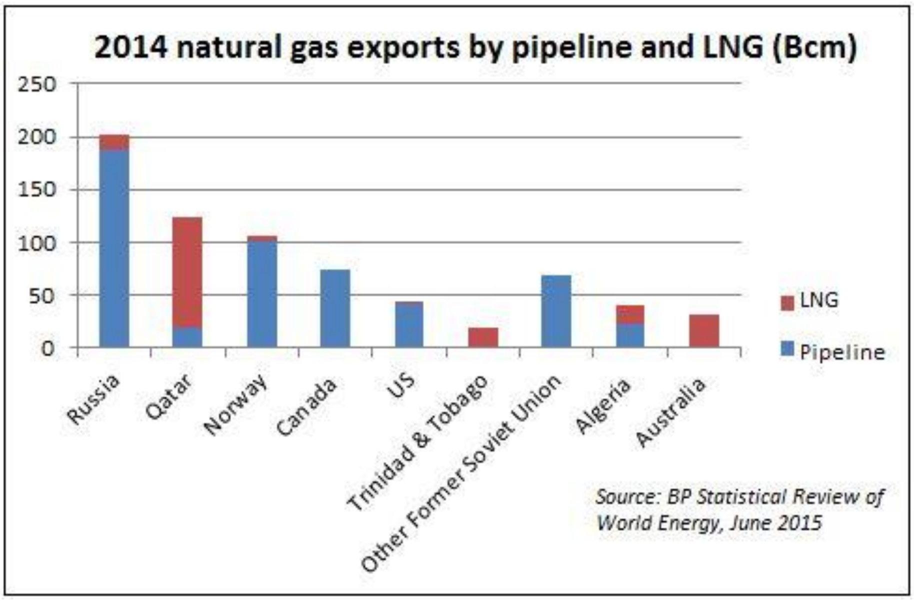
"This was one example among many others within the years of Putin's first presidency in Russia (until 2008) and subsequently within the years of Medvedev's Russia (following 2008), of Russia's energy playing a major role in Russian-European geopolitical and economic relations" (Avni, n.d.).

Shale Gas – The Game Changer

Russia, USA-EU, and Geopolitics of Energy

Russia holds the world's largest gas reserves, and even though it is currently the world's second producer after the United Sates (which recently outstripped Russia because of the shale gas revolution), Figure 2.6 below shows amounts of gas exports from various nations in 2014.

FIGURE 2.6: EXPORTS OF NATURAL GAS IN 2014 (BP, 2015)



Land Grabbing In the Petroleum Regions of Ghana– Emerging Problems and Challenges

In Ghana, economic activities are fishing and farming, with 80% involved in fishing and farming, and the rest in commerce, tourism, mining, and private informal sectors of coconut, rubber, oil palm, cocoa, coffee, and teak. Seasonal crops include maize, cassava, yam, vegetables, plantain, pineapple, and groundnuts. Tourism, mining, and petroleum exploration are the new emerging sectors of the economy.

Petroleum is a fast-booming business in the western region of Ghana. Land problems in these prime petroleum areas are increasing. Coastal lands of the Jomoro and Elembele District are two of the key areas in Ghana's petroleum regions. This lesson unit discusses emerging problems in the Jomoro District in relation to land acquisition (by the state and private firms)—compensation, transfer, deprivation, and other related problems).

Emerging Problems from Petroleum Development

- Lost lands and farms: construction of roads, power lines, gas lines, and buildings;
- Sea pollution: spillage of oil with large masses of pollutants that look like green algae and produce in the seas and along the shores bad smells, and prevent fishing in the area on a regular basis;
- Restrictions on fishing at sea: buffer zones of 500 to 1000 units into sea;
- Unfavorable land transfer deals: community attuned to customary ways, and elite "land grabbers" are using the statutory system to protect their interests; and
- Compensation problems: multiple ownership rights in the land; retention of perpetual interest and right of indigenes; compensation for crops/plantations at a particular time/period of year—inspection/counting.

Dealing With the Challenges/Problems

- Education of the indigenes about legal rules governing land rights and transfer of those rights;
- Proper documentation of customary land rights, owners, and boundary demarcations to guide land acquisitions and compensations;
- Provision of, and training in, alternative sources of sustainable livelihood for the indigenes;

- Development of effective means to deal with multiple ownership;
- Adoption of negotiation instead of imposition to arrive at amicable agreements and commitments; and
- Attractive compensation packages – indigenous families are shareholders in the projects.

Conclusion

Collaboration among affected people, traditional leaders/council, government officials, project developers, and private partners is critical to avert unforeseeable conflict fault lines. Management systems should ensure an alternative source of economic livelihood with perpetual ownership right. Surveyors should play vital roles in management of land ownership and compensation issues. It is advisable to address emerging conflict fault lines now, when problems are still at low key. Intensive education of all parties involved in the problems will be important, and resolutions to issues involving culture and customs, government/public laws, socioeconomic conditions, and roles, opportunities, and responsibilities of each party/group will be required to address problems effectively.

Policy Options and Recommendations

Overcoming the first dimension of conflict risk enjoins a country to sincerely address some core challenges, which include:

- Reducing government's dependence on oil revenue through effective diversification;
- Focusing on non-resource revenues;
- Reforming the tax system;
- Tackling corruption and lack of transparency and accountability in management of oil wealth;
- Dealing with patronage politics at all levels of government; and
- Addressing agitation for local (or increased local participation in) ownership and control of mineral resources.

Efforts to reduce violent conflicts in the Niger Delta would be more effective if these also would increase individuals' propensity to participate. In this regard, consider the following:

Source: Oyefusi, 2007

- "Measures that increase the opportunity cost of participation such as increasing formal educational attainment (human capital development); "
- "Increasing income levels and asset endowments of the lower strata of society (most of whom are not employed in formal settings and are likely to depend on environmental resources for their livelihoods);"
- "Creation of the right set of institutional arrangements that clearly define legally enforceable responsibilities of governments in provision of public goods, social amenities, and employment to local communities, and assign oil revenue shares to each party in a way commensurate with assigned responsibilities;"
- "Provision of an effective way of channeling compensations and minimizing conflict between oil companies and communities;"
- "Promotion of property and human rights, assurance of the rule of law, and requirement for extractive firms to adopt internationally accepted standards of operation;"
- "Agitation for increased local control of mineral resources that also may require restructuring of property rights to such resources, for example, by delegation of certain aspects of fiscal authority in oil matters to state and local governments or by transfer of full property rights to onshore

mineral resources to states and local communities, while the federal government retains full ownership and control of offshore resources;" and

- "Assurance that individuals in local communities benefit from such a transfer and that it does not translate to increased rent-seeking conflicts at the local level, mandated to be accompanied with creation of restraining institutions at the local level and targeting of oil spending to pro-poor activities."

Case Study: Nigeria

Source: Oyefusi, 2007

This case study examines oil-dependence and civil conflict in Nigeria, focusing on the economic dynamics of resource-induced conflicts. It involves two dimensions of oil-related civil conflict in Nigeria.

- The first is violent, rent-seeking political violence among various ethno-regional groups that oil-availability generates, linked to the following:
  - Excessive government dependence on oil revenue
  - An institutionally unstable revenue allocation system
  - Weak political institutional arrangements
  - Lack of effective agencies of restraints to demand transparency and accountability on the part of political office holders
  - Failure to translate oil wealth to sustainable growth
  - Need for increased standard of living for a larger majority of Nigerians
  - A defective property rights structure in relation to mineral resource endowment.
- The second is the Niger Delta Crisis.
  - Violence in the Niger Delta area is attributed, in the main, to weak institutional arrangements manifested in poorly conceived laws and lack of enforcement.
  - Regulatory capture, and a marriage of interest between the state and oil companies that often encourages the state to exert repressive measures against host communities in cases of disputes.
  - Incentives to looting and secession, as well as rent-seeking contests that oil availability and allure of ownership create among local participants. Three factors (educational attainment, income level, and asset possession) consistently explain the propensity to general violence among individuals in the region in the ordered and multinomial regressions of civil disobedience.
  - Policy options and measures must be devised to break the conflict trap and overcome the corrupting influence of oil-dependence in Nigeria.

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Havoc caused by discovery of oil in Nigeria. https://www.youtube.com/watch?v=zalqYjcjA2Y)

Poison fire. https://www.youtube.com/watch?v=bq2TBOHWFRc

1990 Gulf Kuwait War – A documentary on oil-rich Kuwait after Kuwait-Iraq War. https://www.youtube.com/watch?v=IS7CPSzJ1Ac

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LECTURE 3: CUMULATIVE ENVIRONMENTAL AND SOCIAL ECONOMIC IMPACTS

SYLLABUS

Teaching Aims

(i) Create an understanding of the different categories of socio-economic impacts resulting from various activities of the petroleum value chain.

Learning Objectives

(i) Discuss cumulative socioeconomic impacts of petroleum activities.

(ii) Render correct advice to stakeholders on how to deal with potential and real socioeconomic impacts.

Outline of Lecture Content

Topic and Subtopics	Suggested Approach, Methods & Equipment
1. Introduction to the Petroleum Environmental Impacts	A brainstorming exercise is in order here because the subject would have been introduced earlier in the training process
2. Types Of Environmental Impacts In the Petroleum Industry	Group discussions
3. Why Should we Care about Cumulative Effects?	
4. In-Depth Understanding of Cumulative Environmental Impacts	
5. Managing Cumulative Effects	Group discussions based on a real-life case study of assessed indirect and cumulative impacts, as well as interactions of impacts
6. Field work	Discuss with field practitioners issues of cumulative socioeconomic impacts

DETAILED NOTES

1. INTRODUCTION

Over the last 10 years, industrial development has increased within areas of petroleum development in Uganda. Development has resulted in numerous activities in the Albertine Graben and at the national level, affecting the natural environment in one way or another. Some projects exert more impacts than others, but small effects add up. These "cumulative effects" are a growing concern for many organizations who share responsibility to care for humans and the environment. Understanding and minimizing cumulative effects is essential to informed decisions about resource and human management within the country.

2. TYPES OF ENVIRONMENTAL IMPACTS IN THE PETROLEUM INDUSTRY

What is Environmental Impact?

Environmental impact is "Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization's activities, products, or services"—any change due to a project activity that affects an environmental receptor and may be observed through the relevant environmental parameter/indicator (International Organization for Standards [ISO] 14001, 2004).

According to the U.S. Environmental Protection Agency (EPA) (1999), three major types of impacts are (1) direct impacts, (2) indirect impacts, and (3) cumulative impacts / synergistic impacts. Further breakdown of these is as follows:

- Positive and negative impacts;
- Random and predictable impacts;
- Local, regional, national, and global impacts;
- Short, medium and long term impacts;
- Reversible and irreversible impacts; and
- Significant and insignificant impacts.

Direct Impacts

These are caused directly as a result of petroleum projects (e.g., drilling, installation, hydro-testing, operation, and decommissioning).

Indirect Impacts

These are usually not direct results of petroleum project activities, but are due to complex pathways (occur away from the original source of impact). These are also called secondary or tertiary chain, or second- or third-level impacts. These are more difficult to assess/measure, and likely to have greater consequences than direct impacts.

Cumulative Impacts

These are caused by incremental changes resulting from past, present, and reasonably foreseeable future actions—including both direct and indirect impacts of a given project action (plus other existing projects) on an environmental receptor or medium (water, soil, air). These may arise from accumulation of similar impacts (additive), or multiplicative or synergistic interaction with different impacts over time. Thresholds may be required to determine if the impact of an action or actions will be within acceptable limits (e.g., mean total phosphorus threshold for onset of eutrophication in a river could be 75 milligrams per cubic meter (Schmidt et al., 1999).

Synergistic Impact

Synergistic impact is a type of cumulative impact that occurs when impacts interact to produce an impact greater than the sum of individual impacts.

Reversible (Temporary) and Irreversible (Permanent) Impacts

Reversible Impacts

These do not last, and the affected system is naturally restored to its previous condition (e.g., an offshore seabed could recover from localized and discontinuous seismic survey effects within weeks, such that no change from the original condition is observable).

Irreversible impacts

These are permanent, and the affected system is not restored to its previous state within our lifetime (e.g., drilling pad and associated facilities [pipelines, access roads, etc.] may result in permanent impacts on wetlands (U.S. Army Corps of Engineers, 2007)

3. WHY SHOULD WE CARE ABOUT CUMULATIVE EFFECTS?

Activities such as logging, oil and natural gas development, commercial fishing, mining, hunting, recreation, and human settlement all contribute to cumulative effects. Since the early 1990s as development of natural resources has intensified, these activities have significantly increased throughout the world. Understanding cumulative effects of such activities is important for making informed decisions about management of land, water, and other natural resources.

Are Cumulative Effects Always Harmful?

No—cumulative effects can be positive or negative. It's often easy to think of how industrial development harms the environment, but human activities can also produce benefits. For instance, since establishment of the diamond mines, more residents have finished degrees and earned higher salaries. Many individuals and groups in business and industry are working to find ways to conduct development in a way that does not permanently harm the environment.

How Do Cumulative Effects Work?

No one activity causes cumulative effects. Cumulative effects are caused by addition or accumulation of impacts from different activities over time. One impact by itself may not be a cause for concern; it might even seem insignificant. However, addition of many small impacts over time adds to the end result—cumulative effects and an increase of concern.

Can All Cumulative Effects be Predicted?

Understanding and predicting cumulative effects is challenging. By collecting information over long periods of time, we can learn how certain types of activities contribute to cumulative effects. Moreover, natural changes that occur continuously must be taken into account in assessing further impacts of a human activity.

What Can People Do About Cumulative Effects?

If there is industrial development in your area, there is probably a community-based monitoring program already in existence. Check with your local office, regional with indigenous people governments, to see what is happening in the area, and how they can participate.

The land and water boards, environmental impact review boards, consider cumulative effects and make recommendations on how to mitigate them when approving development projects. You can make a difference by learning about the regulatory system and participating in public hearings.

Social-Economic Impacts

The most significant social change that an oil operation causes in a remote area is presence of hundreds of oil workers and contractors. Contact between oil workers and local people can significantly impact traditional social structures. This impact differs depending on sensitivities and perspectives of various social groups and their degree of previous contact. While all groups face health and economic threats, less integrated indigenous groups are at much greater risk of cultural displacement and marginalization than colonists or other local residents who have already undergone the larger consequences of cultural change and abandoned their traditional lands and practices.

Resources, Psychological, and Community Aspects

- Resettlement of indigenous people.
- Compensation for resource uptake.
- Use of natural resources and wealth redistribution.
- Changes from traditional lifestyles (e.g., the Nenets of Northern Russia, the peoples of the Niger Delta, the Inupiat Eskimos of Point Hope, Alaska). These changes affect community cohesion, attitudes, and behavior.
- Health: spread of new diseases to indigenous communities, impacts on health of operations personnel.
- Impact of local diseases on workers and spread of pandemics such as HIV and sexually transmitted diseases.
- Social infrastructure: adequacy of health care and education facilities, transport and roads, and power supply.
- Fresh water supply to support project activities and personnel, as well as the community.
- Resources: land-take for facilities and resettlement, new or increased access to rural or remote areas, use of natural resources.
- Psychological and community aspects: changes from traditional lifestyles, community cohesion, attitudes and behavior plus community perception of risk.
- Cultural property: sites and structures with archaeological, historical, religious, cultural, or aesthetic values that may be changed or be subject to limited access.

Social Equity

Identifying who gains and who loses as a result of a project or operation can alter traditional balances of power and established community hierarchies. As a result, communities can rapidly lose their ability to sustain their nomadic lifestyles and traditional methods of subsistence economy, and face increased dependence on outside aid. Even after only sporadic contact with oil workers, colonists, or Western goods, indigenous people have historically been disinclined to return to their traditional social strategies.

Access to New Areas

Introducing roads or pipelines within areas previously inaccessible for development can facilitate access for settlement, logging, and hunting—increasing pressures on natural resources.

Socioeconomic Considerations

From an economic perspective, activities of the petroleum industry, taxes, and royalties affect indigenous supply chain opportunities and employment and labor issues. These also can cause shifts from traditional industries to petroleum and vice versa (e.g., policemen serving as security personnel in oil companies, return of construction workers to menial jobs, and the Dutch Disease as a result of possible neglect of other sectors of government (especially agriculture). Indigenous people may be subtly forced to leave traditional occupations to pave way for the petroleum activities, a situation that may jeopardize community livelihoods. On the other hand, communities have claimed that land grabbing occurs in oil-rich region development areas.

Employment

Petroleum jobs in active areas include maintenance, inspection, and other activities related to petroleum exploration and production. Residents of the license area would likely benefit from development of oil or gas resources in the area through increased job opportunities in the petroleum industry.

The exploration license may create additional employment opportunities in service, transportation, utilities, and retail sectors of the local economy. Short-term job opportunities could arise during the exploration phase. Long-term employment benefits in the vicinity of the license area will depend on subsequent production of commercial quantities of oil or gas. The local labor force may not be able to meet demands for many technical positions. As a result, these jobs may be filled by workers from the service support industry active in other regions of the state, or outside Uganda.

Chad-Cameroon Case Study

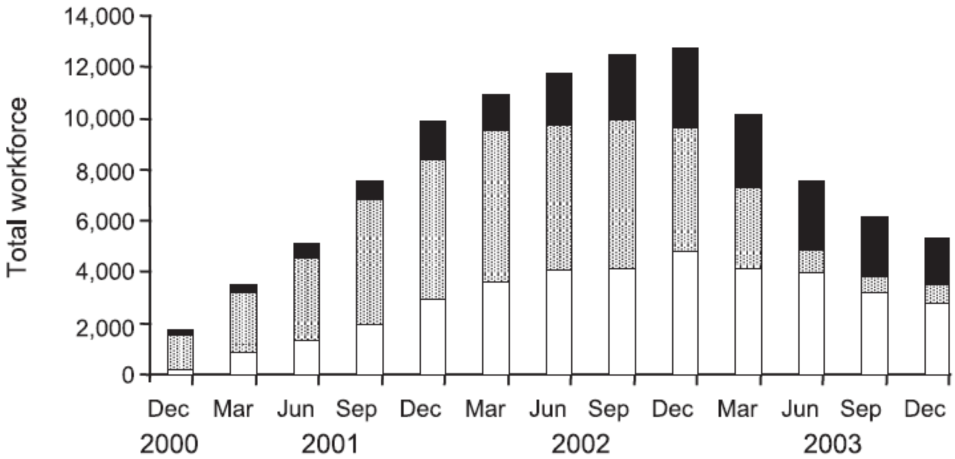
Figure 3.1 shows the Chad-Cameroon pipeline.

FIGURE 3.1: CHAD-CAMEROON PIPELINE

Source: The Economist, 2008

Figure 3.2 shows the Chad-Cameroon project's total workforce stratified by nationals from Chad (white portion of the bars), Cameroon (grey portion of the bars) and expatriate workers (black portion of the bars).

FIGURE 3.2: CHAD-CAMEROON PROJECT WORKFORCE



Source: IPIECA and International Association of Oil & Gas Producers (OGP), 2005.

Access and Land Use

Communities and surface estate owners in the area adjacent to exploration activities could be affected. For example, use of transportation systems could increase, such as air charter services, airstrips, or roads, for transportation of personnel or construction equipment. Roads could be constructed to provide access to more remote areas. Other effects include disturbance due to increased air traffic, machinery noise, and loss of privacy due to presence of project workers. Extents of these effects depend on size of exploration projects, proximity of facilities, and utility, pipeline, and transportation corridors to the affected community. Some portions of the area could be developed from existing roads or access routes; however, much of the acreage is remote from existing infrastructure. Some use of existing roads and trails may occur during exploration license activities. Likely increases in vessel traffic and mooring activity as a result of any exploration work in the license area could affect the economy (Klouda, 2012; Armstrong, 2013; Homer, 2013).

Immigration

Immigration and new settlements induce high demand for labor, prospect of new economic opportunities, and new infrastructure—often leading to a significant population increase in the area surrounding an oil or gas operation. This in turn increases pressure on land, water, wildlife, and other natural resources, and the new settlements may remain in the area after cessation of oil or gas extraction.

Spread of diseases to which indigenous people have no immunity, disruption of traditional hierarchies and social structures, and an increasing dependence on outside aid can destroy long-established and healthy societies. Even in towns and communities already integrated into the local economy, traditional lands and production systems can be deeply affected by presence of an oil operation. Social issues are often beyond the expertise and experience of project developers, who are usually trained as engineers or environmental managers. Gradual changes may exert an accumulating effect. In cumulative effect, these small changes can ultimately be harmful. The people best equipped to discover these subtle potential changes are often the holders of traditional knowledge of the area. When traditional knowledge is used in its original context, and in partnership with other knowledge systems, the combination is often a powerful tool. Table 3.1 below lists health risk assessment potential for HIV spread across petroleum value chain levels.

TABLE 3.1: HEALTH RISK ASSESSMENT POTENTIAL FOR HIV SPREAD ACROSS PETROLEUM VALUE CHAIN LEVELS

Type of activity	Risk category	Key reasons
Upstream/E&P		
Pipeline—construction	Very high	Mobility/low level of risk awareness/ high discretionary income
Production facility—construction	Medium	Lack of prevention methods
Normal facility operations	Medium to low	Lack of prevention methods
Refining and distribution		
Construction	Medium to high	Low level of risk awareness/ high discretionary income
Operations—road transport	Very high	Extremely mobile/ low level of risk awareness
Normal facility operations	Medium to low	Lack of prevention methods
Retail/commercial operations		
Construction	Medium to low	Low level of risk awareness/ high discretionary income
Normal facility operations	Low	Lack of prevention methods
Travelling sales representatives	Medium to high	Extremely mobile/ low level of risk awareness

Source: IPIECA and OGP, 2005.

Russian Gazprom in the Yamel Peninsula

According to a study by the Arctic Centre (University of Lapland) and Cambridge University (2004):

- Nenets nomads manage ~150,000 reindeers.
- A number of these reindeers are shot by oil workers.
- Pasture lands are lost because of overgrazing and shrinking size.
- Expatriates perhaps furnish alcohol to nomads.
- Modern practices are evolving (e.g., mobile phone revolution).
- Nomads have increasing access to markets and new business opportunities.

4. IN-DEPTH UNDERSTANDING OF CUMULATIVE ENVIRONMENTAL IMPACTS

Source: Alaska Department of Natural Resources, 2014

The largest effects of petroleum activities are from physical disturbances (Huntington, 2007). During initial exploration phases, disturbances caused by cross-country travel and construction are the most significant (Hanley et al., 1983). Other activities that may induce impacts include installation of pile foundations, construction of gravel roads, and general disturbances to terrain.

Until recently, oil operations in tropical rain forests have largely depended on technology and practices that, while effective in certain ecological surroundings, have proven ill-suited to the environmentally fragile ecosystems of the humid tropics. Severe, direct environmental impacts, including land-clearing, air pollution, water contamination, soil erosion, sedimentation, and disturbance of wildlife and habitats, have resulted. Perhaps even more threatening are indirect impacts, including colonization and extensive deforestation that result from opening of access into the forest via roads and pipeline paths.

FIGURE 3.3: FISH DEAD IN A LOUISIANA MARSH HEAVILY IMPACTED BY THE GULF OIL SPILL

Source: Hahn, 2010

What Happens to Wildlife and the Land?

With presence of more roads, seismic lines, and cleared areas, more people can access the land for work and recreation. Areas once too difficult to travel through become accessible by vehicles. This new access bodes possible collisions with wildlife and an increase in hunting and fishing. Some studies estimate that poachers kill as many fish and wildlife as are taken legally. General concern in Canada is that unlimited access to recreational fisheries could be causing collapse of some populations. Impacts on wildlife range from loss of habitat to poisoning to reduction in herd size and home range. Species in decline as a result of industrial development in Alberta include caribou, lynx, martin, fisher, wolverine, and various bird species.

In countries like Uganda, where tourism is driven by wildlife, declines in wildlife can have significant effects on the tourism sector and the communities that are dependent on the employment in the sector.

The Legacy of Waste

Cumulative effects are not limited to active operations but also include what is left behind. First Nations in northeastern British Columbia estimate that more than 1,800 sites on their territory have not been rehabilitated after petroleum activity, and that 90% of these sites remain contaminated and badly in need of cleanup. In Alberta, hundreds of abandoned well sites called "orphan wells" exist that no company is legally responsible to clean up and rehabilitate.

FIGURE 3.4: ORPHAN WELL

Source: BBC, 2014

Land-Based Seismic Surveys

Source: Alaska Department of Natural Resources, 2014

"Clearing operations to prepare seismic lines, and explosions that occur during seismic surveys may disturb wildlife. Birds and wildlife are particularly sensitive during nesting and calving periods (Schneider, 2002). Repeated disturbances can result in increased movement rates of wildlife and subsequent significant energy losses, which can be particularly problematic during winter when food supplies may be scarce (Schneider, 2002)."

"Traditional seismic lines may leave a long-lasting footprint in boreal forests. However, surveys now use global satellite positioning instruments, rendering past practice of long clear-cuts through forests for line-of-sight measurements unnecessary. Plant communities on seismic lines have been found damaged. Seismic lines may alter predator-prey interactions. In boreal forests, radio-collared wolves were observed."

Habitat Fragmentation

Source: Alaska Department of Natural Resources, 2014

"Habitat fragmentation may occur, which may impact biological diversity (Spellerberg and Morrison, 1998). Direct loss of habitat, degradation of habitat quality, degradation of water quality, habitat fragmentation, and reduced access to vital wildlife habitats may result with building and maintenance of roads, trails, highways, and railways. Fish and wildlife may avoid these areas. Fish and wildlife may undergo increased exploitation by humans, splitting and isolation of populations, and disruption in their social structure and processes that maintain regional populations (Alaska Department of Fish and Game [ADF&G], 2006, citing Jackson, 2000). Invasive species may also displace native species, as roads can act as travel conduits (ADF&G, 2006)."

Alteration of the Land Surface

Source: Alaska Department of Natural Resources, 2014

Land surface disturbances may change and destroy vegetation, and alter soil characteristics.

"Types of land surface disturbances may include vegetation clearing, slash disposal, altered soil characteristics, hydraulic erosion, altered surface hydrology, aboveground obstructions, and filled areas (Hanley et al., 1983). Construction activities relating to petroleum extraction can exert impacts from the following: off-road transportation; road, pad, and airstrip construction; pile foundations; below-ground pipelines; and terrain disturbance (Hanley et al., 1981). Some effects of constructing production pads, roads, and pipelines may include direct loss of habitat acreage due to gravel infilling, and loss of dry tundra habitat due to entrainment and diversion of water. Construction of roads and gravel pads can interrupt surface water sheet flow and stream flows (National Research Council [NRC], 2003)."

"A secondary effect of construction activities includes dust deposition, which may reduce photosynthesis and plant growth (McKendrick, 2000). Effects on ecosystems impacted by roads include potential chemical input from roads to water bodies and to the airshed, and bioaccumulation in soils. Roads can impact fluvial dynamics, sediment transport, and floodplain ecology. When roads alter habitats, plant species can be changed or removed, and non-native plants can be introduced. Additional wildlife habitat impacts from roads can change the density and composition of animal species and populations (NRC, 2003)."

"Road construction, vehicular passage, and oil spills can alter surface albedo (reflectivity of sunlight off the earth's surface) or water drainage patterns, resulting in thaw and subsidence or inundation. Such changes can affect regeneration and revegetation of certain plant species, and species composition may also change after disturbance from construction activities (Linkins et al., 1984)."

Wildlife and Human Interaction

Unconventional O&G development brings many socio-economic benefits such as job creation, royalty payments, and changes in property values; however, it can also pose significant and costly environmental and public health risks associated with water contamination, water overuse, and gas emissions. Contamination of underground sources of drinking water and surface water resulting from spills, faulty well construction, or from other causes can exert adverse impacts from discharges into surface waters or from disposal into underground injection wells; stress on surface water and groundwater supplies from withdrawal of large volumes of water used in drilling and hydraulic fracturing; and air pollution resulting from release of volatile organic compounds, hazardous air pollutants, and greenhouse gases.

Groundwater Effects

Source: Alaska Department of Natural Resources, 2014

"Petroleum activities may affect groundwater in the license area. Water use from groundwater wells may be required for construction and maintenance of ice roads and pads, for blending drilling muds in drilling activities, and for potable and domestic water uses at drilling camps (NRC, 2003; Van Dyke, 1997). Industrial use of groundwater could draw down the elevation of the water table in the vicinity of the industrial well or wells, and could affect nearby domestic well water depths. These effects are usually insignificant and temporary, as other hydraulically connected groundwater sources replace pumped volume."

Gas Blowouts

Source: Alaska Department of Natural Resources, 2014

"During drilling, shallow gas pockets of natural gas may be encountered. Gas can get trapped in soils, water, and ice in permafrost environments. Sediments in which gas has accumulated are potential hazards for drilling that penetrates them (Hyndman and Dallimore, 2001). Explosions and resultant fires may occur during a natural gas blowout. Gas vapors from an explosion are lighter than air and may migrate downwind where they are readily dispersed. Blowouts occur only if hydrogen sulfide is present and can also cause a toxic cloud to accumulate at shallow depths. Condensates, a low-density mixture of hydrocarbon liquids present in raw natural gas, which did not burn in the blowout would be hazardous to any organisms exposed to high concentrations (Kraus, 2011)."

Hazardous Spills

Source: Alaska Department of Natural Resources, 2014

"Hazardous spills can exert toxic effects on vegetation, soils, wildlife, birds, and fish. Effects of spills depend on time of year, vegetation, and terrain. Oil spilled on the tundra would migrate both horizontally and vertically, affecting characteristics of the soil such as porosity, permeability, and texture."

"Degree of water saturation and organic matter content would affect substance movement (Jorgenson and Cater, 1996). If oil penetrates soil layers and remains in the plant root zone, longer-term effects such as mortality or reduced regeneration would occur in following seasons (Linkins et al., 1984). Hydrogen degrading bacteria and fungi can act as decomposers of organic material, and under the right conditions can assist in breakdown of hydrocarbons in soils. Natural or induced bioremediation by use of microorganisms can also occur (Linkins et al., 1984; Jorgenson and Cater, 1996). Natural recovery in wet habitats may occur in time durations of 10 years or less, if aided by cleanup activities and additions of fertilizer (McKendrick, 2000)."

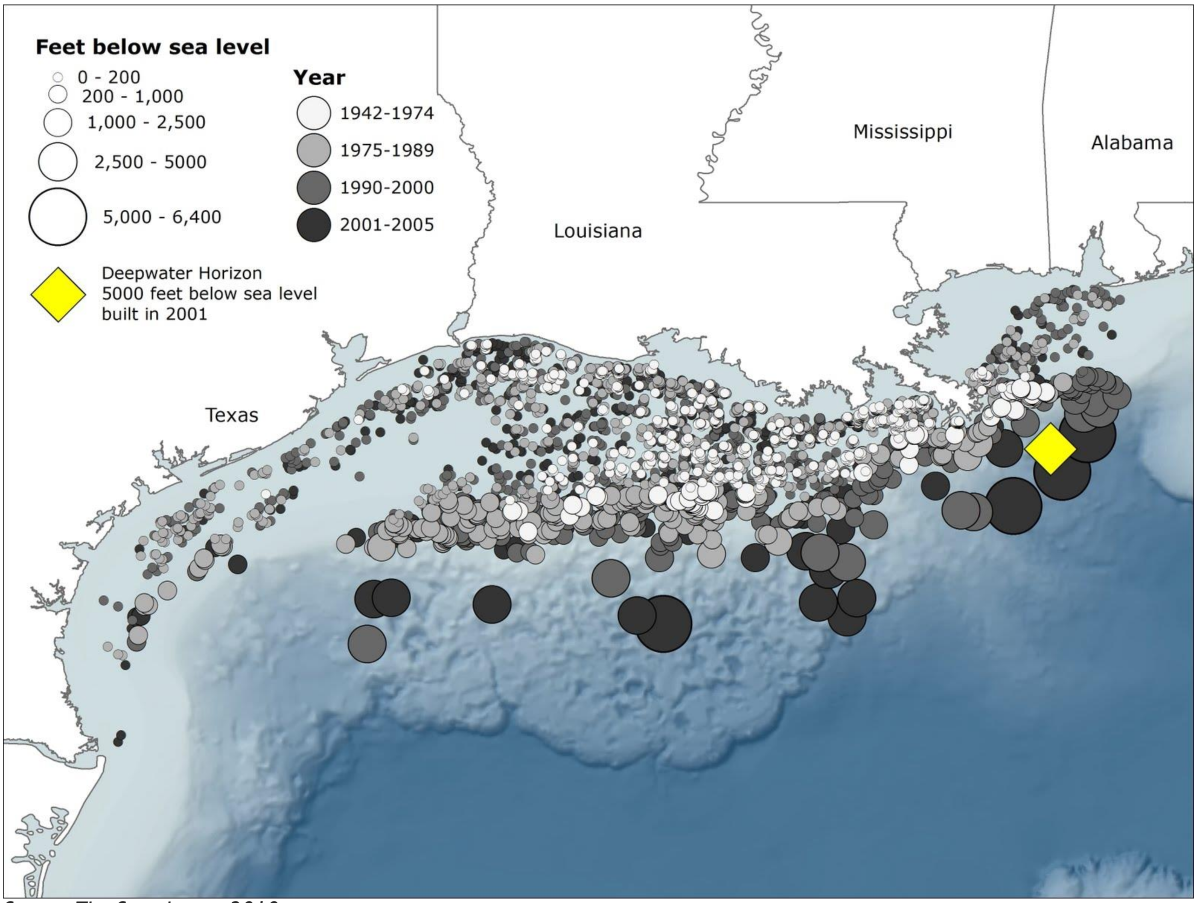
"Long-term effects of oil may persist in sediments for many years—shifting population structure and impacts on species abundance, diversity, and distribution, especially in areas sheltered from weathering processes (U.S. Fish and Wildlife Service [USFWS], 2004). Oil leaks or spills in forests can have a range of potential effects, including killing plants directly, slowing growth of plants, inhibiting seed germination, and creating conditions under which plants cannot receive adequate nutrition. Although a single addition of petroleum hydrocarbons does not appear to limit microbial communities in the long term, species richness often decreases (Robertson et al., 2007)."

Releases of Drilling Muds, Spills and Produced Water

Source: Alaska Department of Natural Resources, 2014

"Common drilling fluids contain water, clay, and chemical foam polymers. Drilling additives may include petroleum or other organic compounds to modify fluid characteristics during drilling. Down-hole injection of drilling muds and cuttings are unimportant if these are not placed into a subsurface drinking water aquifer (NRC, 2003)." Waters and drilling muds produced and discharged during petroleum production activities may contain toxic levels of heavy metals, radioactive particles, and brine, and persist for longer periods of time, as indicated below.

FIGURE 3.5: CUMULATIVE IMPACTS OF OIL RIGS (1942-2005) IN GULF OF MEXICO



Source: The Swordpress, 2010

"When these production waters are discharged to land, they can be more devastating to plants and animals than crude oil. Where they are discharged into marine waters, the toxic components are distributed differently than oil, which floats to the surface (LaRoche and Associates, 2011). They may exert acute effects on sea floor flora and fauna, reducing both their abundance and diversity in the immediate area of discharge (Arctic Council, 2009). The technique of injecting mud and cutting disposal has greatly reduced potential adverse impacts caused by releases of drilling muds and reserve pit materials (NRC, 2003)."

Air Quality

Potential Activities and Cumulative Effects

Source: Alaska Department of Natural Resources, 2014

"Petroleum activities may produce emissions with potential to affect air quality. Gases may be emitted to the air from power generation, flaring, venting, well testing, leakage of volatile petroleum components, supply activities, shuttle transportation boilers, diesel engines, drilling equipment, flares, glycol dehydrators, natural gas engines and turbines, and fugitive emissions (leaks from sealed surfaces associated with process equipment) (Boemre, 2011; Arctic Council, 2009). On-road and off-road vehicles, heavy construction equipment, and earth-moving equipment could produce emissions from engine exhaust and dust. Sources of air emissions during drilling operations include rig engines, camp generator engines, steam generators, waste oil burners, hot-air heaters, incinerators, and well test flaring equipment. Emissions could be generated during installation of pipelines and utility lines, excavation and transportation of gravel, mobilization and demobilization of drill rigs, and during construction of gravel pads, roads, and support facilities. Emissions could also be produced by engines, turbines, and heaters used for oil/gas production, processing, and transport. In addition, aircraft, supply boats, personnel carriers, mobile support modules, as well as intermittent operations such as mud degassing and well testing, could produce emissions (Boemere, 2011)."

Sport and Commercial Fishing and Sport Hunting

Source: Alaska Department of Natural Resources, 2014

"In addition to subsistence, other important uses of fish and wildlife populations in and around the license area include sport and commercial fishing; and sport hunting. Effects from petroleum development on fish, wildlife, and their habitats could affect recreation and tourism. Petroleum activities could decrease an area's visual quality and attraction to tourists. Excess turbidity and sedimentation in an area's waters can decrease recreation value and fish stocks (USGS, 2014)."

Historic and Cultural Resources

Potential Activities and Cumulative Effects

Source: Alaska Department of Natural Resources, 2014

"The license area has documented occurrences of historical and cultural resources. Potential impacts on these resources may be from accidental oil spills, erosion, and vandalism (Dekin et al., 1993). Impacts on and disturbances to historic and cultural resources could be associated with installation and operation of petroleum facilities, including drill pads, roads, airstrips, pipelines, processing facilities, and any other ground disturbing activities. Damage to archaeological sites may include direct breakage of cultural objects; damage to vegetation and the thermal regime, leading to erosion and deterioration of organic sites; shifting or mixing of components in sites, resulting in loss of association among objects and damage or destruction of archaeological or historic sites by oil spill cleanup crews collecting artefacts (Bureau of Land Management [BLM], 2007, USFWS, 1986)."

Cumulative Aesthetic, Cultural, and Spiritual Consequences.

Source: Alaska Department of Natural Resources, 2014

"Many activities associated with oil development have compromised wild land and scenic values over large areas. Some Alaska Natives told the committee that these violate what they call "the spirit of the land," a value central to their relationship with the environment. These consequences have increased in proportion to the area affected by development, and they will persist as long as the landscape remains altered."

5. MANAGING CUMULATIVE EFFECTS

Source: Alaska Department of Natural Resources, 2014

Understanding and minimizing cumulative effects is an important part of overall environmental management and stewardship of lands and resources. Good environmental management requires putting together all the pieces of an environmental stewardship framework. Each piece provides information that helps regulators and land managers make good decisions about sustainable development.

Cumulative effects assessments should occur before development. These assessments help communities weigh costs and benefits of development. Scientific and traditional ecological knowledge should be referenced to determine how much development an ecosystem can sustain. Monitoring programs are critical to understand changes on the land resulting from development. "Prior identification of sensitive areas can support construction of infrastructure away from sensitive habitats. A study of impacts on habitats from construction of the Trans-Alaska Pipeline System found that the greatest percentage loss of habitat was from gravel material sites used for construction materials, with work pad areas and road construction causing the next greatest habitat loss percentages (Pamplin, 1979)."

Cumulative effects management involves examination of impacts from past and present, predicting what impacts may occur from planned future activities, and deciding how to best deal with negative effects.

Involve Local Stakeholders Throughout an Operation.

Source: Alaska Department of Natural Resources, 2014

An operating company should establish a formal mechanism for consultation and communication with local communities, governments, NGOs, and other stakeholders. These groups should be consulted and involved in planning, data collection, review of project documents, and monitoring.

Use Extreme Caution

Whenever possible, workers should avoid contact with groups that have had little or no involvement with the outside world. This policy is extremely important to prevent spread of deadly illnesses among these groups, and to avoid potential disruption of long-established social and production systems.

Conduct environmental and social monitoring and evaluation programs during every phase of an operation. These programs should assess impacts of project activities on the surrounding ecosystem, cultures, and economies. Monitoring can also determine whether environmental and social programs instituted by the company are having the desired effect, and suggest alternatives if not.

Return the Project Site to Its Pre-operations Condition

When an oil project finishes, a company should institute complete remediation procedures to reseed and revegetate affected land areas. All facilities and equipment should be broken down and removed from the site, and roads and stream crossings should be taken up and the soil loosened to promote regeneration.

Avoidance

Source: Alaska Department of Natural Resources, 2014

"Various mitigation measures used to protect archaeological sites during oil spill cleanups include avoidance (preferred), site consultation and inspection, on-site monitoring, site mapping, artefact collection, and cultural resource awareness programs (Bittner, 1996). Measures in this best interest should ally with regulations imposed by other state and local agencies."

Enact a Comprehensive Legislative Framework of Environmental and Social Regulation

Conservation efforts require legislative and administrative support at every level of governance, from constitutional provisions and national environmental policies, to more specific sectoral legislation and agency rules and regulations.

Allow Oil Development Activities Only After a Thorough Bidding and Permitting Process

Government agencies should screen bids for oil contracts applying environmental criteria as an essential factor. Bids should be publicly available, and citizen groups should be allowed to comment on the relative merits of each proposal.

Funding Mechanisms to Offset Environmental Damage

Performance bonds and mitigation trust funds controlled by citizen groups or local governments, as well as environmental insurance policies, should be prerequisites to oil development projects. Governments should also study the feasibility of tax incentives to promote conservation measures.

Require Companies to Conduct Comprehensive Studies of Land Tenure Patterns for any Operations in Areas with Competing Land Tenure Systems

Companies that will be working on lands where ownership patterns are unclear should exert a concerted effort to work with the government to clarify the situation as fully as possible. Regardless of legal title, the rights of all local residents should be respected.

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LECTURE 4: MULTIPLIER EFFECTS OF PETROLEUM RESOURCES

SYLLABUS

Teaching Aims

(i) To provide an overview of multiplier effect of petroleum resources.

Learning Objectives

(i) Demonstrate an understanding of why fossil fuels remain the leading source of energy globally.

(ii) Explain the role fossil fuels play in global energy supply and global economic performance in terms of support to other sectors through backward and forward linkages.

(iii) Explain the multiplier effects of the petroleum industry in the context of development of the offshoot industries, as well as emergence of other business opportunities tied to the petroleum supply chain and oil field services.

Outline of Lecture Content

Topic and Subtopic	Suggested Approach, Methods & Equipment
1. Introduction	
2. The Preference of Fossil Energy in Modern Economies – Why Oil?	Methods: • Lecture • Brain storming • Q&A session • Peer-assisted learning • Handouts • Video clips • Discussions and team presentations • Graphic illustration Equipment: • Computer hardware • PowerPoint projector • Screen • Sound system • White board/flip charts • Markers Transportation to the field Same as immediately above
3. Fossil Energy as a Catalyst of Industrialization	
4. Petroleum Industry Supplies and Services	Methods: • Lecture • Brain storming • Q&A session • Peer-assisted learning • Handouts • Video clips • Discussions and team presentations • Graphic illustration Equipment: • Computer hardware

Topic and Subtopic	Suggested Approach, Methods & Equipment
	• PowerPoint projector • Screen • Sound system • White board/flip charts • Markers Transportation to the field

DETAILED NOTES

1. INTRODUCTION

Scholars in the energy profession have described oil as "the life blood of modern economies." This description is supported by statistical figures showing that oil remains the leading fuel for the world economies, accounting for about 33% of global energy consumption (BP Statistical Review of World Energy, 2013). Various factors that explain why global economies prefer oil have been documented, ranging from environmental factors, health and safety, to technical factors including energy conversion efficiency.

This lesson will therefore explore why modern economies prefer oil as a source of energy. The historical perspective for the contribution of petroleum to development and growth of industrialization will also be presented. Account will then be given of the offshoot industries with foundations in the petroleum industry.

2. THE PREFERENCE OF FOSSIL ENERGY IN MODERN ECONOMIES – WHY OIL?

Traditional Energy Sources

Coal

Coal has traditionally been the global source of energy. It underpinned the industrial revolution in Europe during the eighteenth century. To date, coal still remains a major source of energy in some countries. For example, in the UK, coal still provides 28% of the country's energy needs although it has been surpassed by oil in recent decades as the principal energy fuel (taking up 40% of total energy consumption).

Coal is converted to energy in thermal plants that produce waste energy in amounts equaling or exceeding the amount of energy generated by electricity.

Crude Oil

From the commercial point of view, this is the most valuable product in the hydrocarbon family. It comprises a mixture of different types of oils broken down into their various components during processing in thermal and catalytic crackers of a refinery.

Gas

This is generally associated with oil and coal (but also occurs on its own), and is gaining popularity because it is the most environmentally friendly member of the hydrocarbon family. Moreover, displacement of oil by gas as the leading energy source is anticipated in the UK by 2020.

In the context of thermal power generation, it is significant that coal and oil produce only 30-49% of the available energy, whereas gas fires can achieve an efficiency output of more than 50%.

Renewables

Running water has been used for grinding corn for millennia, and hydropower accounts for 20% of the world's electricity supply. The system involves construction of dams to trap water, forming an artificial lake from which the water is channeled downslope through a tunnel to drive turbines to generate electricity. The dam widens toward the base to enable it to withstand increased pressure. Hydro-electricity can be produced cheaply and can be scaled up rapidly to cope with peak demand.

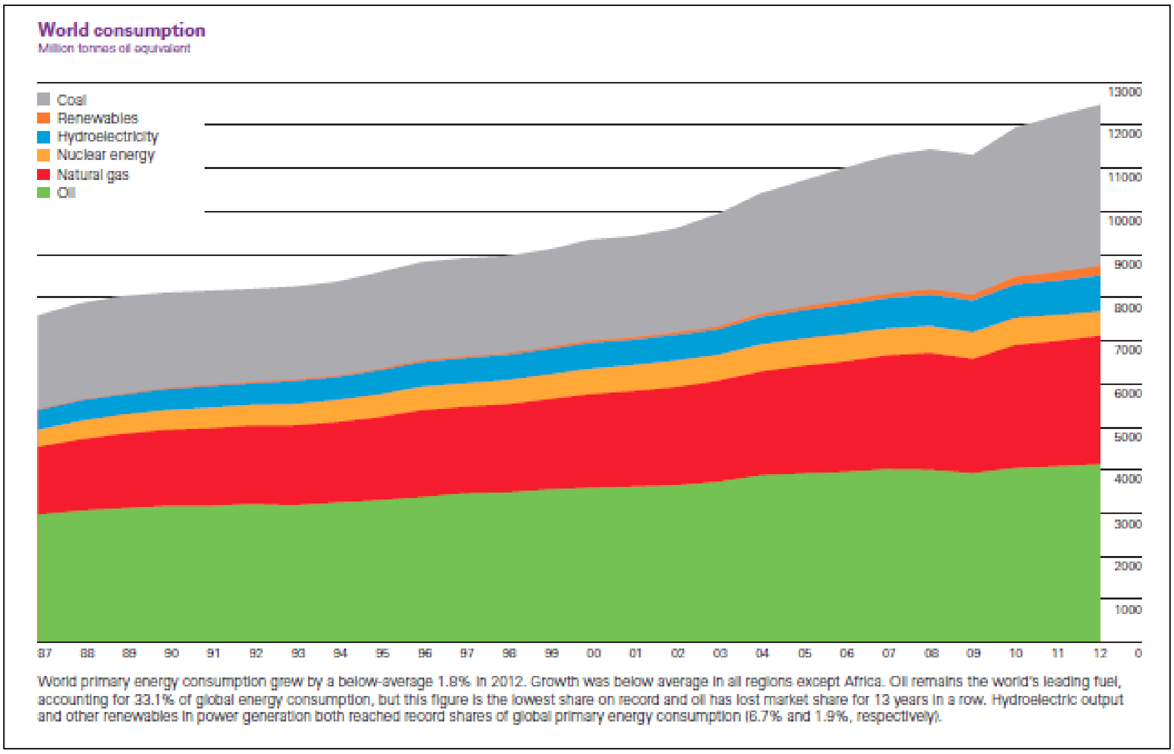
Geothermal is another type of renewable energy. The principle involved in geothermal power generation is that the temperature rises with depth to 270 degrees Celsius over about 3.5 kilometers (km) (it rises at an average rate of 1 degree every 12–15 meters). Thus this energy source is readily exploitable in areas of high heat flow, particularly in volcanic areas where it provides a natural hot water system ideal for cooking and central heating.

Wind power has been used as a source of power for millennia (e.g., the Babylonians and the Chinese 4,000 years ago). It was also harnessed to propel sailing boats and by mills to grind corn in the Middle Ages. Modern uses of wind power include pumping water and conversion to mechanical power for driving turbines, which account for 2% of worldwide uses.

A Closer Look at Why Oil Commands the Highest Demand

Figure 4.1 shows world consumption of various forms of energy.

FIGURE 4.1: WORLD PRIMARY ENERGY CONSUMPTION



Source: BP Statistical Review of World Energy, 2013

As Figure 4.1 indicates, oil is the greatest contributor to the world's energy mix, accounting for approximately 33% of global energy consumption. Various reasons why oil remains the leading energy source are as follows:

- The economies of the world are addicted to oil (cash value of $13 billion/day).
- Oil is easy to produce and use.
- Little waste occurs in production and usage of oil (compared to, for example, nuclear and coal).
- Oil is in liquid form and therefore easy to transport and convert to gas in engines.
- Oil is less bulky and cleaner than coal.
- Oil is best suited for transportation than other fossil fuels.

3. FOSSIL ENERGY AS A CATALYST OF INDUSTRIALISATION

The Movement from Coal to Petroleum

Ever since the Industrial Revolution in the eighteenths century, vast quantities of fossil fuels have been used to power economies and deliver unprecedented affluence to huge numbers of people. Fossil fuels are organic matter made from remains of flora and fauna subjected to immense pressure and heat deep within the Earth over millions of years. Coal, oil, and natural gas are major fossil fuels. During the Industrial Revolution, fossil fuels seemed to be the ideal energy source.

In recent times however, a paradigm shift from use of coal in industries to use of petroleum has occurred. Factories began using oil instead of coal to run their machines. Petroleum created new products with significant multiplier effect and helped other industries grow. Demand for workers in these new industries increased populations of urban areas and led to significant urbanization.

Petroleum Refining and its Offshoot Industries

Petroleum refining is a process that converts crude oil into finished petroleum products. It is an organized and coordinated arrangement of manufacturing processes that engineer physical and chemical changes of crude oil. It leads to attainment of salable products with specifications and volumes as demanded by the market. A wide range of products results from this process.

Industries that use products of the refinery either as fuel or as feed stock include the following:

- The automotive industry employs a wide range of products, including gasoline, gasoil, jet fuel, lubricants, and fuel additives. Large automobiles and ships use heavy fuel oil (HFO) to power their engines.
- Chemical and manufacturing industries employ feed stock such as naphtha, and produce a wide range of products including pharmaceuticals, solvents and inks, paints and coatings, adhesives, plastics and plasticizers, detergents, and ingredients for many cosmetics and pharmaceuticals, among others. The manufacturing industry may also use HFO as a source of power.
- In the construction industry, road construction and housing both utilize asphalt for tarmac and roofing, respectively. Asphalt (or bitumen) is part of "bottom of the barrel processing" in petroleum refining. This residue comes out as solid and is extremely viscous.
- In electric power generation, HFO is employed in thermal generation by use of generators. The power produced can be connected to the national grid and enter the pool for transmission and distribution. Alternatively, thermal generation can be used for small-scale processing industries, mainly agro-based industries. Some power plants utilize gas to generate electricity that can similarly be transmitted through the national grid.
- In domestic heating, cooking, and heating, the main products employed are natural gas (methane), liquefied petroleum gas (LPG), kerosene, and paraffin wax.

4. PETROLEUM INDUSTRY SUPPLIES AND SERVICES

The Petroleum Supply Chain

In the context of multiplier effects of petroleum development, the petroleum supply chain presents one of the most attractive business opportunities for suppliers and for the host country where petroleum operations occur. This is because a bulk of the money expended in petroleum operations is spent on supplies necessary for project execution. Typical supplies among others include:

- Drilling mud chemicals;
- Drilling pipes;
- Casing pipes;
- General equipment supply or lease (folk lifts, cranes, boats);
- Food supplies;
- Vehicles for transport;
- Computer equipment; and
- Camp equipment; and
- Office equipment.

As much as every industry involves supply requirements, none is as complex as the petroleum industry. It involves everything from supplying materials for oil rigs to moving extremely heavy equipment and hazardous materials, with transportation requiring special equipment, strict regulatory compliance, and extensive safety procedures.

In addition, logistics in the petroleum industry demands a great sense of urgency and need for visibility. Few industries are as financially vulnerable when complications arise. Many petroleum operations occur in remote regions of the world, and run 24 hours a day, 7 days a week all year round. If materials are not delivered on time, consequences are daunting. For instance, if an oil rig ceases activity as a result of lack of proper materials in place, $1 million per day can be lost during standby. Logistics reliability is paramount.—petroleum companies invest in outsourcing to ensure no service interruption, rather than risk a problem.

In spite of the challenges associated with the petroleum supply chain, industry suppliers often have sufficient motivation, given the enormous sums of money involved, to develop their capacity and expertise and obtain the necessary certifications required to supply the industry. This capacity development becomes invaluable even when a petroleum facility ceases activity, because the expertise can be transferred to another area of trade, or exported to other countries where petroleum operations are occurring.

In the final analysis, it is fair to conclude that the petroleum industry has enormous potential to transform several sectors of development.

Oil Field Services

The petroleum industry also has high demand for specialized and other general services—an opportunity for local firms to obtain contracts to offer these services.

Most specialized services require specialized training and professional competencies. This presents opportunity for training institutions in the host country to develop training programs to supply the necessary human resources. Typical services required by the petroleum industry include the following:

- Reservoir engineering studies;
- Transport;
- Clearing and forwarding;
- Environment consultancy;
- Construction and civil works;
- Fabrication and facility maintenance (plumbing, electrical, mechanical);
- Man power management services – recruitment;
- Support services (catering, camps, etc.);
- Banking and insurance;
- Legal services;
- Health services; and
- Housing.

With these potential areas of “everyone’s involvement,” opportunities presented by petroleum development and its attendant multiplier effects cannot be overemphasized.

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LECTURE 5: LOCAL AND NATIONAL ECONOMICS OF THE PETROLEUM INDUSTRY

SYLLABUS

Teaching Aims

(i) To introduce to participants the general concepts/tools of economics and how these are applied to operations and functions of the petroleum industry.

(ii) To provide an overview of interaction among demand, supply, and prices, and relationships among technical aspects of the industry and their effects on the economics of the industry.

(iii) Create understanding of international petroleum markets and how these influence national economics.

Learning Objectives

(i) Describe the linkage between the petroleum industry and other day-to-day operations within the community and economy.

(ii) Explain the role, influence, and socio-economic benefits of the petroleum industry to the economy.

Outline of Lecture Content

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Lecture.
Brain storming
Q&A session
Peer-assisted learning
Handouts
Video clips
Discussions and team presentations
Graphic illustration</td></tr>
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<tr><td>3. Overview of Capital Investment and Risk Analysis</td></tr>
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DETAILED NOTES

1. IMPORTANCE, INFLUENCE AND ROLE OF PETROLEUM IN THE NATIONAL ECONOMY

This lesson introduces various foundational fundamental principles of petroleum economics to staff of the Environmental Pillar Institutions (EPI) to emphasize the importance of the petroleum industry in both local and national economies. This lesson unit conveys application of economic tools of analysis for positioning and understanding the role of the petroleum industry in economies of countries that own natural resources and should ordinarily benefit from those resources. The lesson unit focuses on economics and the pertinent forces that drive the petroleum industry, markets, and players.

Petroleum is important in the economy because of the following:

- Factor input;
- Influence through political and economic spheres; and
- Energy transition.

Factor Input

Economists recognize four factors in production of goods and services: land, labor, capital, and entrepreneurship. Though critical in all major economic activities, energy (oil, gas, and electricity) is categorized as part of land, which covers all natural resources. This categorization also embraces all primary energy sources. As a factor of input, energy is widely used in all sectors of the economy—including homes, businesses, industry, and travel.

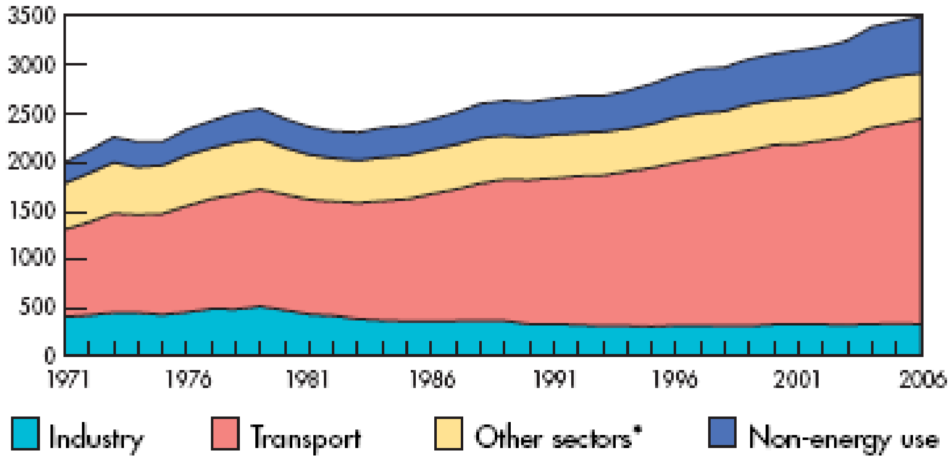
The International Energy Agency (IEA) classifies energy use into four sectors: residential, commercial, industrial, and transportation.

- Residential use of energy includes heating, cooking, and lighting in our homes.
- Commercial use of energy mainly refers to heating, lighting, and to a lesser extent, cooking in commercial buildings, such as offices, hospitals, schools, police stations, churches, warehouses, hotels, libraries, and shopping malls.
- Industrial (manufacturing) sector covers many different uses of energy sources, including boiler fuel (producing heat that is transferred to the boiler to generate steam or hot water) and process heating (energy used directly to raise the temperature of products in a manufacturing process. Specific examples include separating components of crude oil in petroleum refining, drying paint in automobile manufacturing, and cooking packaged foods. Energy-intensive industries include iron and steel, basic metals, mining, construction, and the chemical industry.
- Transportation includes energy use by cars, trucks, airplanes, ships, railways, and tractors on farms.

Petroleum can also be used for non-energy purpose, for example, as a feedstock to petrochemical industries.

Global use of energy is shown on Figure 5.1 below.

FIGURE 5.1: WORLD OIL CONSUMPTION BY SECTOR



Source: International Energy Agency (IEA), n.d.

Discussion:

Engage participants in discussion about the increasing use of energy for transport, which is significantly outstripping use of energy in the other sectors. Emphasize that few alternative fuels can be used in the transportation sector, while other fuels (e.g., natural gas, coal) can be utilized in other sectors.

Influence through Political and Economic Spheres

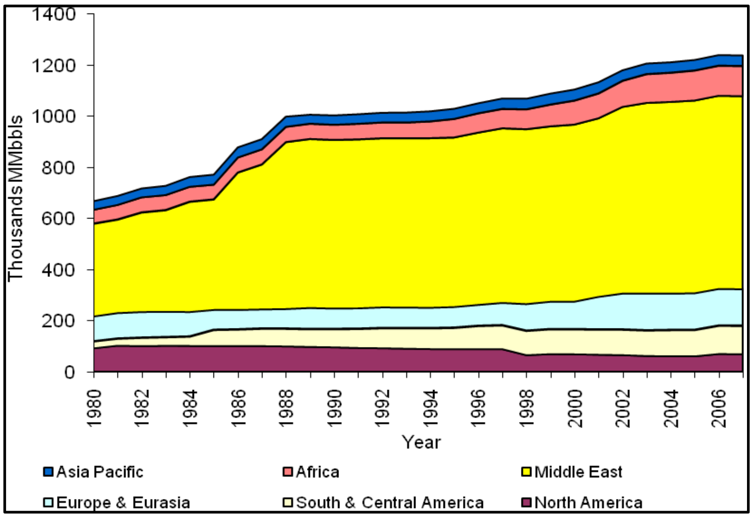
Oil is an important economic variable with far reaching impact on economic trends and international prosperity. Some have suggested that energy is the lifeblood of the global economy—a crucial input to nearly all goods and services of the modern world. The energy industry also extends its reach into economies as an investor, employer, and purchaser of goods and services.

Undoubtedly, stable, reasonably priced energy supplies are central to maintain and improve living standards of billions of people. For example, price of oil varies inversely with general growth of the global gross domestic product (GDP). Relatively higher energy prices universally dampen economic growth except in economies dominated by energy production. The 1973-74 oil crisis and current oil price volatility bear out this inverse relationship. Global oil prices entered an extended upward swing in 2004, and the trend accelerated sharply in 2007. This price rise contributed to the deep recession in the developed world that began in late 2007. Rising energy prices remove purchasing power from consumers, particularly from lower-income groups. They also negatively impact consumer confidence, leading to a decline in consumer spending. Oil price increase may accordingly negatively affect consumption, investment, and unemployment. Oil price increase has led to inflationary shock and may exert secondary effects via the price-wage spiral/swoop.

Importance of petroleum is evident in geo-political dynamics. Oil has been at the center of wars and political tensions enveloping the Middle East. A statement by a U.S. Senator underscores the importance of oil in geopolitics: "if Kuwait were a carrot producer, it would still be under Iraq occupation."

Figure 5.2 shows proved petroleum reserves by region.

FIGURE 5.2: REGIONAL PROVED PETROLEUM RESERVES



Source: British Petroleum, 2008

Africa (Price Waterhouse, 2014) currently has a share of about 10% of global oil production, a drop from 12% a several years ago. The untapped proven oil reserves are estimated to be 8% of the global total. The encouraging news is a flurry of activities focusing on exploration of natural resources, and undoubtedly Africa's share of reserves will increase as appraisals of new discoveries ensue. Year 2013 bears this out: of the 10 biggest discoveries of natural resources in the world, six occurred in Africa.

The impact of oil on a country depends on position of that country in the oil chain. Some countries produce and export oil, while others are importers. For oil importers, oil often is a major drain on balance of payments and correlates positively with the inflation rate. African countries with import-dependent economies are also adversely affected by shifts in oil supplies and prices.

Oil producing and exporting countries receive astronomical oil revenues, and many come to depend heavily on oil revenues, rendering them vulnerable to fluctuations in oil prices. Large-scale revenues can damage an economy, crowding out the manufacturing sector and agriculture. Some African countries have evidenced these failings, with high dependence on oil, as indicated in Table 5.1 below:

TABLE 5.1: AFRICAN COUNTRIES WITH HIGH DEPENDENCE ON PETROLEUM

Country	Dependence Level (percentage of exports)
Algeria	97.8
Nigeria	97.8
Libya	96.9
Angola	92.2
Gabon	79.5
Sudan	74.2

Source: United Nations Conference on Trade and Development [UNCTAD], 2007
Note: This is based on percentage of total exports over a five-year period (2000-2004)

Interestingly, except for Yemen, oil exporting Arab countries' dependence on oil is less than 90%. The related consideration is that, possibly, excessive government involvement in the economy as the government dispenses oil revenues crowds out other economic activities. This could also be the result of a bad attack of Dutch Disease[6] or the Resource Curse[7]. Petroleum production projects

[6] This refers to over-evaluation of the exchange rate because oil revenues create inflation and lead to appreciation of the exchange rate because the currency is perceived as a petro-currency.

[7] This is a matter of universal concern where richly endowed resource countries are mired in poverty—attributable to poor policy choices and corruption that unwittingly exacerbates the cycles of poverty and conflict.

involve huge capital investments, and lead to large projects with a multiplicity of linkages. Production also competes with other economic activities, leading to displacements of these, with implications for the environment, populations, and human rights. The ultimate interest is whether oil activities can be integrated into the national economy without much adverse impact on people, environment, and economy.

Energy Transition

"Energy transition" occurs when the main or primary source of energy in an economy changes. For example, in the United States, two energy transitions occurred between 1860 and 2000. The first occurred between 1860 and 1900, when wood was replaced by coal. The second occurred between 1900 and 1970, when coal was replaced by oil.

The switch from wood to coal began because of a growing shortage of wood within commercial distance of markets (wood had been a high-volume, low-value commodity). The result was a rise in relative prices for wood, leading to greater interest in coal, which in turn induced improvements in the technology of producing and burning coal such that coal became relatively cheaper. The second transition was also driven by relative prices (oil became relatively cheaper than coal), but as well, improved technology led to development of the automotive engine (gasoline- and diesel-powered) and development of flight.

What will be the next transition? When it will occur and with what fuel is debatable. Some think gas will be the next major fuel, others solar, and others hydrogen. Some drivers of the next transition might include growing concern about environmental damage from burning coal and oil. If people predicting future oil shortages are correct, this would also force a transition.

2. INTRODUCTION TO THE PETROLEUM VALUE CHAIN

This lecture unit introduces the labyrinth through which the petroleum industry will move from search for the natural resource through to its distribution in the market. Participants will appreciate the different levels, and how these influence the government policy mix regarding the petroleum industry.

What is a Value Chain?

A value chain identifies the full range of activities and tasks required to bring a product or service from its conception, through the different phases of production (involving a combination of physical transformation and input of various producer services), delivery to final customers, and final disposal after use. The chain actors who transact a particular product as it moves through the value chain may include input providers, processors, transporters, traders (wholesalers and retailers), and final consumers.

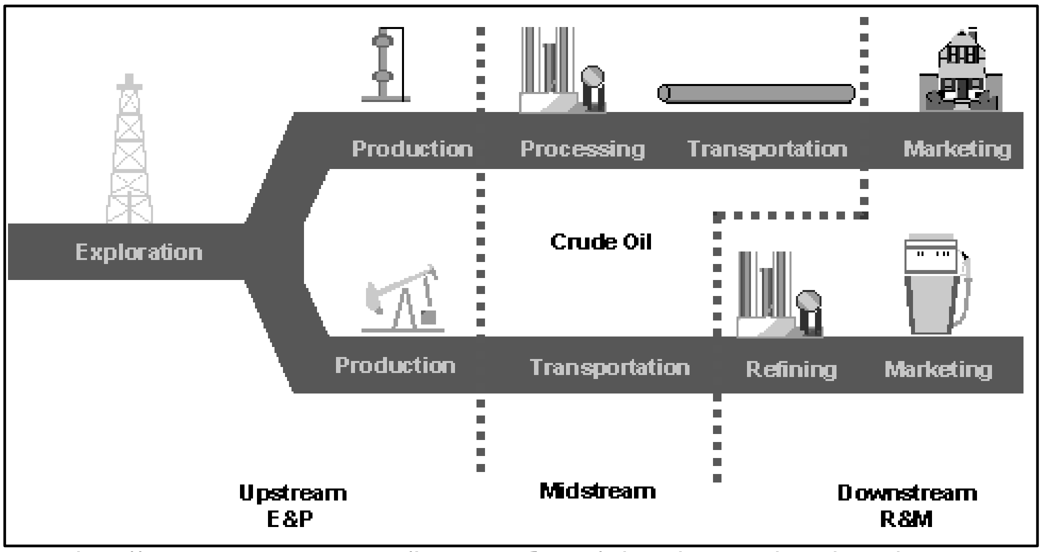
Discussion:

Apply the concept of value chain to different activities such as agriculture and mining.

The Petroleum Value Chain

Figure 5.3 shows the petroleum value chain. Ensuing Tables 5.2 and 5.3 explain the value chains for crude oil and natural gas, respectively.

FIGURE 5.3: THE PETROLEUM VALUE CHAIN



Source: http://www.petrostrategies.org/Learning_Center/oil_and_gas_value_chains.htm

TABLE 5.2: CRUDE OIL VALUE CHAIN

Exploration		Production[8]		Transportation		Refining		Marketing
Using technology to find new resources		Bringing oil to the surface using natural and artificial methods		Moving oil to refineries and consumers with tankers, trucks and pipelines		Converting crude oil into finished products		Distributing and selling refined products

Source: http://www.petrostrategies.org/Learning_Center/oil_and_gas_value_chains.htm

TABLE 5.3: NATURAL GAS VALUE CHAIN

Exploration		Production		Processing		Transportation		Marketing
Using technology to find new oil resources		Bringing gas to the surface		Treating gas to be sent to markets		Moving gas with pipelines and tankers		Distributing and selling natural gas

Source: http://www.petrostrategies.org/Learning_Center/oil_and_gas_value_chains.htm

Exploration and Development Stage

Normally, the natural resource deposits sought for commercial exploitation consist of gas, oil, and water contained within porous rocks, allowing their movement. Often, the deposits lie under an impervious cap rock. There are, however, infrequent cases where the deposits lie on the surface if the cap rock has been eroded by extended periods of weathering. To discover the petroleum deposits thus requires geological and geophysical surveys to determine the underground geology. Geophysical surveys can be magnetic, gravity, or seismic, the latter being the most expensive and sophisticated. Recent developments in computer technology have allowed use of three-dimensional seismic surveys, and even more recently, once the field is producing, four-dimensional seismic surveys, with time as the fourth dimension. However, the only sure way to establish presence of oil or gas is to drill an exploratory well called a "wildcat."

[8] This would include the development decision.

Three types of risks under the exploration stage define the risk profile of a given petroleum industry. These risks depend particularly on concealment of petroleum deposits underground:

- Prospect risk;
- Contract risk; and
- Commercial risk.

Prospect Risk

This is the risk from possibility that the prospecting company may not discover hydrocarbons in commercial quantities. This would imply that the wildcat is technically a dry hole. Drilling is a very expensive venture, and requires capital and financial outlays beyond the capacity of most developing countries such as Uganda. In practice, most developing countries place the prospect risk on the companies carrying out exploration of oil. This implies no claim against the government if a company drills a well that ends up as a dry hole.

However, improvements in exploration technology have lowered the risk of finding a dry hole. Advanced technology has enabled the more or less reliable predictions that of the world's unexplored basins, 20-50% contain hydrocarbons, and that, however, only 10% of drillable targets contain oil.

Contract Risk

Often, Governments enter into contracts with oil companies that would provide a probable share of profits from the venture. This occurs, however, at a point of conjecture, and when actual discoveries occur, the agreements are reviewed. In developing countries, the petroleum and the land under which it is found belong to the government. As the owner, government has stronger bargaining power, and this accounts for the concept of the "obsolescing bargain" whereby the government begins to try and squeeze ever better terms from the agreement.

Commercial Risk

Two types of commercial risks are involved in petroleum exploration. First, the geology may turn out to be less than favorable. Whereas the geological and geophysical surveys suggest what may be underground, the decision to embark on development depends on data from only one well—the wildcat. If this information is not borne out by the geology, the cost of development and production may adversely affect profitability of the field/venture.

Second, because the petroleum market is very volatile, predicting market conditions for its products is very difficult, considering the extended lead time due to petroleum exploration and development. For example, a several years ago, the oil price was about US$ 100 per barrel, but currently approximates US$40. It is also possible that profitability has been compromised by rising costs of professional staff engineering, procurement of raw materials, and equipment within the past several years.

Development and Investment Decision

Deciding to carry out development of an oilfield is a deliberate and well-considered investment decision, which involves creating capacity to produce oil. This entails drilling development wells and then capping them with "Christmas Trees" to control their flow. The function of these wells is to increase production.

The investment decision is based on well-considered predictions that are the basis for determining the recovery factor and subsequently determining project cash flow.

It is important to construct a development plan for the oilfield that lays out a roadmap for the oil company and typically includes the following items:

- Number of wells to be drilled and completed for production and injection;
- Well spacing and pattern;
- Processing facility requirements;
- Transportation options;
- Cost projections; and
- Project schedules and depletion plans.

Production

This is the next stage in the value chain that involves sustained removal of petroleum from the underground. It is carried out via application of three recovery methods:

- Primary recovery method, which involves utilizing natural pressure in the underground reservoirs, which may be several km from the surface, to drive the oil to the surface. Typically, the primary recovery can yield about 20% of original oil-in-place.
- Secondary recovery method, which entails injecting gas or water through injection wells to maintain reservoir pressure and to displace oil to the wellbore. Successful use of primary recovery and secondary recovery can yield 25-40% of original oil-in-place.
- Tertiary recovery methods, which entail more advanced methods of recovery such as washing the oil out with chemicals, or raising its temperature by burning or use of steam hoses. These methods can recoup an additional 5-15%.

Primary recovery and secondary recovery together are called "conventional recovery," and tertiary recovery is known as "enhanced oil recovery." Notably, changing production methods raises costs of production.

Production Phases

There are primarily three Production phases: the development phase, the plateau phase, and the decline phase. The development phase is the initial phase during which output increases as more development wells are drilled and successfully put into production. When the desired number of wells has been drilled, production reaches peak level (at the plateau phase) and may stay there for a years. Afterwards, production starts to decline (the decline phase) as pressure in the reservoir falls, and ultimately ceases when value of production cannot cover operating costs.

Petroleum Transport

Transport of oil is a delicate and demanding venture. Oil can be transported by a variety of means including water-borne barges and tankers, pipelines, railways, trucks, and even horse wagons. Gas transport is limited to pipelines unless it is converted to liquid. There is universal preference to use pipelines because of their considerable economies of scale. Transport of oil is, however, more often affected by trans-border considerations.

Refining

Refining is the process through which crude oil, a mixture of chemical compounds, is broken down and separated into useful products such as gasoline, kerosene, diesel, fuel oil, lubricants, and so on. The various components within crude oil are selectively reconfigured into new products. All refineries perform three basic functions: separation, conversion, and treatment.

Developing countries such as Uganda are challenged by the decision whether to own an oil refinery as part of the petroleum industry. This is appealing as a political decision, but critical economic considerations must be considered. Even if this decision is affirmative, a subsequent decision is necessary regarding location of the refinery. Options available include location at the oil fields, at the markets, or at some intermediate point. From an economics perspective, the decision regarding refinery location is to balance crude transportation costs and delivery costs of refined products. Because refineries receive crude oil inputs in bulk quantities and send out refined products in smaller quantities, economies of scale in transportation imply that it is generally more economical to locate a refinery closer to market than to an oil field. This argument would ordinarily discourage developing countries from building refineries, as these countries do not provide the major markets for the petroleum products.

Marketing and Distribution

Oil companies use a variety of distribution channels to distribute their petroleum products. These include:

- Using their own retail outlets;
- Granting a franchise to the outlet of an independent dealer and directly supplying it with petroleum products such as gasoline or diesel;
- Utilizing an independent wholesaler or "jobber," who gains the right to franchise the brand in a particular area; and
- Using "hypermarkets" such as Carrefour (France), Tesco (UK) and Wal-Mart and Costco (United States).

The mix of distribution channels varies widely across firms, and refiners often employ a combination of distribution channels, depending on which type is perceived as most efficient.

3. OVERVIEW OF CAPITAL INVESTMENT AND RISK ANALYSIS

This lesson unit introduces course participants to concepts of investment management and analysis. Ultimate intent is for participants to understand that parties in the petroleum industry commit resources with a view to earn profits, and that project viability is a critical consideration in the decision-making process. In engagement with the oil companies, one should never forget that oil companies are note charitable do-good institutions.

Time Value of Money

Time value of money is a concept that value of money today as not the same as yesterday or tomorrow (future). The difference between value of money today and in the future may be due to factors such as:

- Possibility of inflation (money losing purchasing power), so that, say, $10,000 that could buy an item today would not suffice to buy the same item at some future date.
- When a person is denied use of money today through, say, investment, such person would need to be compensated by payment first of the risk-free rate, and second of the risk premium, which is a compensation for exposure to various types of investment risk.

Compounding and Discounting

In determining the time value of money, consideration is given to present value (PV) and future value (FV) or expected value; these values are determined by operations known as compounding and discounting.

For compounding, take a monetary value today (PV), and by applying an interest factor to it (I/YR) over time (N), arrive at a bigger value in the future (FV). When one calculates the PV of an investment, one is carrying out a compounding operation. This is an exponential effect, as it takes the value today and multiplies it by a factor to the power of the number of periods.

Example:

Happy Limited invested US$ 100,000 today at a rate of interest of 10%. FV will be:

FV = PV (1+0.1)5

FV = 100,000 (1.1)5

FV =US$ 161,051.

Normally in an investment, the initial capital outlay is an outflow and is therefore a negative value. The value that one gets after considering capital outlays is referred to as net present value (NPV). NPV is accordingly the total PV of a time series of cash flows. It is a standard method for using the time value of money to appraise long-term projects. It measures the economic surplus or shortfall of a project in PV terms after taking into account all capital outlays.

Discounting involves taking a value in the future (FV) and bringing it back to today's terms and price. The FV of US$ 161,051 in year 5 is translated to the PV, which is US$ 100,000.

This would involve the following process:

PV= FV/ (1+0.1)5

Interest

Interest is compensation for lost opportunity for which capital would have been utilized. It is the reward for capital as a factor of production.

Interest could be period, nominal, or effective. Period interest is interest determined for a period, e.g., 2% per month or year. Nominal interest is the quoted interest, for example, quoted interest per year in a case of multiple compounding. Effective interest refers to nominal interest converted to annual basis.

Interest computations are either simple or compound. Simple interest is calculated period interest based on the original principal amount. Compound interest is determined based on capital sum plus any outstanding interest.

Cash Flow and Profitability

Investment analysis uses cash flows in a firm to determine viability of a project. Cash flow depends on movement of money within and out of the firm. Cash flow shows a firm's liquidity. A firm with cash flow challenges will not be able to meet its commitments, and with budgets in disarray, this may lead to deferment of capital expenditure or delay debt repayments. On other hand, profitability considers all resources outlays used in a project including non-monetary outlays such as depreciation and other reserves. It is conceivable that a project is profitable while it encounters liquidity challenges. The categorization that produces profits also considers long-term or capital expenditure, as opposed to revenue expenditure or working capital.

Risk Analysis

Risk refers to the chance that an investment's actual return will be different than expected. This includes the possibility of losing some or all of the original investment. This would happen because the future is not perfectly predictable. A predictable situation is low risk, while an unpredictable situation is high risk.

Determining Project Viability

Through considering the preceding concepts, one can determine the viability of a project. First, to consider whether one will carry out development of the oilfield, one needs to conduct economic analysis. Given the unpredictability, risk, or uncertainty of the exploration outcome, the economic analysis often utilizes probabilistic techniques in evaluating exploration projects. A commonly used tool is the expected monetary value (EMV) approach. It entails weighing each possible outcome from, say, a dry hole, a big discovery, or a small discovery with a probability (or likelihood), and calculating the weighted average of NPVs.

Example:

Oil Limited carried out exploration in the Albertine Graben area and found the following:

Probability of finding	With the NPV (in US$ billion)	Rate of Probability (%)
a dry hole	-2.5	25
a small reserve	1.5	35
a medium reserve	1.2	20
a large reserve	0.75	10

The EMV will be:

EMV=(-2.5)(0.25)+(1.5)(0.35)+(1.2)(0.2)+(0.75)(0.1)= 0.215 billion dollars

In this case, the exploration project could be undertaken because EMV is positive. The probabilities are typically determined on the basis of geophysical and geological survey information and may be subjective (or determined via gut sense), although use of modern portfolio methods such as such as Monte Carlo simulations has greatly improved accuracy of probabilities.

Determination of viability of a project should also consider financing costs of the necessary capital outlays.

Investment Decision and Portfolio Analysis

Investors in the petroleum industry are presumed rational. In line with Markowitz (1959), investors are expected to be cautious when investing and willing to take are only the smallest possible risk (under the circumstances) in order to obtain the highest possible return, optimizing return to the risk ratio. The other underlying consideration is that investors would opt for diversification to reduce overall risk and volatility of their combined investments or portfolios.

Exercise:

Conduct exercises to validate participants' conceptualization and assimilation of skills via group discussion and demonstration.

4. FISCAL MATTERS

This lesson unit overviews fiscal matters with implications for the petroleum industry. Often, fiscal policies and practices adopted by government influence and determine ultimate profit that an investor takes out a project, and can determine whether a project will be viable or unviable. Participants will appreciate the importance of proper fiscal management for a nation to take appropriate share of a natural resource.

Fiscal Regime

The perennial challenge facing governments in designing a fiscal regime is how to construct a regime that will bring into state coffers a publicly acceptable share of revenues without discouraging private investment. The rent-based[9] fiscal regime should ensure that both government as owner of the resources and the investor obtain maximally competitive returns so that each has incentives to

[9] This is based on the concept of Economic Rent or Producer Surplus, which represents the difference between the cost of producing something, including a reasonable level of profit, and the price at which it is sold.

continue the partnership. The system must be simple, rendering compliance easy, manipulation difficult, and risks affordable. It should also be stable, instilling in the private sector the confidence needed to invest for the long term.

Types of Fiscal Regimes

Two primary broad categories of fiscal regimes or models are as follows:

Concessions (also Called Licenses or Tax/Royalty Systems)

This regime usually has royalties, corporate income taxes, and special taxes as its main components. The concession would traditionally entail giving the investor a free hand with more or less exclusive rights over the resources within a vast area for long durations. The investor assumes all risks and costs associated with exploration, development, and production of petroleum within the area covered by the concession. Governments are increasingly withdrawing and taking the liberty to review concessions to their favor. The main forms of rent capture under the concession arrangement are signature bonuses, royalties, income taxes, indirect taxes, surface taxes, resource rent taxes, work commitments, and ring-fencing. The importance of ring-fencing or consolidation is to preclude the possibility of a company carrying out multiple projects to defer tax payments by using losses from different areas or projects; for tax purposes, each contract area or project is delineated from others. Examples of countries whose governments use this regime are the United States, Canada, Norway, UK, Brazil, Algeria, South Africa, Thailand, and Australia.

Contracts, (which include Service Contracts and Profit Sharing Agreements)

The two categories under this fiscal regime are conceptually different in terms of levels of control exercised by government, ownership rights, and the mechanism of sharing risks and rewards/compensation between the investor and host government. In practice, hybrid arrangements with features of both categories occur, such as profit sharing agreements with taxes in Nigeria, Russia, and China.

Some countries prefer to use profit sharing agreements because these offer opportunity not only to assert national sovereignty over a natural resource but also allows the country to progressively enter into the complexities of petroleum exploration, development, and production operations. The contracted corporation is hired to explore for and produce hydrocarbons within a specified area and for a limited time period. The contractor assumes all exploration risks and costs in exchange for a pre-negotiated share of profit from petroleum produced in the contracted area. Importantly, ownership of the resource is retained by the state, and is surrendered to the contractor only at time of delivery or at the exporting point. Government must impose a ceiling on the cost of oil that is recoverable to discourage excessively increasing costs or "gold plating." The principal drawback of profit sharing agreements is that these require refined understanding of petroleum operations necessary to monitor and supervise the complex international corporation's activities in the host country. Profit sharing can take any of the following formats (Table 5.4):

TABLE 5.4: FORMS OF PROFIT SHARING

Form	Description
Daily Rate of Production (DROP)	Government share of profit petroleum increases with daily rate of production from the field or license, often with several tiers. Weaknesses are that field size is often a poor proxy for profitability, and the mechanism is not progressive with respect to oil prices or costs. Attempts have been made to blend this with a scale of prices.
Cumulative production from project	Government share of profit from petroleum as total cumulative production increases—again an inaccurate proxy for the contractor's rate of return. Such schemes are becoming rarer.
R-factor	Government's profit share increases with the ratio of contractor's cumulative revenues to contractor's cumulative costs (the R-factor). This improves on

Form	Description
	DROP in being a more direct measure of profitability, but does not recognize the time value of money.
Rate of Return (ROR)	This is a form of rent tax (provided that exploration is part of costs) under which the government's share is set by reference to the cumulative contractor rate of return, no tax being levied if that falls short of some benchmark rate. Single or multiple tiers are used, though staff analysis suggests a single tier is effective.

Source: International Monetary Fund, 2012, Page 17.

Examples of countries whose governments use these regimes are Indonesia, Malaysia, Egypt, Gabon, Ivory Coast, Syria, Yemen, and Trinidad and Tobago.

Service agreements entail contracting a corporation to carry out exploration and/or production in a specified area over some limited time for either a fixed or variable fee. Under the restrictive risk service contract, the contractor finances and carries out the petroleum operations and receives a fee in kind, which allows for recovery of all costs and includes a profit component. In other service contracts, the government may opt to participate in the oil venture through state equity. Government may offer a "working interest" as it becomes a partner in a joint venture with other investors. Often, government will enter the venture after confirming discovery of petroleum, having left the private investor to assume all exploration and development costs and risks. Currently, risk service contracts exist in Mexico and Iran, while Iraq and Kuwait are considering these.

5. FISCAL INSTRUMENTS

Fiscal instruments (Tordo, and Johnston. 2009, 52) include the following:

- Bonuses: This instrument is paid by the investor upon occurrence of a specific event, such as contract signature, discovery, declaration of commerciality, commissioning of facilities, start of production, and/or reaching target production levels. The maximum level of a bonus depends on several factors, such as overall fiscal terms, characteristics of the asset, country political risk, and risk profile of the investors.
- Royalties: This is an instrument based on either the volume ("unit" or "specific" royalty) or the value ("advalorem" royalty) of production or export.
- Ring-fencing: This refers to delineation of taxable entities and may be applied to the contract area or the individual project. Normally, when ring-fencing is applied at the contract area or project level, income derived from one area/one project cannot be offset against losses from another area/project.
- Corporate income tax: This refers to taxes payable when annual revenues exceed a certain measure of costs and allowances. The applicable rate is fixed, and may be the same or higher than other industries.
- Progressive income tax: This instrument uses stepped tax rates linked to prices, volumes, values, and so on. The instrument is a tax additional to the conventional corporate income tax.
- Resource rent tax: This instrument ties taxation more directly to project's profitability (R-factor or rate of return).
- Government participation: This includes a range of options—from carried interests, joint venture to full equity.
- Cost recovery limit: Defines percentage of net crude oil that can be used for cost recovery. Carry forward of unrecovered costs may be limited or unlimited.
- Profit oil or gas split.

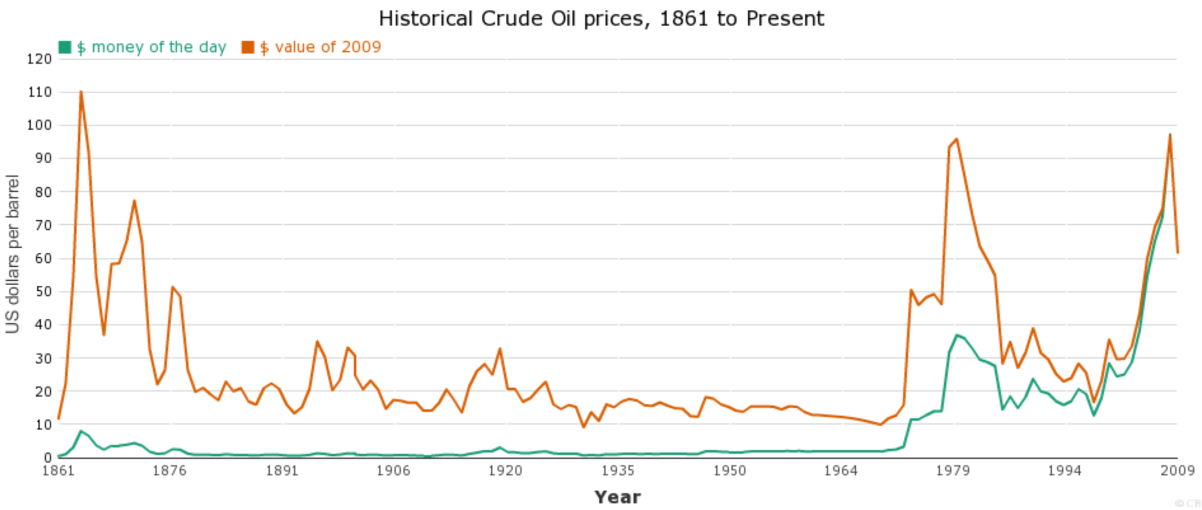
6. OIL MARKETS AND PRICING

Undoubtedly, energy prices tend to be more volatile than prices of other commodities, and this has implications for petroleum markets. Developing countries depend on petroleum as either a source of income or a material to be used in support of other economic activities. This lesson unit focuses on fluidity of petroleum market and prices.

Overview of Petroleum Markets

Petroleum prices tend to be more volatile than prices of other commodities. This may be explained by factors such as short-term inelasticity of energy supply and demand, or by speculation in energy commodity markets. Volatility of oil and other energy prices has also been trending upward since the mid-1950s, with particularly dramatic increases following the 1973 oil crisis, deregulation in 1981, the 1991 Gulf War, and the post-2008 crisis. Figure 5.4 below shows the trend in oil prices over the past two centuries.

FIGURE 5.4: CRUDE OIL PRICE 1861-2007



Source: ChartsBin, 2009

History of Oil Prices

Systems used for energy pricing are as follows:

- Gulf Plus Basing Point: This was a cartel arrangement system established in 1928 by the as-is agreement to stop price wars. The starting point was the U.S. domestic price of oil products in the Gulf of Mexico, and to this was added freight cost of moving the product to its destination.
- Oil Prices Post-World War II: During the period 1949-1973, price was set by the major oil companies. They set the price for each crude oil as it emerged.
- Impact of Persian Gulf Oil: Increased production of oil from the Persian Gulf led to erosion of the real price of oil, and control of the market by major oil companies weakened. It was no longer possible to maintain the link between U.S. domestic and international prices that had been the basis of the Gulf Plus Basing Point system.
- OPEC take-over: With decline of excess capacity at the advent of the 1970s (partly because of producer governments taking over the operating companies, leading to a freeze of investment in producing capacity by the major oil companies) and spectacular growth of demand occasioned by the global economic boom, OPEC unilaterally decided to announce a fourfold increase in price between October and December 1973. This was the first oil shock.

Subsequent political considerations, emergence of notable producers outside of OPEC, and inability of OPEC to obtain complete information have diluted OPEC's control over the petroleum market and prices.

Factors Determining Energy Prices

Source: Cantore, Antimiani, and Anciaes, 2012

One of the most common explanations offered for the recent energy price increase is disequilibrium between global oil supply and demand. Recently, increased demand has coincided with stagnant supply. The increase in oil demand is linked mainly to fast growth of emerging economies such as China and India. Although China has been growing rapidly for 25 years, only within the past decade has the size of its economy become large enough to influence the global oil market significantly. Changes in demand are thus particularly relevant to the 2007-8 shock, as previous oil shocks had been caused mainly by physical disruptions of oil supply.

Another consideration could be the influence of geopolitical events on oil prices owing to expectations of future disruption in oil supply. Uncertainty about this can also contribute to competition in financial markets, leading to further price increases. Overall, geopolitical tension in oil-producing countries may affect oil prices by a third for one to two years.

Some also have suggested the significance of macroeconomic factors related to the economies of the United States or other key countries, such as variable decreases in interest rates and in the value of major currencies such as the US dollar. This is based on the assumption that prices in commodity markets (such as oil) tend to be efficient. A decline in nominal interest rate would render investments in the oil market more attractive than investments in the financial market, and then increase demand. At the same time, this would lower supply because extraction of exhaustible resources would become less profitable than investing the proceeds in financial markets. As crude oil is mainly priced in U.S. dollars, a depreciation of this currency leads to lower prices in other currencies, increasing demand and decreasing supply. A more controversial aspect regards the role of speculation in the volatility of oil markets. A series of studies claims that speculation has amplified the price surge initiated by the disequilibrium between demand and supply.

Public Regulation and Implications for Oil Supply and Demand and Pricing

Tissot (2010), in analyzing Latin American fiscal regimes, noted a pendular character to government decision-making, with governments moving alternately between populism and focused, market-oriented models. Approaches adopted—including investment in the industry, level of government take, role of national oil companies either as monopolies or privatized companies—will affect energy prices. The challenge for policymakers is to take into account and learn from that history, and design more stable fiscal models that resist not only the uncertainties caused by price variances but those due to political fluctuation

7. LOCAL AND NATIONAL POLICIES ON EXPLOITING OIL

This lesson unit focuses participants on the role of the petroleum industry in supporting development of the national economy. It explores initiatives and policies that would enable the industry to add value to communities through integration with and facilitation of local businesses and labor to achieve the international level in the energy sector.

Discussion:

Consider how the petroleum industry can be integrated or linked to local economic activities.

Cluster Development

Normally, government focuses on reaping economic effects of petroleum exploitation and development through primarily higher government revenues. Oil companies may be an island of prosperity not fully integrated or functionally linked with the local economy, and thus not leading employment creation and spurring broader regional prosperity and economic diversification via increases in knowledge, skills, relationships, and infrastructure. Industry clustering is a powerful framework for regional development because it captures economic relationships among specific industry sub-sectors. Close contact and knowledge exchange in a cluster boosts competitiveness of its members and the region as a whole. Avenues for industry clustering include:

- Promoting value-added downstream industries, such as refining or petrochemical processing;
- Developing networks of upstream suppliers by enhancing capacities of local firms to deliver inputs that would typically be imported from outside the region; and
- Developing complementary activities as bases for a new seed cluster or innovative product, and therefore a potential new source of revenue for the region.

Supportive Public Policies

Supportive public policies can encourage growth of value-added petroleum industry clusters, including:

- Well-crafted facilitation via services of public-sector officials as advisors who bring together stakeholders and encourage the right mix of collaboration and competition. They may implement marketing strategies and encourage development of industry associations. Policy-makers can also identify gaps between suppliers and buyers, and recruit businesses to fill them.
- Local content requirements—mandating, as do many energy-producing jurisdictions, local procurement of a portion of material inputs and labor. Though these requirements would support development of local industry, these should not be structured in a way that raises costs or delays projects. This would especially be counterproductive if local goods and skilled workers are not available in sufficient quantity and quality. Local procurement is as high as 90% in some countries.
- Government policy support for development of specialized resources and infrastructure—for example, "hard infrastructure" needed by industry, transportation networks, pipelines, and telecommunications networks. Also crucial is "soft infrastructure," such as financial institutions and regulatory systems.
- Policymakers can help local residents gain industry-specific skills by supporting training, higher education, and lifelong learning programs.

Sharing Oil Revenue

Whereas in most producing countries, central governments maintain responsibility for collecting revenue from the petroleum industry, statutory provision also is in place to grant local authorities a portion of the revenue to support local programs and deal with energy impacts on the environment and ecology.

8. NATURAL GAS

This lesson unit focuses participants on the future of natural gas as a clean source of energy for developing countries to adopt to stem the spiraling destruction of the environment.

Natural Gas Features

Natural gas can be produced either from an oil field as associated gas or from a gas field as dry gas. Compared with coal or oil, natural gas has many environmental advantages. In producing the same amount of heat, burning natural gas emits only 50% of carbon dioxide and 20% of nitrogen oxides emitted by burning coal. Sulfur and mercury content of natural gas is almost zero.

Similar to oil, natural gas is also used by residential, commercial, and industrial customers as a primary energy and as a feedstock for chemical industries. Residential households and commercial buildings use natural gas to fuel stoves, furnaces, water heaters, and other home appliances. Industry customers use gas as a primary energy to produce electricity, steel, glass, paper, and so on. As a feedstock, natural gas is an essential material for fertilizers, plastics, paints, wax, and even medicines.

Gas as a Constrained Fuel

Though it is an environmentally friendly fuel, natural gas historically was a constrained fuel. Unlike the crude oil market, which is a global market thanks essentially to the low transportation cost of crude oil, the world gas market has been largely constrained within each continent, although the growing LNG trade between regions may change the landscape. The following reasons account for the relatively slow growth of gas industry:

- Transportation: Before the advent of LNG, the only viable way for transporting gas over long distance was pipeline, which naturally limited the gas trade to within a continent. Average transportation cost of gas through a pipeline is more than four times higher than that of oil because of the low heat content of gas relative to oil on a volumetric basis. In addition, safety of supply for gas is of much greater importance than for other fuels because of the high pressure in gas pipelines and storage facilities.

- Premium fuel tag: OECD countries in the 1970s imposed a barrier for use of gas, based on the presumption that the many advantages of natural gas rendered it too precious to be burnt as fuel. The decision, therefore, was to retain natural gas only for premium uses. As a consequence, until the 1990s, it was actually illegal in United States and the EU to use gas for power generation.

Many supplies of natural gas had not been available. During the 1970s, many countries discovered gas reserves, but development of these reserves was painfully slow due to expensive infrastructure required to support gas consumption; moreover, many reserves were discovered by foreign oil companies, which were reluctant to undertake development.

Future of Natural Gas

Natural gas has a promising future based on the following considerations:

- Regulatory restrictions on gas consumption arising from the premium fuel argument in OECD countries have been removed.

- Growing environmental concerns, especially over the climate change, have pushed governments to look for low-emitting fuels and sustainable ways of development. If the Kyoto Protocol objectives are to be achieved, without a massive expansion in nuclear capacity, the only realistic option is for a very large increase in the share of gas in primary energy consumption.

- Advancement in power generating technologies, particularly development of the combined cycle gas turbine (CCGT), has fueled expansion of natural gas use in power generation. These plants have very short paybacks—very attractive to private-sector investors.

- Changes to the international LNG industries may help solve gas transport problems and foster a real gas commodity market. This would involve a series of specialized investments in gas field development, liquefaction facilities, specialized LNG tankers, and regasification plants and customer-end pipelines. Traditionally, the LNG project was (and still is) very capital intensive. Capital expenditure required for a 4 million ton per annum LNG project is nearly $6 billion. It was impossible to develop bits of a project (although could be in phases). LNG projects typically require long-term contracts of 15-25 years.

- Gas-to-liquids (GTL) is another promising technology to monetize stranded natural gas. Compared with LNG, marketing and transport of GTL products do not require any specialized equipment and can use existing infrastructure. However, the major challenge to GTL projects is that the capital cost is quite prohibitive. Nonetheless, a sharp revival of interest in the technology is evident, and numerous pilot plants under development to try and improve the economics of the process.

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LECTURE 6: MINIMIZING THE SOCIAL COSTS OF PETROLEUM DEVELOPMENT

SYLLABUS

Teaching Aims

(i) To examine the causes of weak development outcomes in resource-rich environments.

(ii) To elaborate on some tools available to improve distribution, management, and use of petroleum.

Learning Objectives

(i) Explain the social externalities associated with petroleum development.

(ii) Advocate for application of full cost accounting as a means of addressing market and government failures in petroleum production.

(iii) Discuss application of regulatory and market-based approaches to correct social costs of petroleum development.

Outline of Lecture Content

Topic and Subtopic	Suggested Approach, Methods & Equipment
1. Introduction	
2. Concept of externalities	• Brainstorming, examples of positive and negative externalities of petroleum development • Equipment: projector, laptop, white board/flip charts, markers, white board duster
3. Minimizing Negative Externalities	• Brainstorming, case study of the polluter pays principle (PPP), Kyoto protocol • Equipment: projector, laptop, markers whiteboard/flipchart, white board duster, stationary for participants
4. Economics of Negative Production Externalities	• Brainstorming, examples on how the three negative externalities have occurred in the Albertine Graben, case study • Equipment: laptop, markers, whiteboard/flipchart, white board duster
5. Positive Externalities	• Brainstorming, examples of types of positive externalities in Uganda. • Equipment: laptop, markers, whiteboard/flipchart, white board duster
6. Public Sector Solutions to Negative Externalities	• Brainstorming, local examples, case study on Coase Theorem solution
7. Public Sector Remedies for Externalities	• Brainstorming, examples of corrective taxation, subsidies and regulation in addressing externalities • Equipment: laptop, markers, whiteboard/flipchart, white board duster
8. Distinctions between Price and Quantity Approaches to Addressing Externalities	• Case study • Equipment: laptop, markers, whiteboard/flipchart, white board duster
9. Field trip	Refer to 2 and 3 above and how externalities play out on the ground – discussions with field practitioners

DETAILED NOTES

1. INTRODUCTION

- This lesson discusses economic contributions of petroleum production in supporting other sectors of the economy.
- In particular, petroleum resources provide energy and other products subsequently used throughout the economy to generate electricity, provide fuel for transportation, and provide raw materials used as inputs in a number of industries.
- Yet, in many cases, benefits provided by raw materials and products that flow from petroleum production, distribution, and use also may exert adverse effects on the environment, economy, or society. Economists typically characterize these adverse effects as "negative externalities." Conversely, petroleum production results in external benefits called "positive externalities."
- This introduces the concept of externalities, discusses application of this concept in the context of petroleum development, and highlights the importance of moving toward full cost accounting of petroleum development activities. Full cost accounting refers to collection and presentation of information about economic, environmental, and social costs and benefits related to a particular policy decision.

2. CONCEPT OF EXTERNALITIES

Distinguishing Externalities from Secondary and Indirect Effects

Source: US Department of Interior, 2011.

Activities or actions by one party that are not reflected in market prices and that affect the wellbeing of another party are termed "externalities." Externalities can be distinguished from secondary or indirect effects. For example, increased food prices caused by conversion of agricultural land from food to petroleum development projects or bio-fuel production are not considered an external cost, as these result from (presumably properly functioning) markets. Higher food prices may of course raise important social concerns and may thus be an issue for policy makers, but these would not be considered an externality.

Ability to evaluate negative externalities is an important component of strengthening the set of information available to decision makers. Use of a common metric allows comparisons across alternatives on a consistent basis. Full cost accounting would help promote more cost-effective investments in petroleum exploitation and production.

Again, market prices typically account for both positive and negative effects associated with use of a good or service. However, it is common for market prices to not fully reflect the impacts of petroleum development and management decisions on environmental goods and services because these goods and services are not directly bought and sold in markets.

Externalities can be Positive or Negative

Source: US Department of Interior, 2011.

The explanation for why market prices may not fully reflect opportunity costs (value of the next-highest-valued alternative use of the resource) associated with environmental goods and services (e.g., clean air and water) is complex. It is closely related to the fact that goods such as clean air and clean water are not typically bought and sold in markets (thus they do not have a market price that consumers and producers can readily observe and account for in the market value of the product). The reason these environmental goods and services are not typically bought and sold in the market is often associated with lack of clear property rights of these goods and services—"tragedy of the commons."

What is a Negative Externality?

Source: US Department of Interior, 2011.

A negative externality is an activity that imposes uncompensated costs on other people. For example, externalities from energy exploration, development, production, and use can include air pollution emitted by cars and power plants, oil spills, radioactive emissions from nuclear power plants, acid mine drainage, and congestion from overloaded streets and highways. More recently, scientists have identified greenhouse gas emissions, such as carbon dioxide that comes from burning fossil fuels, as a particularly important externality.

Why Environmental Goods and Services are Not Typically Bought and Sold in Markets

Source: US Department of Interior, 2011.

Some goods and services are easy to price and integrate into the economy—for example, a movie ticket or a loaf of bread. Others such as a clean air and water, biodiversity, resilient ecosystems, and clear vistas are not typically bought and sold in markets, and thus very difficult to value or price. This lack of markets is often due to the lack of specification for property rights for these resources. When ownership of resources is unclear, markets to allocate them are slow to arise.

The Importance of Accounting for Externalities

Source: US Department of Interior, 2011.

Presence of externalities has implications for decision making because if market prices leave out important benefits or costs, buyers and sellers cannot make informed decisions. Thus, failure to account for externalities can distort decision making and reduce society's total welfare. When prices of goods and services do not adequately reflect the monetary value of benefits or adverse effects, decision makers (including individual consumers, public land managers, and private sector entities that lease, develop, or purchase energy, minerals, and other resources) may not recognize the full effects of their actions.

In general, when external benefits are ignored, the result is an underproduction and overpricing of goods that generate positive externalities. In contrast, when external costs are ignored, the result is overproduction and underpricing of goods that generate these negative externalities.

Why Negative Externalities Matter

Source: US Department of Interior, 2011.

Negative externalities matter because, when not accounted for, they can lead to a lower quality of life for at least some members of society, quite often the underprivileged of society and those within the proximity of petroleum development projects, or resource-rich host communities. For example, suppose that a proposed energy development on public land can reduce the amount of air pollution emitted during exploration and development by 10 tons, at a cost of $40 per ton. Suppose further that the full cost of the air pollution (for example, health and visibility impacts) is $50 per ton. If the developer were to reduce its air pollution emissions, total social welfare would increase—the additional cost to the developer would be $400 (10 tons at ~ $40 per ton), but the "savings" to society (that is, reduction in adverse effects) would be $500 (10 tons at ~ $50 per ton). Society's wellbeing would be increased by this change. However, if the externality had not been accounted for in the developer's decisions, aggregate wellbeing of all members of society would be lowered.

The Role of Government in Correcting Externalities

Source: US Department of Interior, 2011.

Government investments as well as regulatory policies can improve wellbeing by correcting market failures and protecting health, safety, and environmental quality. In fashioning long-term policies, the nation should not overlook those factors that contribute to wellbeing even if these are not fully captured in economic statistics.

3. MINIMIZING NEGATIVE EXTERNALITIES

Source: US Department of Interior, 2011.

When market prices do not fully reflect opportunity costs associated with a particular activity, there may be a case for government intervention. The goal of policies that correct for externalities is to essentially have private companies or individuals "internalize" the externality in their decision-making or production decisions so that more socially optimal levels of output are produced. Possible policy approaches to correct externalities range from "command and control" policies to "market-based" policies (or perhaps a combination of the two approaches).

Command and Control vs. Market-Based Policies

Source: US Department of Interior, 2011.

Command and control policies are generally regulatory approaches, whereas market-based policies rely on establishing markets for pollution or markets for activities to offset impacts of environmentally damaging activities (examples include transferrable permits, pollution taxes, and habitat conservation banks). Each approach may have advantages in particular situations.

Advantages of Command and Control

Source: US Department of Interior, 2011.

To address pollution issues involving highly toxic materials (e.g., nuclear waste) or high-cost events (e.g., large oil spills), a regulatory approach might be appropriate. Thus, regulation by the new Bureau of Safety and Environmental Enforcement (BSEE) or in the case of Uganda, the National Environment Management Authority (NEMA) is intended to reduce likelihood of significant oil spills.

Advantages of Market-based Approaches

Source: US Department of Interior, 2011.

Market-based approaches offer advantages in situations where the concern is with large numbers of polluting entities that have varying pollution control costs. Market-based policies that may have relevance for addressing externalities associated with Petroleum Development activities, including habitat conservation banks, policies to facilitate the development of ecosystem service markets, and policies that promote the sale or lease of -managed resources at their societal opportunity cost.

The Value of Understanding Why Externalities Occur

Source: US Department of Interior, 2011.

Understanding why particular externalities occur, and the monetary value of such externalities, is important because these provide an example of a situation where government involvement can potentially improve market outcomes. For example, estimates of the monetary value of externalities associated with energy development could be used to inform decisions about locations, scale, scope, and technology choices when making public land use decisions. These decisions might be whether mining of coal, extraction of petroleum, development of renewable energy, grazing, or timber harvesting activities should be allowed in a particular area, or whether the area should be set aside for recreation use?

Gaps in the Ugandan Policy and Legal Framework

While the National Environmental Management Policy and Laws compliance process is designed to disclose impacts resulting from state actions and private-sector decisions, it does not provide a set of information that allows comparisons of impacts relative to a baseline across alternatives in a common metric (such as dollars). Valuing all impacts, including those associated with external costs, would allow such comparisons and could be used to inform decisions about petroleum development.

TABLE 6.1: EXTERNAL COSTS OF ENERGY

Sector and Fuel	External Costs as a Percentage of Market Price
Electricity generation—coal	70%
Electricity generation—natural gas	19%
Transportation—primarily automotive gasoline	25%
Heat production—natural gas	42%

Source: National Resource Council, 2010

The Kyoto Protocol Solution

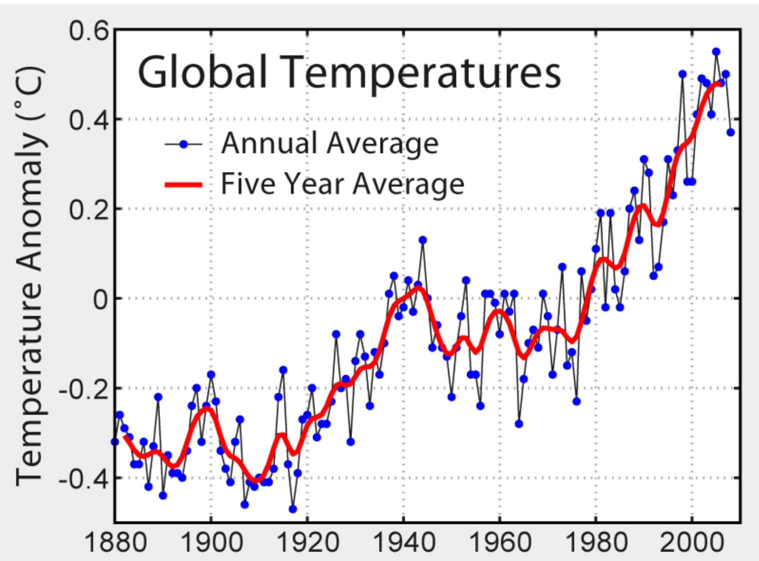
Source: Gruber, 2013

In December 1997, representatives from over 170 nations met in Kyoto, Japan, to attempt one of the most ambitious international negotiations ever: an international pact to limit emissions of carbon dioxide worldwide. The motivation for this international gathering was increasing concern about the problem of global warming.

Global temperatures steadily rose over the twentieth century. A growing scientific consensus suggests that the cause of this warming trend is human activity, in particular use of fossil fuels. Burning of fossil fuels such as coal, oil, natural gas, and gasoline produces carbon dioxide, which in turn traps heat from the sun in the earth's atmosphere. Many scientists predict that, over the next century, global temperatures could rise by as much as 10 degrees Fahrenheit.

In most areas around the world, however, impacts of global warming would be unwelcome, and in many cases, disastrous. The global sea level could rise by almost 3 feet, increasing risks of flooding and submersion of low-lying coastal areas. Some scientists project, for example, that 20-40% of the entire country of Bangladesh will be flooded due to global warming over the next century, with much of this nation under more than 5 feet of water. Figure 6.1 below shows the upward trend in global temperatures between 1880 and 2008.

FIGURE 6.1: AVERAGE GLOBAL TEMPERATURES FROM 1880 TO 2010



Source: Rohde, n.d.

Despite this dire forecast, the nations gathered in Kyoto faced a daunting task. Cost of reducing use of fossil fuels, particularly in the major industrialized nations, would be enormous.

Fossil fuels are central to heating our homes, transporting us to our jobs, and lighting our places of work. Replacing these fossil fuels with alternatives would significantly raise costs of living in developed countries.

4. ECONOMICS OF NEGATIVE PRODUCTION EXTERNALITIES

Source: Gruber, 2013.

Somewhere in the United States is a steel plant next to a river. This plant produces steel products, but it also produces "sludge," a byproduct useless to the plant owners. To get rid of this unwanted byproduct, the owners build a pipe out the back of the plant and dump the sludge into the river. The sludge produced is directly proportional to production of steel; each additional unit of steel creates one more unit of sludge as well.

The steel plant is not the only producer using the river, however. Farther downstream is a traditional fishing area where fishermen catch fish for sale to local restaurants. Since the steel plant began dumping sludge into the river, fishing has become much less profitable because many fewer fish are left alive to catch. This scenario is a classic example of what we mean by an externality. The steel plant is exerting a negative production externality on the fishermen, because its production adversely affects the wellbeing of the fishermen, but the plant does not compensate the fishermen for their loss.

One way to perceive this externality is to graph the market for the steel produced by a plant and to compare private benefits and costs of production to social benefits and costs.

Private Benefits and Costs

Source: Gruber, 2013.

Using the example of the steel plant cited above, private benefits and costs are benefits and costs borne directly by the actors in the steel market (producers and consumers of steel products). Social benefits and costs are private benefits and costs plus benefits and costs to any actors outside this steel market who are affected by the plant's production process (i.e., the fishermen).

Private Marginal Cost (PMC)

Source: Gruber, 2013.

PMC is the direct cost to a producer to produce an additional unit of a good. Each point on the market supply curve for a good (steel, in our example) represents the market's marginal cost of producing that unit of the good—that is, the PMC of that unit of steel.

Social Marginal Cost (SMC)

Source: Gruber, 2013.

What determines the welfare consequences of production, however, is the social marginal cost (SMC), which equals the private marginal cost to the producers of producing that next unit of a good plus any costs associated with production of that good that are imposed on others.

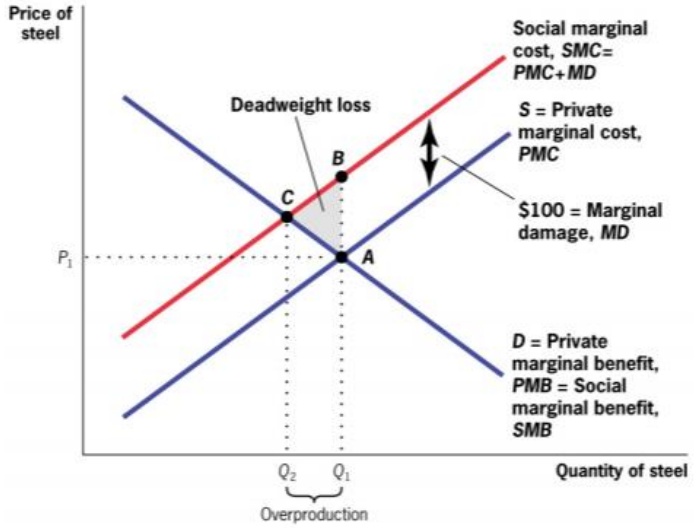
Without market failures PMC = SMC, the social costs of producing steel are equal to the costs to steel producers

Market Failure Due to Negative Production Externalities

Source: Gruber, 2013.

Figure 6.2 shows the elements of a negative production externality associated with steel production.

FIGURE 6.2: NEGATIVE PRODUCTION EXTERNALITY



Source: Gruber, 2013

A negative production externality of $100 per unit of steel produced (marginal damage [MD]) leads to an SMC above the PMC, and a social optimum quantity (Q2) lower than the competitive market equilibrium quantity (Q1). There is overproduction of Q1 Q2, with an associated deadweight loss of area BCA.

Marginal Damage (MD)

Source: Gruber, 2013.

When there are externalities, SMC=PMC+MD, where MD is the marginal damage done to others, such as the fishermen, from each unit of production (marginal because it is the damage associated with that particular unit of production, not total production).

Suppose, for example, that each unit of steel production creates sludge that kills $100 worth of fish. In Figure 6.2 above, the SMC curve is therefore the PMC (supply) curve, shifted upward by the MD of $100.5. That is, at Q1 units of production (point A), SMC is the private marginal cost at that point (which is equal to P1) plus $100 (point B). For every level of production, social costs are $100 higher than private costs, because each unit of production imposes $100 of costs on the fishermen for which they are not compensated.

Social Marginal Benefits (SMB)

Source: Gruber, 2013.

The welfare consequences of consumption are defined relative to the SMB, which equals the private marginal benefit (PMB) to the consumers minus any costs associated with consumption of the good that are imposed on others. In our example, no such costs are imposed by consumption of steel, so SMB =PMB.

PMB and SMB

Source: Gruber, 2013.

Again, PMB is the direct benefit to consumers of consuming an additional unit of a good. SMB is the PMB to consumers minus any costs associated with consumption of the good that are imposed on others.

Each point on the market demand curve for steel represents the sum of individual willingness to pay for that unit of steel, or the PMB of that unit of steel. Once again, however, the welfare consequences of consumption are defined relative to the SMB, which equals the PMB to the consumers minus any costs associated with consumption of the good that are imposed on others. In our example, no such costs are imposed by consumption of steel, so SMB =PMB.

Social Efficiency

Source: Gruber, 2013.

Social efficiency is defined relative to SMB and cost curves, not to PMB and cost curves. Because of the negative externality of sludge dumping, the social curves (SMB and SMC) intersect at point C, with a level of consumption Q2. Because the steel plant owner doesn't account for the fact that each unit of steel production kills fish downstream, the supply curve understates the costs of producing Q1 to be at point A, rather than at point B. As a result, too much steel is produced (Q1 Q2), and the private market equilibrium no longer maximizes social efficiency.

Dead Weight Loss

Source: Gruber, 2013.

When we move away from the social efficiency maximizing quantity, we create a deadweight loss for society because units are produced and consumed for which the cost to society (summarized by curve SMC) exceeds the social benefits (summarized by curve D SMB). In our example, the deadweight loss is equal to the area BCA. Width of the deadweight loss triangle is determined by the number of units for which social costs exceed social benefits (Q1 Q2). Height of the triangle is the difference between the SMC and the SMB, which is MD.

Negative Consumption Externalities

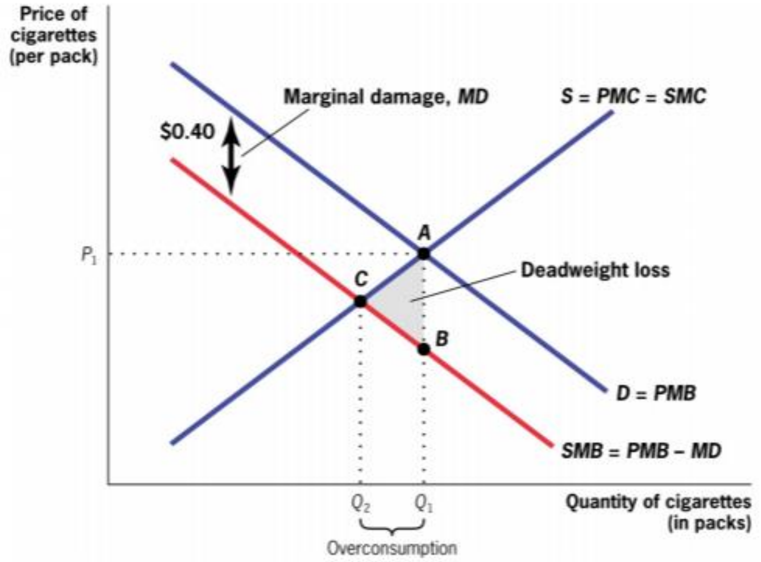
Source: Gruber, 2013.

A negative consumption externality occurs when an individual's consumption reduces the wellbeing of others who are not compensated by the individual. It is important to note that externalities do not arise solely from the production side of a market. Consider the case of cigarette smoke. In a restaurant that allows smoking, your consumption of cigarettes may have a negative effect on my enjoyment of a restaurant meal. Yet you do not in any way pay for this negative effect on me. This is an example of a negative consumption externality, whereby consumption of a good reduces the wellbeing of others, a loss for which they are not compensated. When there is a negative consumption externality, SMB=PMB-MD, where MD is the marginal damage done to others by your consumption of that unit. For example, if MD is 40¢ a pack, the MD to others by your smoking is 40¢ for every pack you smoke.

Market Failure Due to Negative Consumption Externalities in the Cigarette Market

Figure 6.3 below shows the elements of a negative consumption externality.

FIGURE 6.3: NEGATIVE CONSUMPTION EXTERNALITY



Source: Gruber, 2013

A negative consumption externality of 40¢ per pack of cigarettes consumed leads to an SMB below the PMB, and a social optimum quantity (Q2) lower than the competitive market equilibrium quantity (Q1). There is overconsumption Q1 Q2, with an associated deadweight loss of area ACB.

The supply (S) and demand (D) curves represent the PMC and PMB. The private equilibrium is at point A, where supply (PMC) equals demand (PMB), with cigarette consumption of Q1 and price of P1. The SMC equals the PMC because there are no externalities associated with production of cigarettes in this example. Note, however, that the SMB is now below the PMB by 40¢ per pack; every pack consumed has a social benefit that is 40¢ below its private benefit. That is, at Q1 units of production (point A), the SMB is the PMB at that point (which is equal to P1), minus 40¢ (point B). For each pack of cigarettes, social benefits are 40¢ lower than private benefits, because each pack consumed imposes 40¢ of costs on others for which they are not compensated.

The social-welfare-maximizing level of consumption, Q2, is identified by point C, the point at which SMB=SMC. There is overconsumption of cigarettes by Q1 Q2: the social costs (point A on the SMC curve) exceed social benefits (on the SMB curve) for all units between Q1 and Q2. As a result, there is a deadweight loss (area ACB) in the market for cigarettes.

Application—Automobiles/Sport Utility Vehicles (SUV)

Source: Gruber, 2013.

In 1985, the typical driver sat behind the wheel of a car that weighed about 3,200 pounds, and the largest cars on the road weighed 4,600 pounds. In 2008, the typical driver was in a car that weighed about 4,117 pounds, and the largest cars on the road could weigh 8,500 pounds. The major culprits in this evolution of car size were SUVs. The term "SUV" was originally reserved for large vehicles intended for off-road driving, but it now referred to any large passenger vehicle marketed as an SUV, even if it lacked off-road capabilities. SUVs, with an average weight of 4,742 pounds, represented only 6.4% of vehicle sales as recently as 1988, but 20 years later, in 2008, they accounted for over 29.6% of the new vehicles sold each year. Consumption of large cars such as SUVs produces three types of negative externalities: global warming, wear and tear on roads, and safety externalities.

Global Warming

Source: Gruber, 2013.

The contribution of driving to global warming is directly proportional to the amount of fossil fuel a vehicle requires to travel a mile. The typical compact or mid-size car gets roughly 25 miles to the gallon, but the typical SUV gets only 20 miles per gallon. This means that SUV drivers use more gas to go to work or run their errands, increasing fossil fuel emissions. This increased environmental cost is not paid by those who drive SUVs.

Wear and Tear on Roads

Source: Gruber, 2013.

Each year, federal, state, and local governments in the United States spend $33.1 billion repairing roadways. Damage to roadways comes from many sources, but a major culprit is the passenger vehicle, and the damage it does to roads is proportional to vehicle weight. When individuals drive SUVs, they increase the cost to government of repairing roads. SUV drivers bear some of these costs through gasoline taxes (which fund highway repair), as the SUV uses more gas, but it is unclear if these extra taxes are enough to compensate for the extra damage done to roads.

Safety Externalities

Source: Gruber, 2013.

One major appeal of SUVs is that they provide a feeling of security because they are so much larger than other cars on the road. Offsetting this feeling of security is the added insecurity imposed on other cars on the road. For a car of average weight, the odds of having a fatal accident rise by four times if the accident is with a typical SUV and not with a car of the same size. Thus, SUV drivers impose a negative externality on other drivers because they don’t compensate those other drivers for the increased risk of a dangerous accident.

5. POSITIVE EXTERNALITIES

Source: Gruber, 2013.

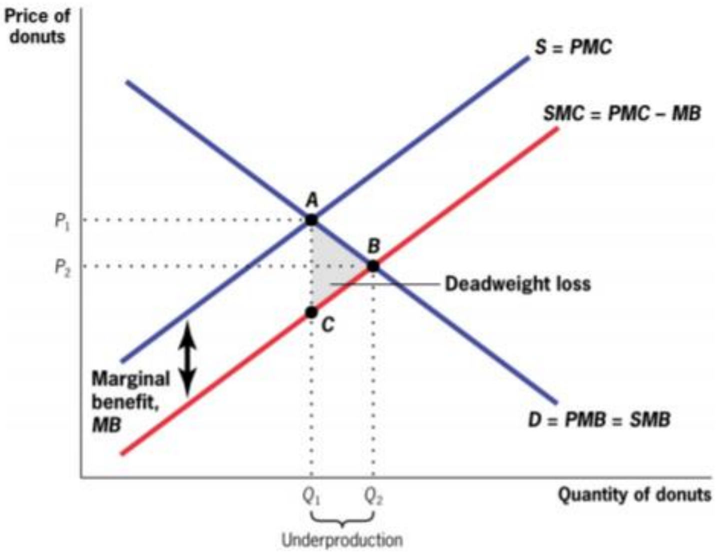
Positive Production Externality

Source: Gruber, 2013.

When economists think about externalities, they tend to focus on negative externalities, but not all externalities are bad. Positive production externalities associated with a market also occur, whereby production benefits parties other than the producer and yet the producer is not compensated. Consider the following scenario:

> Beneath an area of public land might be valuable oil reserves. The government allows any oil developer to drill in those public lands, as long as the government receives some royalties on any oil reserves found. Each dollar the oil developer spends on exploration increases the chances of finding oil reserves. Once found, however, the oil reserves can be tapped by other companies; the initial driller has only the advantage of getting there first. Thus, exploration for oil by one company exerts a positive production externality on other companies: each dollar spent on exploration by the first company raises the chance that other companies will have a chance to make money from new oil found on this land.

FIGURE 6.4: POSITIVE PRODUCTION EXTERNALITY



Source: Gruber, 2013

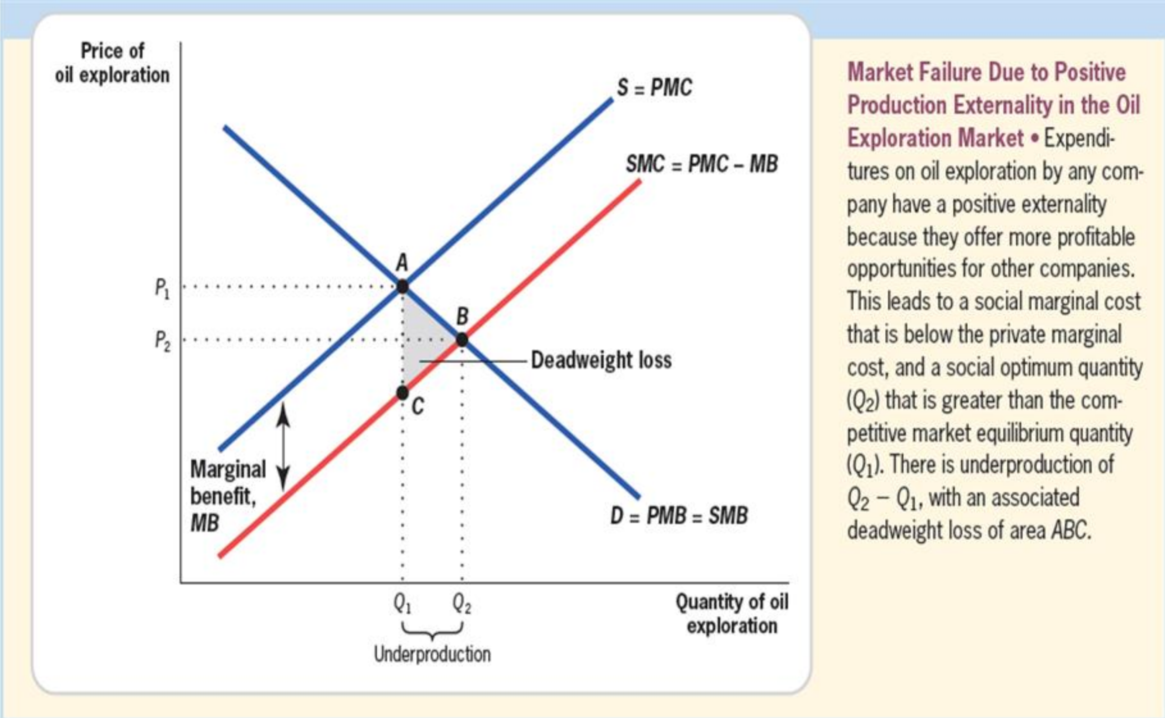
Examples of Positive Socioeconomic Externalities in Uganda

- Increase in the utilization of domestic labor and businesses by oil, gas industry (e.g., utilization of local labor in construction of road infrastructure in the Albertine Graben, pipe line and refinery construction);
- Consumption of locally produced agricultural goods by petroleum companies;
- Shared infrastructure-road network to access markets for agriculture;
- Skills transfer;
- Technology transfer;
- Business development and competitiveness;
- Development of downstream industries;
- Generation of true partnerships between foreign operators/suppliers and local businesses, universities, research centers, and civil society;
- Improved healthcare services (e.g., construction of health centers by the industry); and
- Training and employment of local manpower through scholarships provided under the upstream and midstream legal framework.

Examples of Positive Social Externalities

Figure 6.5 is a graph of a positive social externality.

FIGURE 6.5: MARKET FAILURE DUE TO POSITIVE PRODUCTION EXTERNALITY IN THE OIL MARKET



Source: Gruber, 2013.

The SMC of oil exploration is actually lower than the PMC because exploration has a positive effect on future profits of other companies. Assume that the marginal benefit of each dollar of exploration by one company, in terms of raising the expected profits of other companies who drill the same land, is a constant amount MB. As a result, the SMC is below the PMC by the amount MB. Thus, the private equilibrium in the exploration market (point A, quantity Q1) leads to underproduction relative to the socially optimal level (point B, quantity Q2) because the initial oil company is not compensated for the benefits it confers on other oil producers.

Note also that there can be positive consumption externalities. Imagine, for example, that my neighbor is considering improving the landscaping around his house. The improved landscaping will cost him $1,000, but it is only worth $800 to him. My bedroom faces his house, and I would like to have nicer landscaping to look at. This better view would be worth $300 to me. That is, the total SMB of the improved landscaping is $1,100, even though the PMB to my neighbor is only $800. Since this SMB ($1,100) is larger than the SMC ($1,000), it would be socially efficient for my neighbor to do the landscaping. My neighbor won't do the landscaping, however, because his private costs ($1,000) exceed his private benefits. His landscaping improvements would have a positive effect on me for which he will not be compensated, thus leading to an under consumption of landscaping.

Assessment of Graphical Analyses of Externalities

Source: Gruber, 2013.

One confusing aspect of a graphical analysis of externalities is knowing which curve to shift, and in which direction. To review, there are four possibilities:

- Negative production externality: SMC curve lies above PMC curve.
- Positive production externality: SMC curve lies below PMC curve.
- Negative consumption externality: SMB curve lies below PMB curve.
- Positive consumption externality: SMB curve lies above PMB curve.

Armed with these facts, the key is to assess which category into which a particular example fits. Two steps are involved here:

1. Assess whether the externality is associated with producing a good or with consuming a good.
2. Assess whether the externality is positive or negative. The steel plant example is a negative production externality because the externality is associated with production of steel, not its consumption; the sludge doesn't come from using steel, but rather from making it. Likewise, our cigarette example is a negative consumption externality because the externality is associated with consumption of cigarettes; secondhand smoke doesn't come from making cigarettes, it comes from smoking them.

6. PRIVATE SECTOR SOLUTIONS TO NEGATIVE EXTERNALITIES

Source: Gruber, 2013.

In microeconomics, the market is innocent until proven guilty (and, similarly, the government is often guilty until proven innocent!). An excellent application of this principle appears in a classic work by Ronald Coase, a professor at the Law School of the University of Chicago, who asked in 1960: "Why won't the market simply compensate the affected parties for externalities? (Coase, 1960).

Internalizing the Externality

Source: Gruber, 2013.

"Internalizing an externality" occurs when either private negotiations or government action lead the price to the party to fully reflect the external costs or benefits of that party's actions.

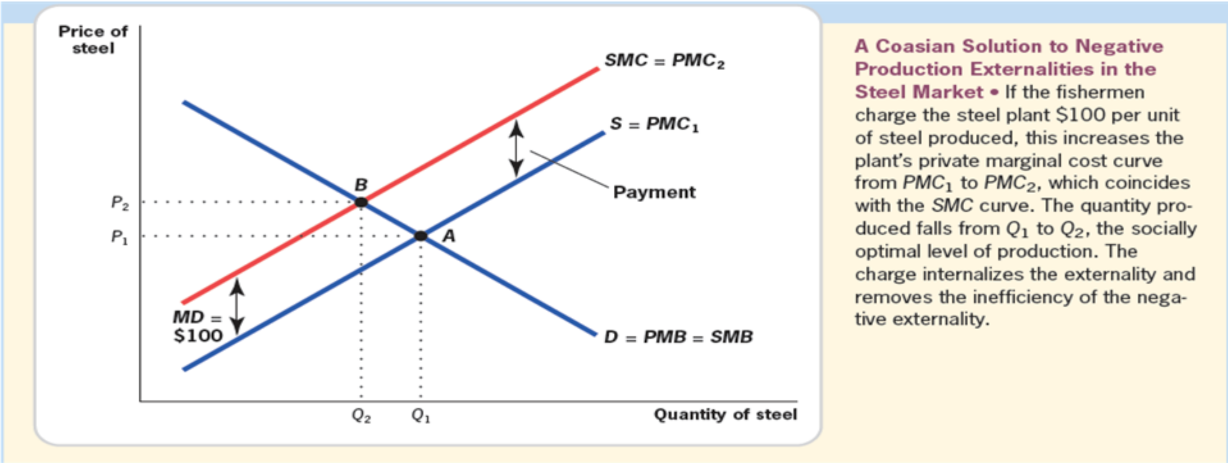
To see how a market might compensate those affected by an externality, let us look at what would happen if the fishermen owned the river in the steel plant example. They would march up to the steel plant and demand an end to the sludge dumping that was hurting their livelihood. They would have the right to do so because they have property rights over the river; their ownership confers to them the ability to control use of the river. Suppose for the moment that when this conversation occurs, no pollution-control technology is available to reduce the sludge damage; the only way to reduce sludge would be to reduce production. So ending sludge dumping would mean shutting down the steel plant. In this case, the steel plant owner might propose a compromise: the owner would pay the fishermen $100 for each unit of steel produced, so that they would be fully compensated for the damage to their fishing grounds. As long as the steel plant can make a profit with this extra $100 payment per unit, this would be a better deal for the plant than shutting down, and the fishermen would be fully compensated for the damage done to them.

This type of resolution is internalizing the externality. Because the fishermen have property rights to the river, they would use the market to obtain compensation from the steel plant for pollution to the river. The fishermen would implicitly create a market for pollution by pricing the bad behavior of the steel plant. From the steel plant's perspective, damage to the fish would become just another input cost, because it has to be paid to produce.

The Coase Theorem

Figure 6.6 illustrates the Coase Theorem.

FIGURE 6.6: THE COASE THEOREM



Source: Gruber, 2013.

The Coase Theorem Solution I

Source: Gruber, 2013.

Given well-defined property rights and costless bargaining, negotiations between the party creating the externality and the party affected by the externality can bring about the socially optimal market quantity. This theorem states that externalities do not necessarily create market failures, because negotiations between the parties can lead the offending producers (or consumers) to internalize the externality, or account for the external effects in their production (or consumption).

The Coase theorem suggests a very particular and limited role for the government in dealing with externalities: establishing property rights. In Coase's view, the fundamental limitation to implementing private-sector solutions to externalities is poorly established property rights. If the government can establish and enforce those property rights, the private market will do the rest.

The Coase Theorem Solution II

Source: Gruber, 2013.

The efficient solution to an externality does not depend on which party is assigned the property rights, as long as someone is assigned those rights. We can illustrate the intuition behind Part II using the steel plant example. Suppose that the steel plant, rather than the fishermen, owned the river. In this case, the fishermen would have no right to make the plant owner pay a $100 compensation fee for each unit of steel produced. The fishermen, however, would find it in their interest to pay the steel plant to produce less.

If the fishermen promised the steel plant owner a payment of $100 for each unit he did not produce, the steel plant owner would rationally consider there to be an extra $100 cost to each unit he did produce. Remember that in economics, opportunity costs are included in a firm's calculation of costs; thus, forgoing a payment from the fishermen of $100 for each unit of steel not produced has the same effect on production decisions as being forced to pay $100 extra for each unit of steel produced.

Once again, the private marginal cost curve would incorporate this extra (opportunity) cost and shift out to the social marginal cost curve, and there would no longer be overproduction of steel.

Quick Hints

Source: Gruber, 2013.

You may wonder why the fishermen would ever engage in either of these transactions: they receive $100 for each $100 of damage to fish, or pay $100 for each $100 reduction in damage to fish. So what is in it for them? The answer is that this is a convenient shorthand economics modelers use for saying, "The fishermen would charge at least $100 for sludge dumping" or "The fishermen would pay up to $100 to remove sludge dumping."

By assuming that the payments are exactly $100, we can conveniently model private and social marginal costs as equal. It may be useful for you to think of the payment to the fishermen as $101 and the payment from the fishermen as $99, so that the fishermen make some money, and private and social costs are approximately equal. In reality, the payments to or from the fishermen will depend on the negotiating power and skill of both parties in this transaction, highlighting the importance of the issues raised next.

7. PUBLIC SECTOR REMEDIES FOR EXTERNALITIES

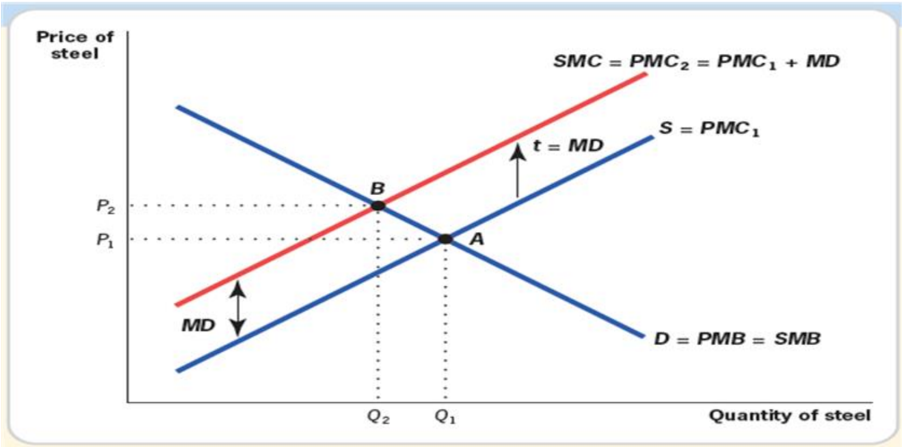
Source: Gruber, 2013.

In the United States, public policymakers do not think that Coasian solutions are sufficient to deal with large-scale externalities. The U.S. Environmental Protection Agency (EPA) was formed in 1970 to provide public-sector solutions to problems of externalities in the environment. The agency regulates a wide variety of environmental issues ranging from clean air to clean water to land management.

Taxation as a Solution to Negative Production Externalities in the Steel Market

Taxation is a possible solution to negative production externalities, as illustrated in Figure 6.7.

FIGURE 6.7: TAXATION AS A SOLUTION TO NEGATIVE PRODUCTION EXTERNALITIES



Source: Gruber, 2013.

A tax of $100 per unit (equal to the marginal damage of pollution) increases the firm's private marginal cost curve from PMC1 to PMC2, which coincides with the SMC curve. The quantity produced falls from Q1 to Q2, the socially optimal level of production. Just as with the Coasian payment, this tax internalizes the externality and removes the inefficiency of the negative externality.

Public policymakers employ three types of remedies to resolve problems associated with negative externalities: corrective taxation, subsidies, and regulation.

Corrective Taxation

Source: Gruber, 2013.

We have seen that the Coasian goal of "internalizing the externality" may be difficult to achieve in practice in the private market. The government can achieve this same outcome in a straightforward way, however, by taxing the steel producer an amount of marginal damage (MD) for each unit of steel produced. Figure 6.7 above illustrates the impact of such a tax. The steel market is initially in equilibrium at point A, where supply (PMC1) equals demand (PMB=SMB), and Q1 units of steel are produced at price P1. Given the externality with a cost of MD, the socially optimal production is at point B, where social marginal costs and benefits are equal. Suppose that the government levies a tax per unit of steel produced at an amount MD.

This tax would act as another input cost for the steel producer, and would shift its private marginal cost up by MD for each unit produced. This would result in a new PMC curve, PMC2, which is identical to the SMC curve. As a result, the tax effectively internalizes the externality and leads to the socially optimal outcome (point B, quantity Q2). The government per-unit tax on steel production acts in the same way as if the fishermen owned the river. This type of corrective taxation is often called "Pigouvian taxation," after the economist A.C. Pigou, who first suggested this approach to solving externalities.

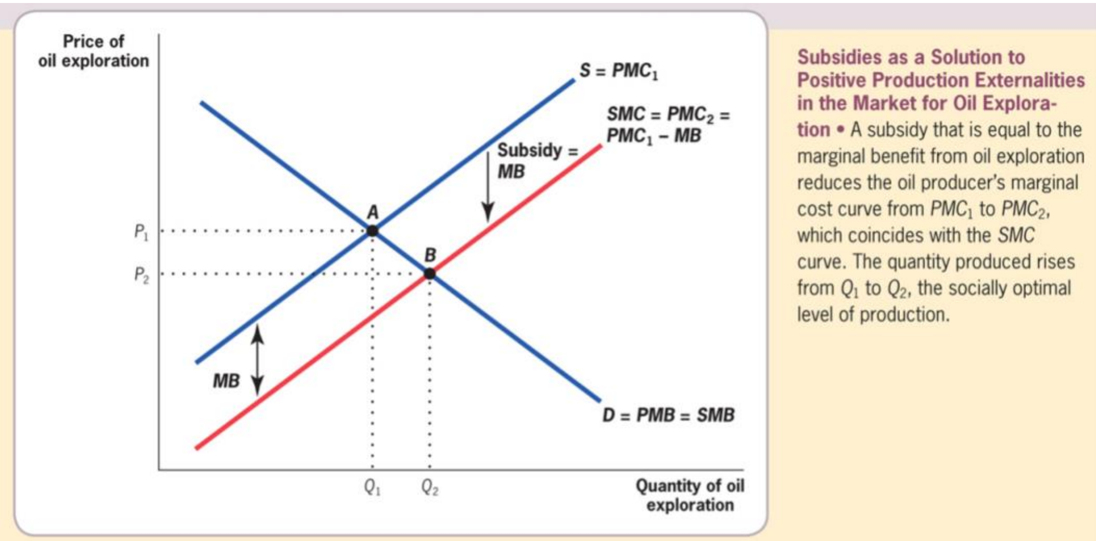
Subsidies

Source: Gruber, 2013.

As noted earlier, not all externalities are negative; in cases such as oil exploration or nice landscaping by your neighbors, externalities can be positive. The Coasian solution to cases such as the oil exploration case would be for the other oil producers to take up a collection to pay the initial driller to search for more oil reserves (thus giving them the chance to make more money from any oil that is found). But, as we discussed, this may not be feasible.

The government can achieve the same outcome by making a payment, or a subsidy, to the initial driller to search for more oil. The amount of this subsidy would exactly equal the benefit to the other oil companies and would cause the initial driller to search for more oil because his cost per barrel has been lowered. The impact of such a subsidy is illustrated in Figure 6.8, which shows once again the market for oil exploration.

FIGURE 6.8: SUBSIDIES AS A SOLUTION TO POSITIVE PRODUCTION EXTERNALITIES



Source: Gruber, 2013.

The market is initially in equilibrium at point A where PMC1 equals PMB, and Q1 barrels of oil are produced at price P1. Given the positive externality with a benefit of MB, the socially optimal production is at point B, where social marginal costs and benefits are equal.

Suppose that the government pays a subsidy per barrel of oil produced of S=MB. The subsidy would lower the private marginal cost of oil production, shifting the private marginal cost curve down by MB for each unit produced. This would result in a new PMC curve, PMC2, which is identical to the SMC curve. The subsidy has caused the initial driller to internalize the positive externality, and the market moves from a situation of underproduction to one of optimal production.

A subsidy equal to the marginal benefit from oil exploration reduces the oil producer's marginal cost curve from PMC1 to PMC2, which coincides with the SMC curve. The quantity produced rises from Q1 to Q2, the socially optimal level of production.

Regulation

Source: Gruber, 2013.

Throughout this discussion, a reasonable question would be why this fascination with prices, taxes, and subsidies? If the government knows where the socially optimal level of production is, why it not just mandate that production at that level, and forget about trying to give private actors incentives to produce at the optimal point? Using Figure 6.8 as an example, why not mandate a level of steel production of Q2 and be done with it?

In an ideal world, Pigouvian taxation and regulation would be identical. Because regulation appears much more straightforward, however, it has been the traditional choice for addressing environmental externalities in the United States and around the world.

When the U.S. government wanted to reduce emissions of sulfur dioxide in the 1970s, for example, it did so by putting a limit or cap on the amount of sulfur dioxide that producers could emit, not by taxing emissions. In 1987, when the nations of the world wanted to phase out use of chlorofluorocarbons (CFC), which were damaging the ozone layer, they banned use of CFCs rather than impose a large tax on products that used CFCs. Given this governmental preference for quantity regulation, why are economists so keen on taxes and subsidies?

In practice, complications may render taxes a more effective means of addressing externalities. The next lesson unit discusses two of the most important complications. In doing so, it illustrates reasons that policy makers might prefer regulation, or the "quantity approach" in some situations, and taxation, or the "price approach" in others.

8. DISTINCTIONS BETWEEN PRICE AND QUANTITY APPROACHES TO ADDRESSING EXTERNALITIES

Source: Gruber, 2013.

This lesson unit compares price (taxation) and quantity (regulation) approaches to addressing externalities, applying more complicated models, where the two approaches might differ in social efficiency implications of intervention. The goal in comparing these approaches is to find the most efficient path to environmental targets. That is, for any reduction in pollution, the goal is to find the lowest-cost means of achieving that reduction.

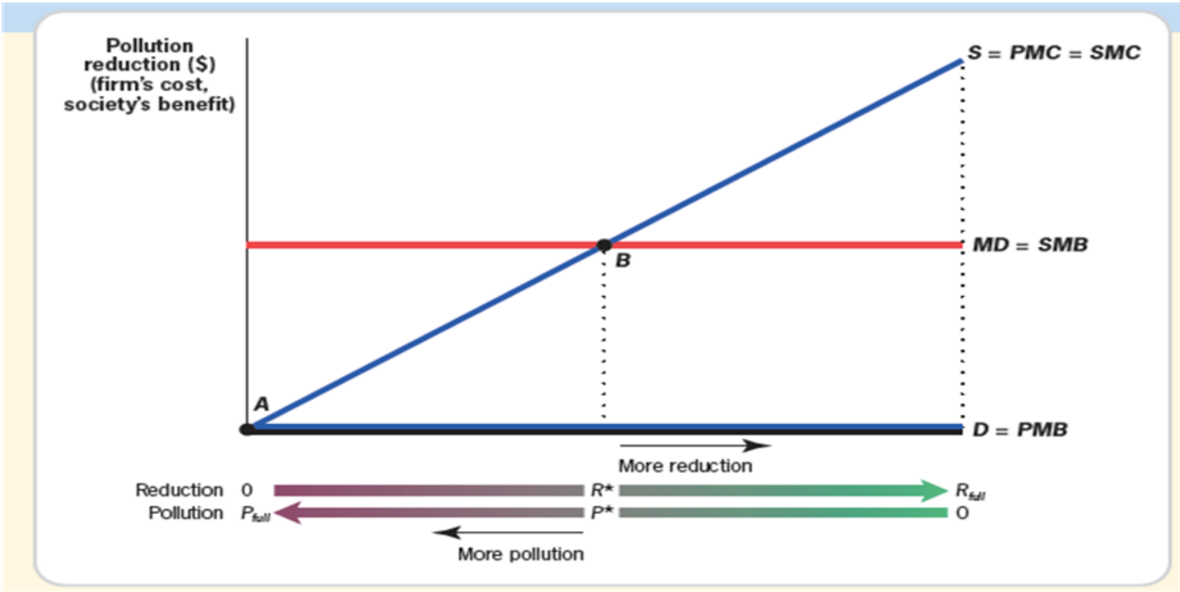
Basic Model

Source: Gruber, 2013.

To illustrate the important differences between the price and quantity approaches, we have to add one additional complication to the basic competitive market with which we have worked thus far. In that model, the only way to reduce pollution was to cut back on production. In reality, many other technologies are available for reducing pollution besides simply scaling back production. For example, to reduce sulfur dioxide emissions from coal-fired power plants, utilities can install smokestack scrubbers that remove sulfur dioxide from the emissions and sequester it, often in the form of liquid or solid sludge that can be disposed of safely.

Passenger cars can also be made less polluting by installing "catalytic converters," which turn dangerous nitrogen oxide into compounds not harmful to public health. To understand the differences between price and quantity approaches to pollution reduction, it is useful to shift our focus from the market for a good (e.g., steel) to the "market" for pollution reduction, as illustrated in Figure 6.9.

FIGURE 6.9: MARKET FOR POLLUTION REDUCTION



Source: Gruber, 2013.

In this diagram, the horizontal axis measures the extent of pollution reduction undertaken by a plant; a value of zero indicates that the plant is not engaging in any pollution reduction. Thus, the horizontal axis also measures the amount of pollution: with movement to the right, there is more pollution reduction and less pollution. Rfull indicates that pollution has been reduced to zero. More pollution is indicated with movement to the left on the horizontal axis; at Pfull, the maximum amount of pollution is produced.

The vertical axis represents cost of pollution reduction to the plant, or the benefit of pollution reduction to society (that is, the benefit to other producers and consumers not compensated for the negative externality). The MD curve represents the marginal damage averted by additional pollution reduction. This measures the SMB of pollution reduction. Marginal damage is drawn flat at $100 for simplicity, but it could be downward sloping due to diminishing returns.

The PMB benefit of pollution reduction is zero, so it is represented by the horizontal axis; there is no gain to the plant's private interests from reducing dumping. The PMC curve represents the plant's private marginal cost of reducing pollution. The PMC curve slopes upward because of diminishing marginal productivity of this input. The first units of pollution are cheap to reduce: just tighten a few screws or put a cheap filter on the sludge pipe. Additional units of reduction become more expensive, until it is incredibly expensive to achieve a completely pollution-free production process. Because of no externalities from production of pollution reduction (externalities come from the end product, reduced pollution, as reflected in the SMB curve, not from the process involved in actually reducing pollution), the PMC is also the SMC of pollution reduction.

The free market outcome in any market would be zero pollution reduction. Because the cost of pollution is not borne by the plant, it has no incentive to reduce pollution. The plant will choose zero reduction and a full amount of pollution Pfull (point A, at which the PMC of zero equals the PMB of zero). What is the optimal level of pollution reduction? The optimum is always found at the point at which social marginal benefits equal costs, here point B. The optimal quantity of pollution reduction is R*: at that quantity, the marginal benefits of reduction (damage done by pollution) and the marginal costs of reduction are equal.

Note that setting the optimal amount of pollution reduction is the same as setting the optimal amount of pollution. If the free market outcome is pollution reduction of zero and pollution of Pfull, the optimum is pollution reduction of R* and pollution of P*.

Price Regulation (Taxes) vs. Quantity Regulation in This Model

Source: Gruber, 2013.

Now contrast operations of taxation and regulation in this framework. The optimal tax, as before, is equal to the marginal damage done by pollution, $100. In this situation, the government would set a tax of $100 on each unit of pollution. Consider the plant's decision under this tax. For each unit of pollution the plant makes, it pays a tax of $100. The plant would find it cost-effective to implement any pollution reduction that costs less than $100: the plant would pay some amount less than $100 to get rid of the pollution, and avoid paying a tax of $100. With this plan in place, plants would have an incentive to reduce pollution up to the point at which the cost of that reduction equals the tax of $100. That is, plants would "walk up" their marginal cost curves, reducing pollution up to a reduction of R* at point B. Beyond that point, the cost of reducing pollution would exceed the $100 that they pay in tax, so they would just choose to pay taxes on any additional units of pollution rather than to reduce pollution further.

Thus, a Pigouvian (corrective) tax equal to $100 achieves the socially optimal level of pollution reduction, just as in the earlier analysis. Regulation is even more straightforward to analyze in this framework. The government simply mandates that the plant reduce pollution by an amount R* to get to the optimal pollution level P*.

Regulation seems more difficult than taxation because, in this case, the government must know not only MD but also the shape of the MC curve. This difficulty is, however, just a feature of our assumption of constant MD; for the more general case of a falling MD, the government must know the shapes of both MC and MD curves to set either the optimal tax or the optimal regulation.

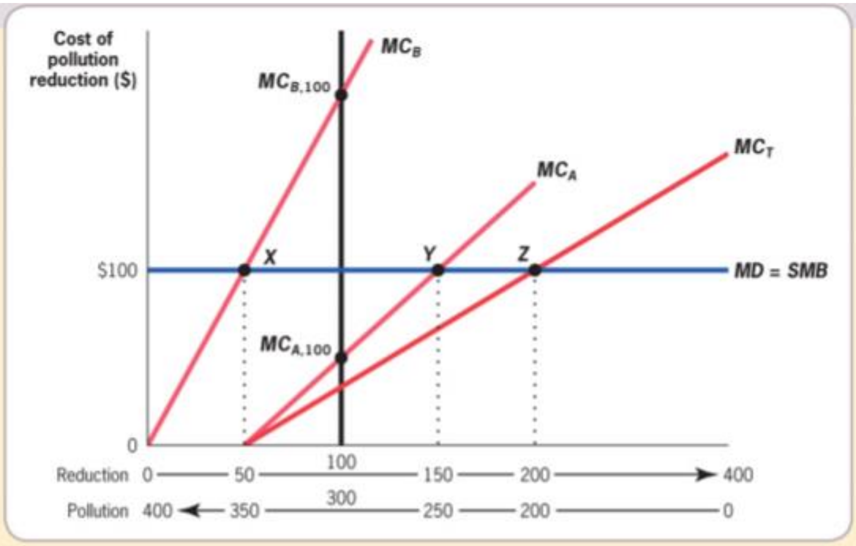
Multiple Plants with Different Reduction Costs

Source: Gruber, 2013

Now, add two wrinkles to the basic model. First, suppose now two steel plants doing the dumping, with each plant dumping 200 units of sludge into the river each day. The marginal damage done by each unit of sludge is $100, as before. Second, suppose that technology is now available to reduce sludge associated with production, but this technology has different costs at the two different plants.

For plant A, reducing sludge is cheaper at any level of reduction because it has a newer production process. For the second plant, B, reducing sludge is much more expensive for any level of reduction. Figure 6.10 below summarizes the market for pollution reduction in this case. In this figure, there are separate marginal cost curves for plant A (MCA) and for plant B (MCB). At every level of reduction, the marginal cost to plant A is lower than the marginal cost to plant B, because plant A has a newer and more efficient production process available.

FIGURE 6.10: POLLUTION REDUCTION WITH MULTIPLE FIRMS



Pollution Reduction with Multiple Firms • Plant A has a lower marginal cost of pollution reduction at each level of reduction than does plant B. The optimal level of reduction for the market is the point at which the sum of marginal costs equals marginal damage (at point *Z*, with a reduction of 200 units). An equal reduction of 100 units for each plant is inefficient since the marginal cost to plant *B* (*MCB*) is so much higher than the marginal cost to plant *A* (*MCA*). The optimal division of this reduction is where each plant's marginal cost is equal to the social marginal benefit (which is equal to marginal damage). This occurs when plant *A* reduces by 150 units and plant *B* reduces by 50 units, at a marginal cost to each of $100.

Source: Gruber, 2013.

The total marginal cost of reduction in the market, the horizontal sum of these two curves, is MCT: for any total reduction in pollution, this curve indicates the cost of that reduction if it is distributed most efficiently across the two plants. For example, the total marginal cost of a reduction of 50 units is $0, because plant A can reduce 50 units for free; so the efficient combination is to have plant A do all the reducing.

Socially efficient level of pollution reduction (and of pollution) is the intersection of this MCT curve with the marginal damage curve, MD, at point Z, indicating a reduction of 200 units (and pollution of 200 units).

Policy Option 1: Quantity Regulation

Source: Gruber, 2013.

Now examine the government's policy options within the context of this example. The first option is regulation: the government can demand a total reduction of 200 units of sludge from the market. The question then becomes: How does the government decide how much reduction to demand from each plant? The typical regulatory solution to this problem in the past was to ask the plants to split the burden: each plant reduces pollution by 100 units to get to the desired total reduction of 200 units. This is not an efficient solution, however, because it ignores the fact that the plants have different marginal costs of pollution reduction. At an equal level of pollution reduction (and pollution), each unit of reduction costs less for plant A (MCA) than for plant B (MCB). If, instead, we got more reduction from plant A than from plant B, we could lower the total social costs of pollution reduction by taking advantage of reduction at the low-cost option (plant A). So society as a whole is worse off if plant A and plant B have to make equal reduction than if they share the reduction burden more efficiently.

This point is illustrated in Figure 6.10. The efficient solution is one where, for each plant, the marginal cost of reducing pollution is set equal to the social marginal benefit of that reduction; that is, where each plant's marginal cost curve intersects with the marginal benefit curve. This occurs at a reduction of 50 units for plant B (point X), and 150 units for plant A (point Y). Thus, mandating a reduction of 100 units from each plant is inefficient; total costs of achieving a reduction of 200 units will be lower if plant A reduces by a larger amount.

Policy Option 2: Price Regulation through a Corrective Tax

Source: Gruber, 2013.

The second approach is to use a Pigouvian corrective tax, set equal to the marginal damage, so each plant would face a tax of $100 on each unit of sludge dumped. Faced with this tax, what will each plant do? For plant A, any unit of sludge reduction up to 150 units costs less than $100, so plant A will reduce its pollution by 150 units. For plant B, any unit of sludge reduction up to 50 units costs less than $100, so it will reduce pollution by 50 units.

Note that these are exactly the efficient levels of reduction! Just as in the earlier analysis, Pigouvian taxes cause efficient production by raising the cost of the input by the size of its external damage, thereby raising private marginal costs to SMCs. Taxes are preferred to quantity regulation, with an equal distribution of reductions across the plants, because taxes give plants more flexibility in choosing their optimal amount of reduction, allowing them to choose the efficient level.

Policy Option 3: Quantity Regulation with Tradable Permits

Source: Gruber, 2013.

Does this mean that taxes always dominate quantity regulation with multiple plants? Not necessarily. If the government had mandated the appropriate reduction from each plant (150 units from A and 50 units from B), quantity regulation would have achieved the same outcome as the tax. Such a solution however, would require much more information. Instead of just knowing the marginal damage and the total marginal cost, the government would also have to know the marginal cost curves of each individual plant. Such detailed information would be hard to obtain. Quantity regulation can be rescued, however, by adding a key flexibility: issue permits that allow a certain amount of pollution and let the plants trade.

Suppose the government announces the following system: it will issue 200 permits that entitle the bearer to produce one unit of pollution. It will initially provide 100 permits to each plant. Thus, in the absence of trading, each plant would be allowed to produce only 100 units of sludge, which would in turn require each plant to reduce its pollution by half (the inefficient solution previously described). If the government allows the plants to trade these permits to each other, however, plant B would have an interest in buying permits from plant A. For plant B, reducing sludge by 100 units costs MCB, 100, a marginal cost much greater than plant A's marginal cost of reducing pollution by 100 units, which is MCA, 100.

Thus, plants A and B can be made better off if plant B buys a permit from plant A for some amount between MCA, 100 and MCB, 100, so that plant B would pollute 101 units (reducing only 99 units) and plant A would pollute 99 units (reducing 101 units). This transaction is beneficial for plant B because as long as the cost of a permit is below MCB, 100, plant B pays less than the amount it would cost plant B to reduce the pollution on its own. The trade is beneficial for plant A as long as it receives for a permit at least MCA, 100, since it can reduce the sludge for a cost of only MCA, 100, and make money on the difference. By the same logic, a trade would be beneficial for a second permit, so that plant B could reduce sludge by only 98, and plant A would reduce by 102. In fact, any trade will be beneficial until plant B is reducing by 50 units and plant A is reducing by 150 units. At that point, the marginal costs of reduction across the two producers are equal (to $100), so no more gains are to be had from trading permits. What is going on here? We have simply returned to the intuition of the Coasian solution: we have internalized the externality by providing property rights to pollution. So, like Pigouvian taxes, trading allows the market to incorporate differences in the cost of pollution reduction across firms.

Uncertainty about Costs of Reduction

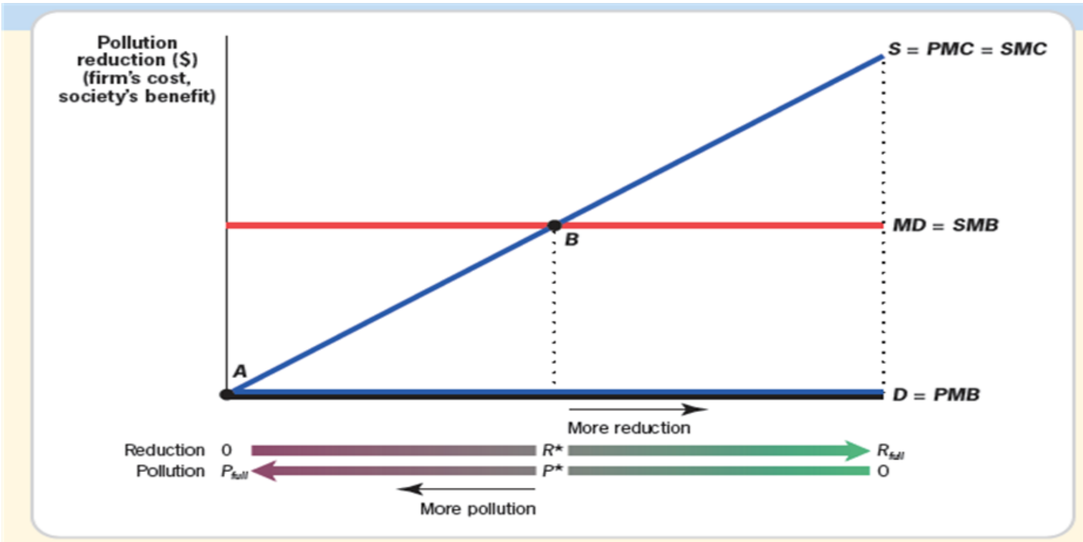
Source: Gruber, 2013.

Differences in reduction costs across firms are not the only reason that taxes or regulation might be preferred. Another reason is that the costs or benefits of regulation could be uncertain. Consider two extreme examples of externalities: global warming and nuclear leakage (Figure 6.11 below) (Note: Uganda has established an Atomic Unit under Ministry of Energy and Mineral Development to exploit the country's potentially rich uranium industry).

Figure 6.11 extends the pollution reduction framework from Figure 6.10 to a situation in which the MD (equal to the marginal social benefit of pollution reduction) is now no longer constant, but falling. That is, the benefit of the first unit of pollution reduction is quite high, but once the production process is relatively pollution-free, additional reductions are less important (that is, there are diminishing marginal returns to reduction).

Figure 6.11 below shows a market for pollution reduction with uncertain costs.

FIGURE 6.11: MARKET FOR POLLUTION REDUCTION WITH UNCERTAIN COSTS



Source: Gruber, 2013.

Consider the Case of Global Warming

Source: Gruber, 2013.

In this case, the exact amount of pollution reduction is not so critical for the environment. Because what determines the extent of global warming is the total accumulated stock of carbon dioxide in the air, which accumulates over many years from sources all over the world, even fairly large shifts in carbon dioxide pollution in one country today will have little impact on global warming.

In that case, we say that the social marginal benefit curve (equal to the marginal damage from global warming) is very flat: that is, there is little benefit to society from modest additional reductions in carbon dioxide emissions.

Consider the Case of Nuclear Leakage

Source: Gruber, 2013.

In this case, a very small difference in the amount of nuclear leakage can make a huge difference in lives saved. Indeed, it is possible that the marginal damage curve (once again equal to the marginal social benefits of pollution reduction) for nuclear leakage is almost vertical, with each reduction in leakage being very important in terms of saving lives. Thus, the social marginal benefit curve in this case is very steep.

Market for Pollution Reduction with Uncertain Costs

Source: Gruber, 2013.

Now, in both cases, imagine that we don't know the true costs of pollution reduction on the part of firms or individuals. The government's best guess is that the true marginal cost of pollution reduction is represented by curve MC1 in both panels. There is a chance, however, that the marginal cost of pollution reduction could be much higher, as represented by the curve MC2. This uncertainty could arise because the government has an imperfect understanding of the costs of pollution reduction to the firm, or it could arise because both the government and the firm are uncertain about ultimate costs of pollution reduction.

Implications for Effect of Price and Quantity Interventions

Source: Gruber, 2013.

This uncertainty over costs has important implications for the type of intervention that reduces pollution most efficiently in each of these cases. Consider regulation first. Suppose that the government mandates a reduction, R1, which is the optimum if costs turn out to be given by MC1: this is where SMBs equal SMCs of reduction if marginal cost equals MC1.

Suppose now that the marginal costs actually turn out to be MC2, so that the optimal reduction should instead be R2, where SMB=MC2. That is, regulation is mandating a reduction in pollution that is too large, with the marginal benefits of the reduction being below the marginal costs.

Implications for Instrument Choice

Source: Gruber, 2013.

The central intuition here is that the instrument choice depends on whether the government wants to get the amount of pollution reduction right or whether it wants to minimize costs.

Quantity regulation assures as much reduction as desired, regardless of cost. So, if it is critical to get the amount exactly right, quantity regulation is the best way to go. This is why the efficiency cost of quantity regulation under uncertainty is so much lower with the nuclear leakage case in panel (b). In this case, it is critical to get the reduction close to optimal; if we end up costing firms extra money in the process, so be it.

For global warming, getting the reduction exactly right is not important; so it is inefficient in this case to mandate a costly option for firms. Price regulation through taxes, on the other hand, assures that cost of reductions never exceeds the level of the tax, but leaves the amount of reduction uncertain.

That is, firms will never reduce pollution beyond the point at which reductions cost more than the tax they must pay (the point at which the tax intersects their true marginal cost curve, MC2). If marginal costs turn out to be higher than anticipated, firms will just do less pollution reduction. This is why the deadweight loss of price regulation in the case of global warming is so small in panel (a): the more efficient outcome is to get the exact reduction wrong but protect firms against very high costs of reduction. This is clearly not true in panel (b): for nuclear leakage, it is most important to get the quantity close to right (almost) regardless of cost to firms.

Summary

Source: Gruber, 2013.

Quantity regulations ensure environmental protection, but at a variable cost to firms, while price regulations ensure the cost to firms, but at a variable level of environmental protection. So, if the value of getting the environmental protection close to right is high, quantity regulations will be preferred; but if getting the protection close to right is not so important, price regulations are a preferred option.

Key Highlights

Source: Gruber, 2013.

- Externalities arise whenever actions of one party make another party worse or better off, yet the first party neither bears the costs nor receives the benefits of doing so. Negative externalities cause overproduction of the good in a competitive market, while positive externalities cause underproduction of the good in a competitive market, in both cases leading to a deadweight loss.
- Private markets may be able to "internalize" the problems of externalities through negotiation, but this Coasian process faces many barriers that make it an unlikely solution to global externalities, such as most environmental externalities. The government can use either price (tax or subsidy) or quantity (regulation) approaches to addressing externalities.
- When firms have different marginal costs of pollution reduction, price mechanisms are a more efficient means of accomplishing environmental goals unless quantity regulation is accompanied by ability to meet regulatory targets by trading pollution permits across polluters. If there is uncertainty about the marginal costs of pollution reduction, the relative merits of price and quantity regulations will depend on the steepness of the marginal benefit curve.
- Quantity regulation gets the amount of pollution reduction right, regardless of cost, and so is more appropriate when marginal benefits are steep; price regulation through taxation gets the costs of pollution reduction right, regardless of quantity, so it is more appropriate when marginal benefits are flat.

Conclusion

Source: Gruber, 2013.

Externalities are the classic answer to the "when" question of public finance: when one party's actions affect another party, and the first party doesn't fully compensate (or get compensated by) the other for this effect, the market has failed and government intervention is potentially justified. In some cases, the market is likely to find a Coasian solution whereby negotiations between the affected parties lead to internalization of the externality. In many cases, however, only government intervention can solve the market failure. This point naturally leads to the "how" question of public goods. Two classes of tools are in the government's arsenal for dealing with externalities:

- Price-based measures (taxes and subsidies); and
- Quantity-based measures (regulation).

Which of these methods will lead to the most efficient regulatory outcome depends on factors such as heterogeneity of firms being regulated, flexibility of quantity regulation, and uncertainty regarding costs of externality reduction.

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LECTURE 7: HEALTH THREATS OF PETROLEUM ACTIVITIES

SYLLABUS

Teaching Aims

(i) Convey understanding of how humans can be impacted when exposed to certain petroleum activities that pose danger to their lives.

Learning Objectives

(i) Explain human vulnerabilities to petroleum activities.

(ii) Provide correct advice to stakeholders on how to deal with health threats from petroleum activities.

Outline of Lecture Content

Topic and Subtopic	Suggested Approach, Methods & Equipment
1. Exposure to Noise- and Vibration	Lecture mixed with Q&A to build on trainees' knowledge and experience
2. Shift Work	Class discussions guided by Q&A
3. Health-Related Issues as a Result of Population Influx	Class discussions guided by Q&A
4. Control of Substances Hazardous to Health Regulations	Lecture mixed with Q&A to build on trainees' knowledge and experience
5. What Mitigation Measures and Laws can be Applied as Prevention Mechanisms?	Class discussions guided by Q&A

DETAILED NOTES

1. EXPOSURE TO NOISE AND VIBRATION

What is Noise?

- Unpleasant or unwanted sound; and
- When unwanted noise gets loud enough:
  - It is distracting,
  - It is tiring and stressful, and
  - Higher levels cause permanent hearing damage.

Exposure to Noise-Associated Hazards

- Causes annoyance and irritation;
- Affects concentration and efficiency;
- Causes fatigue and susceptibility to accidents; and
- Makes one unable to hear other sounds, instructions, and warnings.

Short exposure can lead to temporary hearing loss.

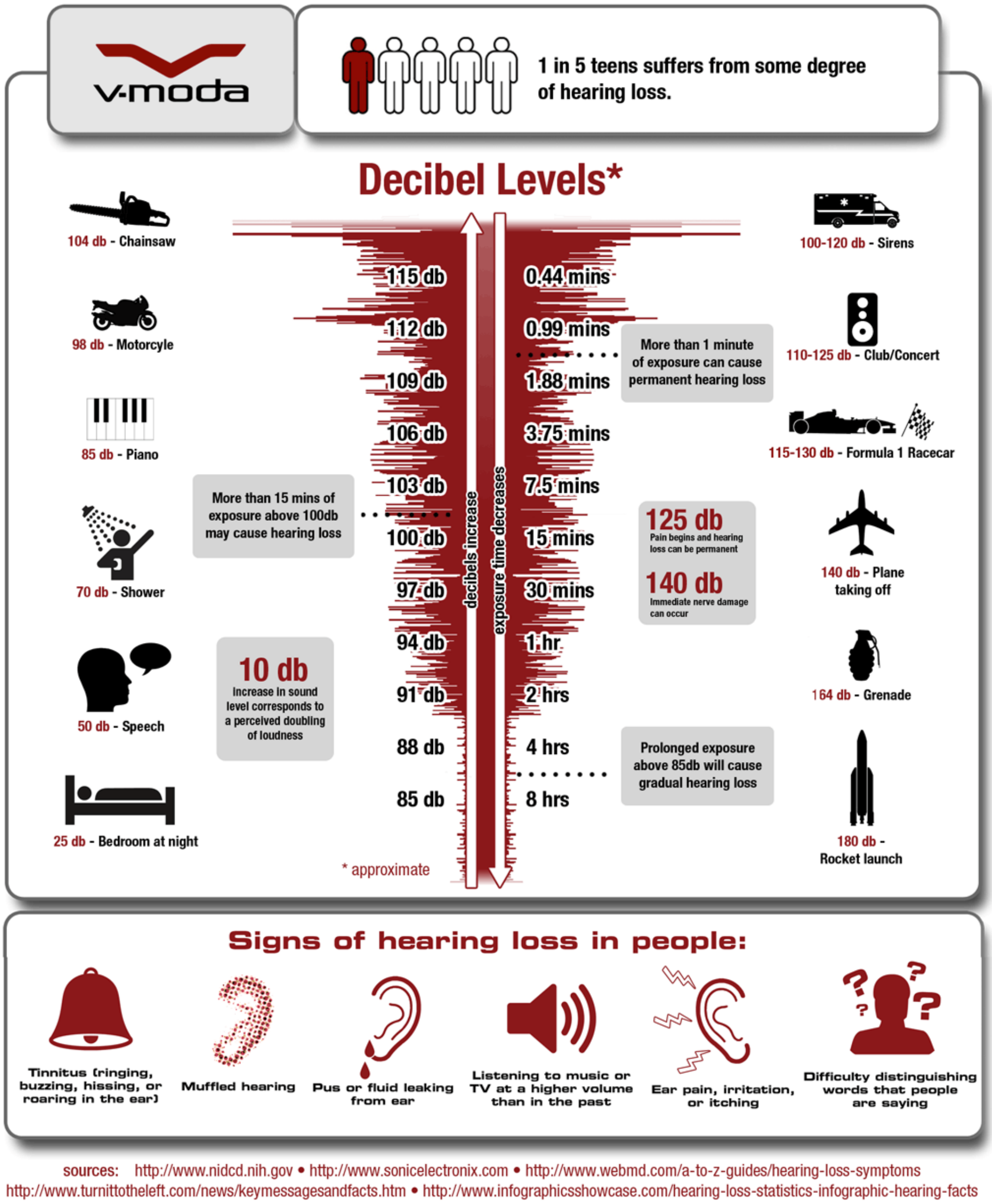
Regular exposure can damage inner ear and lead to permanent loss of hearing.

Action and Limit Values

- Lower action value (LAV): 80 decibels (dBA) over 8 hours; peak at 135 dBA
- Upper action value (UAV): 85 dBA over 8 hours; peak at 137 dBA
- Exposure limit value (ELV): 87 dBA over 8 hours; peak at 140 dBA; can take account of hearing protection

Noise Levels

FIGURE 7.1: LEVELS OF INTENSITY OF DIFFERENT SOUND SOURCES



Source: V-Moda, no date.

If your average daily exposure is over 80db(A)

The employer must:

- Inform you of the risks to your hearing from noise and how you can reduce those risks.
- Make hearing protection equipment available.

If your average daily exposure is over 85b(A)

The employer must:

- Try to reduce noise at source.
- Provide hearing protection and insist on its use.
- Identify and sign ear-protection zones.
- Conduct noise assessments and keep records of them.
- Provide hearing checks if requested.

If your average daily exposure is over 87b(A)

- This is a **maximum** and must not be exceeded.
- Noise to the ear must be reduced:
  - Preferably at source.
  - Otherwise by hearing protection.

Employees exposed to noise must:

- Use ear protectors or other hearing protection measures provided.
- Report any defects in the hearing protection measures provided to employer.

Identifying Noise Hazards

- Noise surveys;
- Audiometric testing;
- Recordkeeping;
- Follow-up;
- Coexisting hearing problems;
- Nature of the environment;
- Distance from the source; and
- Position of the ears relative to the sound source.

Noise Controls

- Engineering controls;
- Administrative controls; and
- Hearing protection.

Control of Noise Hearing and Ear Protection

Ear Plugs

- Must be kept clean (many are single use).
- Must be inserted properly (there is a special technique).
- Generally comfortable to wear, especially in hot weather.
- Re-usable ear plugs:
  - Need regular and careful washing.

- Supply and fitting by trained person.
- May need different sizes for each ear.
- Dirt can cause ear irritation.

Disposable Ear Plugs

- Correct insertion is essential.
- Are not reusable.
- Handle only with clean hands.

Ear Defenders

- Must be correct type for job.
- Will not be effective if damaged or worn out.
- Must fit correctly – headband not too tight or too loose.
- Facial hair or spectacles may cause problems.

Vibration

Hand-arm vibration (HAVS):

- Chainsaws; and
- Handheld rotary tools:
  - Grinding;
  - Sanding; and
  - Polishing.

Whole body vibration:

- Ride-on plant operators.

Threats Associated with Vibration

Annoyance and Irritation

- Affects concentration and efficiency;
- Causes fatigue and susceptibility to accidents; and
- Makes one unable to hear other sounds, instructions, and warnings.

Short exposure can lead to temporary hearing loss.

Regular exposure can damage inner ear and lead to permanent loss of hearing.

Note: Occupational deafness is a reportable disease.

Preventing Vibration Hazards

- Low-vibration tools;
- Limit employee exposure; and
- Change employee work habits.

2. **SHIFT WORK**

What is "Shift Work" and Why is it Important?

- It is groups of people working together alternating with other groups to create a cohesive and productive workplace 24 hours a day, 7 days a week.
- It effects staffing levels, schedules, workload responsibilities, and morale.

It is important because we all deal with shift work—directly or indirectly.

Common Negative Effects of Shift Work

- Lack of communication between staff on different shifts;
- Lack of teamwork;
- Lack of concentration while on duty;
- Potential unsafe conditions;
- Stress and fatigue; and
- Shift lag.

What is Shift Lag?

Shift lag is a condition many worker suffer from, due to rotating schedules and non-conventional hours. Shift lag usually comes in the form of mental and/or physical symptoms.

Mental Symptoms

- **Increased Irritability:** Shift workers become more irritable after working night shifts.
- **Overly Emotional:** "Snapping or losing it" is another symptom of shift workers.
- **Contrary Behavior:** Some workers are so stressed with shift work that they become easily upset and are prone to seeing problems that may not really be there.
- **Forgetfulness:** Forgetting to clock in or out and forgetting to do quality checks are two examples. Also, many small tasks done automatically during the day are forgotten at night.

Physical Symptoms

- **Fatigue/Tiredness:** Being worn out and tired for days after night shifts, generally accompanied by a lack of concentration and motivation, especially for any activity that requires effort or skill
- **Loss of Energy:** Energy level decreases in activities like going to work, gardening, home maintenance, and recreational sports.
- **Broken Sleep:** Working during the hours of 12–5 a.m. disrupts circadian rhythms (normal wake and sleep cycle), causing wakeup during sleep and subsequently, desire to fall asleep during the next shift.
- **Stomach Problems and/or Constipation:** Attributed to shift workers not eating properly.
- **Dehydration:** This can cause headaches, dry skin, nasal irritation, and increase susceptibility to colds, coughs, sore throats, and flu that are floating around in the work place. Drinking plenty of non-alcoholic and non-caffeine liquids will help reduce dehydration during the night.

Because people are different, there is also a big difference to how much each person suffers from shift lag. Some cannot work night shifts, while others find it less stressful than most. Note: changing jobs may be the best long-term solution for those who find night shift work difficult.

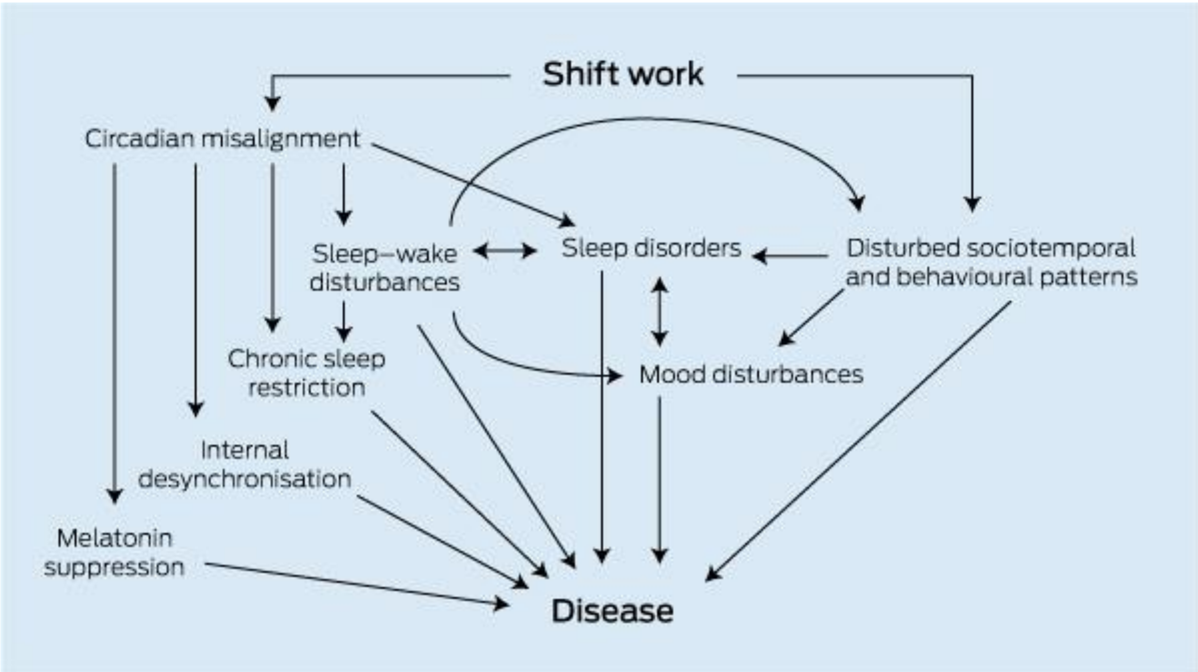
What Causes Shift Lag and Who Gets Shift Lag?

- Work Schedule: evidence suggests that it is best to work days, then evenings, and then nights—otherwise, with work in a different combination, shift lag worsens;
- Working All Night: the main cause of shift lag is working on a night shift, after 11:00 p.m. and before 6:00 a.m.: this period is when the body naturally resets its daily biological clock;
- Lack of Quality Sleep; and
- Many Shift Workers Never Fully Recover from Shift Lag: even if the shift work schedule is an easy one, say two nights on and five days off. The reason is lack of quality sleep.

Adjustment to Shift Work

- Approximately 7 days to adjust to shift;
- External cues hamper adjustment;
- Night work sometimes never leads to adjustment;
- Slow rotating shifts – partial adjustment, continual adjustment; continual dysrhythmia state; and
- Rapid rotating shifts – no adjustment.

FIGURE 7.2: CONSEQUENCES OF SHIFT WORK CYCLE



Source: Rajaratnam et al., 2013

Tips for Reducing Shift Lag

- Get quality sleep after shift. Make the room quiet, dark, temperature controlled and comfortable.
- Get extra exercise, which help reduce stress.
- Seek support from family and friends. An understanding partner and family does help.
- Drink plenty of fluids to reduce dehydration.

Fighting Fatigue

- Establish a consistent bedtime routine.

- Engage in physical activity, such as walking, biking or swimming.
- Reduce alcohol, caffeine and tobacco intake.
- Eat a well-balanced diet. Cut out large or spicy meals late in the evening.
- Get regular checkups and stick with physician's recommended plan.

3. HEALTH-RELATED ISSUES AS A RESULT OF POPULATION INFLUX

Case Study: The Chad-Cameroon Health Risk Assessment: Potential for HIV Spread Across the Petroleum Industry

TABLE 7.1: CLINICALLY DIAGNOSED CASES OF DISEASE AMONG WORKERS, CHAD OIL EXPORT PROJECT

	Months after start of construction						
	6	**9**	**12**	**15**	**18**	**21**	**24**
No. of workers	3521	5087	7559	9788	*	11 243	12 474
Diagnosed cases							
Malaria	400	674	1400	421	473	37	113
Sexually transmitted diseases	109	400	400	192	595	379	342
Other diseases[a]	12	800	800	95	232	236	126
Follow-up							
Hospitalizations	10	14	14	11	29	36	43
Medical evacuations	9	9	8	5	3	14	6

[a] Mainly diarrhoeal diseases and respiratory diseases.
* The estimated number is about 12 000, but Exxon did not report the exact number for that quarter.

Source: Jobin, 2003

4. CONTROL OF SUBSTANCES HAZARDOUS TO HEALTH REGULATIONS[10] (COSHH), 2004

What are Hazardous Substances under the Regulations?

- Substances and mixtures classified as dangerous under Chemicals Hazard Information and Packaging for Supply (CHIP) Regulations, 2008;
- Substances with workplace exposure limits (WEL);
- Biological agents;
- Some dusts, especially at high concentrations; and
- Other substances of comparable hazard.

Non-Classified Hazardous Substance under COSHH

- Asbestos and lead (separate regulations);
- Substances hazardous only because they are radioactive, simple asphyxiates, at high pressure, at extreme temperatures, or explosive or flammable (separate regulations); and
- Biological agents not connected with work (e.g., agents responsible for catching cold).

Normally, presence of a label (or not) indicates whether COSHH is relevant.

Employers' Duties

[10] The following section draws from the United Kingdom regulatory framework. Manual users should compare this framework with that which is emerging in Uganda to address the hazards associated with oil and gas development.

Eliminate or reduce risks from hazardous substances. This is achieved by risk assessment, control measures, monitoring of health and exposure if necessary, and information, training, and supervision.

Employees' Duties

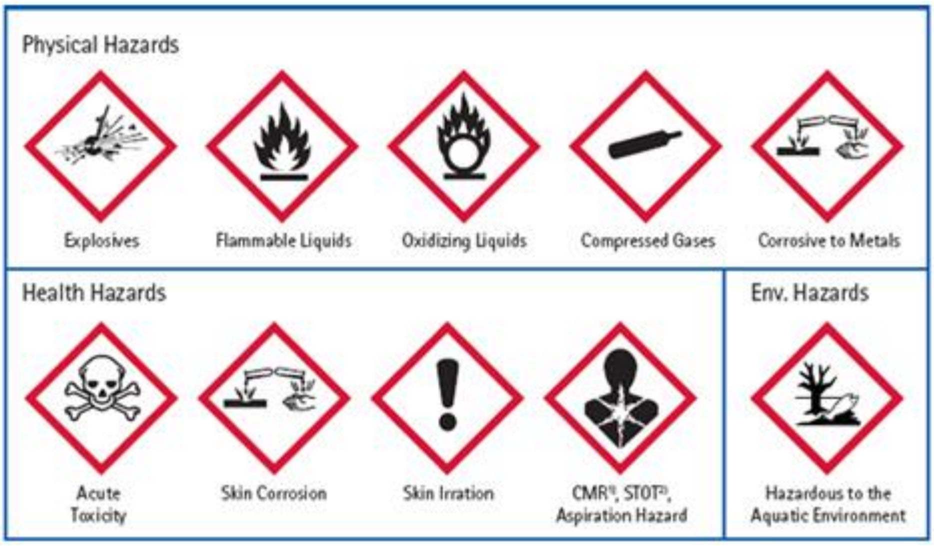
- Take reasonable care of own safety and not endanger others.
- Cooperate with employer.
- Make full and proper use of control measures.

Risk Assessment

- Identify hazardous substances in the workplace.
- Decide who is at risk and how.
- Evaluate the risk—are further controls necessary?
- Record findings.
- Review and revise when necessary.

Risk Assessment for COSHH

FIGURE 7.3: INTERNATIONAL HAZARD SYMBOLS



Source: Indian Institute of Technology Indore, n.d.

- Step 1: Decide **who** is at risk and how (staff, others), and consider their current training (if any) and their background.
- Step 2: Decide who is at risk and **how** (inhalation, skin or eye, ingestion, or injection).
- Step 3: Evaluate the risk. Facts to consider include toxicity, form (gas, spray, dust, liquid, solid), solubility, amount (weight/volume), nature of the operation, length of exposure, and number of people involved.
- Step 4: Decide on control measures. Control exposure in proportion to risk by using the hierarchy of controls. Personal protective equipment should be a last resort as the prime means of control.
- Step 5: Use of control measures (1). Replace substance with a safer alternative, for example, use a lower hazard disinfectant rather than bleach (irritant) if it will do the job adequately.

- Step 5: Use of control measures (2). Use the material in a safer form, for example, use water-based paint instead of solvent-based pant; buy hazardous materials in pre-weighed sachets rather than having to measure and make up form bulk quantities.
- Step 5: Use of control measures (3). Control the operation by isolating the work, controlling at the source (fume cupboard, local exhaust ventilation), and reducing the number of workers.
- Step 5: Use of control measures (4). Personal protective equipment is a last resort. Equipment protects on the worker and not others in the room. Training and maintenance on the equipment is required, and the equipment is often uncomfortable.
- Step 6: Maintenance of control measures. Control measures must be kept in good repair and work properly. Simple checks on the airflow must be regular. LEV and fume cupboards must have engineering checks every 14 months. Records must be kept for five years.
- Step 7: Health surveillance is required with significant exposure of Schedule 6 processes (apart from vinyl chloride use, these are all manufacturing processes). Surveillance is also required if likelihood of exposure to substances is linked to specific diseases, but only if there is reasonable likelihood that this will occur, or if the disease is detected. Records must be kept for 40 years. Workers must have adequate information, instruction, training, and supervision. This will include the procedures themselves, and what to do in an emergency.
- Step 8: Check and review. Are the control measures adequate? Are they working correctly? Is everyone aware of how to use them? Is the necessary equipment available to deal with an emergency or malfunction?

What About…

- Light from flaring, welding, etc.?
- Contamination of air and/or water? Here we consider several factors after risk assessment and evaluation:
  - Toxicity form (gas, spray, dust, liquid, solid);
  - Solubility;
  - Amount (weight and/or volume);
  - Nature of the operation;
  - Length of exposure;
  - Number of people involved; and
  - Water standards may be country specific or regional, so we limit the assessment to that level.

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LECTURE 8: SPECIALIZED HAZARDS

SYLLABUS

Teaching Aims

(i) To increase trainees' knowledge about the range of potential workplace hazards.

Learning Objectives

(i) Demonstrate ability to anticipate specialized hazards and their possible impacts.

(ii) Communicate appropriate safety measures to stakeholders in vulnerable areas and work environments.

Outline of Lecture Content

Topic and Subtopic	Suggested Approach, Methods & Equipment
1. Overview of Specialized Hazards	• Brainstorming to piece together the nature of the hazards and their sources along the value chain • A video on a real-life specialized hazard situation is helpful for trainees to internalize the gravity of the matter
2. Impacts of Specialized Hazards	Brainstorming to piece together impacts of the hazards
3. Regulations and Control Measures	Lecture mixed with Q&A to build on trainees' knowledge and experience
4. Emergency Preparedness and Response	Introduce this topic with a video on the subject matter and lead on to a discussion
5. Practical work	Training in firefighting – Uganda Petroleum Institute, Kigumba (UPIK) has the necessary equipment.

DETAILED NOTES

1. OVERVIEW OF SPECIALIZED HAZARDS

Industrial hazards cover a wide spectrum including fire and explosion, mechanical hazards (e.g., from moving machinery), electrical hazards, occupational exposures to ionizing and non-ionizing radiation, biological hazards (e.g., acute or chronic infections, parasitism, and toxic or allergic reactions to plant and animal matter), physical hazards (e.g., tripping, falling, impact from vehicles or falling objects) and ergonomic hazards (e.g., lifting or carrying heavy or awkward loads or from repetitive operations). Work-related stress can also lead to mental and physical ill health. Different hazards may be associated with production, storage, transport, use, and disposal of chemicals. Environmental hazards, through persistent or accidental losses of chemicals, may also be related to these operations (Carson and Mumford, 2002).

Hazards in the Petroleum Industry

Virtually all health hazards common to industry are present in onshore and offshore petroleum operations. They include:

- Chemical hazards (toxic, corrosive, irritant, and sensitizing substances, and possible carcinogens, fires, explosions)
- Physical hazards (noise, vibration, various forms of radiation, thermal extremes)
- Biological hazards (legionella, food poisoning)
- Ergonomic hazards (manual handling activities, workstations, video display units)
- Psychosocial hazards (stress, depression) associated with either work (overload, underload, hours of work, tour patterns, work relationships, etc.) or location (travel, being away from home, living on the job, etc.)—all of which can contribute to psychological stress.

Chemical Hazards

The upstream petroleum industry uses and produces a variety of chemical products on its work sites. Chemical hazardous (State of North Dakota, 2014) materials are any substances posing an unreasonable risk to safety and health, the environment, and property. The term “hazardous materials” encompasses a vast array of products, from relatively innocuous types to highly toxic or poisonous types such as anhydrous ammonia and phosgene gas. Severity of potential hazards caused by these materials varies, but the primary reason for the designation is risk of these materials to public safety and the environment.

The following categories of hazardous materials are considered in this lesson:

- Gases;
- Flammable and combustible liquids;
- Flammable solids, spontaneously combustible, and dangerous when wet;
- Oxidizing substances and organic peroxides;
- Toxic/poisonous substances and poisons inhaled;
- Radioactive materials;
- Corrosive substances; and
- Miscellaneous hazardous materials/products, substances, or organisms.

Chemical hazardous material incidents can be categorized as uncontrolled releases occurring during transportation (ship, truck, or pipeline) or at a fixed source such as a production, processing, or storage facility. Accidental releases may be due to equipment failure, human error, or a natural or man-made hazard event.

Generally, at a fixed facility, the hazards are pre-identified, and the facility is required by law (in the United States, for example) to prepare a risk management plan and provide a copy to the local emergency planning committee and local fire departments (State of North Dakota, 2014).

Chemical hazardous materials releases often are viewed in a worst-case scenario. Some have resulted in loss of several lives and contamination of soils, rivers, lakes, streams, underground water supplies, and fish and wildlife habitat; however, the majority of incidents involve small spills and releases requiring little response or recovery action. The problem for decision-makers at all levels of government and the petroleum industry is to create a safe system for use, storage, and transport of hazardous materials while expanding the economic viability.

Hazardous material releases occur as a result of multiple causes but are often initiated by a transportation or facility accident. Almost any hazard that destroys infrastructure can lead to a hazardous material release. For example, floods can wash out bridges or roadways, causing transportation accidents, as well as infiltrate storage facilities, causing a hazardous material release at a fixed facility. Strong winds, poor visibilities, or slippery roadways may also instigate a transportation accident. Hazardous material releases can be intentional (e.g., a terrorist act). Hazardous material releases during any hazard event will most certainly compound the complexity of the event.

Chemical hazardous material incidents can happen anywhere, but the most likely locations are associated with oil and natural gas industry development, at fixed facilities of production, housing, or along an interstate, railroad, or pipeline infrastructure.

Crude oil is a complex chemical mixture with many hazardous components (Guzzardi and Associates, 2010). Workers could be exposed during drilling, pumping, and transport of crude, as well as during equipment maintenance. Liquid crude can irritate skin and eyes. Prolonged contact can cause drying and cracking of the skin, which can be painful. Hot fluids can cause severe burns. Vapors can affect the central nervous system, initially causing dizziness or drowsiness (a safety hazard in operational areas). Inhalation effects could progress to unconsciousness or death. The International Agency for Research on Cancer (IARC) considers crude oil to be "not classifiable as to its carcinogenicity to humans;" however, crude contains benzene, a known human carcinogen.

Natural gas extracted from the field typically contains "light hydrocarbons." In addition to being highly flammable, methane, ethane, and propane are asphyxiants—they can displace oxygen. This is especially important to be aware of in confined spaces, as these gases can create an oxygen-deficient environment. Butanes can be anesthetic—causing dizziness, headaches, or impaired judgment. The gas stream will also contain benzene (a known carcinogen) and other volatile organics.

Poisonous hydrogen sulfide gas can be present in both crude oil and natural gas. Furthermore, it can be released in fatal concentrations during normal field activities. In addition to these naturally occurring substances, a wide range of commercial chemicals are used by the oilfield service industry. Each poses its own hazards, which should be disclosed on its material safety data sheet.

Offshore drilling and production of petroleum have become increasingly important for countries that extract petroleum from offshore operations (Thatcher, et al., 2004). These activities often lead to discharges of chemicals into the marine environment and include production chemicals, drilling muds, well cleaning fluids, and cements. These discharges may result in environmental effects and impact human health.

Production Chemicals

- Production chemicals are added to either injection water or produced fluids in order to protect the installation, protect the reservoir, maintain production efficiency, or separate oil/gas from water. After addition of the chemicals, they partition between the produced fluids, some dissolving primarily in the oily fraction, some primarily in the water fraction, and some in both. The chemicals that move into the water phase may be released into the environment with the produced water. Details of a few production chemical groups are as follows:

- Corrosion inhibitors: added to injection water and/or produced fluids to protect the installation against corrosion.
- Scale inhibitors: water-soluble chemicals added to produced fluids to prevent formation of scales.
- Demulsifiers or deoilers: added to produced fluids to accelerate separation of hydrocarbon and water phases.
- Anti-foaming agents: added to produced oil to speed removal of gas bubbles.
- Biocides: added to eliminate bacteria, which produce corrosive by-products such as hydrogen sulfide
- Gas hydrate inhibitors: added to the production stream to prevent formation of gas hydrates in pipelines.
- Scavengers: added to remove hydrogen sulfide from produced gas or oxygen from injection water.

Drilling Fluids

Drilling fluids are used extensively in the upstream petroleum industry, and are critical to ensure a safe and productive oil or gas well. During drilling, a large volume of drilling fluid is circulated in an open or semi-enclosed system, at elevated temperatures, with agitation, posing significant potential for chemical exposure and subsequent health effects (OGP, No date).

Drilling muds are liquids used in drilling operations to cool and lubricate the bit, to carry away drill cuttings, and to balance underground hydrostatic pressure. Muds are pumped down the drill string, through the bit, and then carry the drill-cuttings through the annulus back up to the surface. Drilling muds can be divided into three broad categories based on the base fluid used: oil-based muds (OBM), synthetic-based muds (SBM), and water-based muds (WBM). In addition to the base fluid, drilling muds contain barite and a variety of chemicals added to give the mud the desired properties (Thatcher et al., 2004).

Potentially hazardous substances can arise from formations being drilled. This is not always predictable. One known source of hydrocarbon contamination will derive from the reservoir formation. Often, however, formations drilled through to the reservoir also contain hydrocarbons, but not at producible or commercial quantities. These hydrocarbon sources can introduce oil, condensate, and gas contamination into a drilling fluid. Gases from formations are primarily composed of methane.

Formations can contain hydrogen sulfide gas and hydrogen sulfide-containing water samples. These gases must be closely monitored and treated to eliminate hazardous exposure to personnel. Carbon monoxide can be present, particularly when coal beds are drilled. This occurrence is, however, extremely rare. Low Specific Activity (LSA) radioactive scale contamination of a circulating fluid can occur during scale cleanout operations, or when abandoning production wells. Operators should be conscious of this risk and control exposure as appropriate.

Cementing Chemicals

Source: Thatcher et al., 2004.

After the first sections of a well have been drilled, casings are inserted in the well and cemented into place. Cementing is the process of mixing a slurry of cement, cement additives, and water, and pumping it down through casing to critical points in the annulus around the casing or in the open hole below the casing string. The two principal functions of the cementing process are to prevent fluid movement or migration between sub-surface formations, and to bond and support the casing in a well.

As the cement reaches the lower end of the casing, it is forced up into the annular spaces. During this process, some excess cement might be forced out of the annular spaces and deposited on the sea-bed. This cement may remain liquid for several hours, during which time the release of chemicals into the ambient waters is considered negligible.

The volume of cement slurry to be used is normally overestimated to ensure adequate cementing throughout the annulus. This excess cement is brought back to the surface along with the spacer, both of which will be heavily contaminated with the drilling mud. In cases where OBM are used, these wastes will not be discharged even if the contaminated drilling mud is separated.

Completion, Workover Chemicals

Completion and workover chemicals are used to optimize production of a well, and act on the well or formation itself. Completion operations are carried out after completion of drilling and before production begins. Chemicals used in completion and workover fluids include acids, alkalis, biocides, brines, corrosion inhibitors, well-cleaning chemicals, surface active agents, and oxygen scavengers, among others.

The risk of adverse health effects from these chemicals is determined by the hazardous components of the fluids and by human exposure to those components (OGP, No date). These chemicals and fluids pose hazards to workers and the environment. Level of exposure depends on the chemical's partitioning characteristics, concentration in the waste stream, dilution in the receiving environment, in-process degradation mechanisms, and residence time before release.

Chemical Hazards in Oil Refining

Source: Purvis and Herman, 2005

Petroleum refineries are stark examples of safety hazards posed by use of toxic chemicals in the manufacturing process and opportunities to switch to safer alternatives. In the United States, for example, petroleum refineries are responsible for nearly 11% of all high-risk processes in EPA's Risk Management Program, the agency's primary chemical accident prevention program established under the 1990 Clean Air Act Amendments. Notably, many of these refineries use hydrofluoric acid, also known as hydrogen fluoride, as a catalyst to produce an additive to gasoline. This additive is then used to increase octane levels in gasoline, which addresses the problem of engine "knocking." Currently, 148 petroleum refineries operate in the United States, 50 of which use hydrofluoric acid as a catalyst to produce alkylate.

Fire

Fire remains one of the most serious risks facing offshore crews, and is one of the most feared maritime events. When faced with a fire, possibly miles away from the nearest port or rescue services, a crew will have to deal with the emergency themselves. Ensuring that oil rigs are properly equipped for fire detection, prevention, fire-fighting, and rescue is an important part of any crew's responsibilities (SHP Online, 2014).

Hydrocarbon Releases

Hydrocarbon releases are often the precursor to major incidents, and in 2012/13, hydrocarbons accounted for 26.8 percent of all dangerous occurrences reported. In liquid form, hydrocarbons can create slippery and dangerous surfaces, and in gas form, they are equally hazardous, with the main danger being accidental ignition that results in an explosion (ibid).

Gas Hazards

(Crowcon News, 2011)

In most industrial environments posing risk of explosion or fire because of presence of flammable gases or vapors, a mixture of compounds is likely to be encountered. In the oil, gas, and petrochemical industries, the raw materials are a mixture of hydrocarbons and chemicals, some of which may be altered by a process. For example, crude oil is separated into many materials via fractionation (or fractional distillation); fractions are further converted by application of processes such as "cracking" or "catalytic reforming." Flammable hazards are therefore likely to be posed by many substances in a typical petrochemical refining plant.

Explosive Risk

Ignition of a gas requires an ignition source, typically a spark (or flame or hot surface), and oxygen. For ignition to occur, concentration of gas or vapor in air must be at a level such that the "fuel" and oxygen can react chemically. The power of the explosion depends on the fuel and its concentration in the atmosphere. Relationships among fuel/air/ignition are illustrated in the following "fire triangle."

Fire Triangle

The "fire tetrahedron" concept has been introduced more recently to illustrate the risk of fires sustained because of chemical reaction. With most types of fire, the original fire triangle model works well—removing one element of the triangle (fuel, oxygen, or ignition source) prevents a fire. However, when fire involves burning metals like lithium or magnesium, using water to extinguish the fire could result in it getting hotter or even exploding because such metals can react with water in an exothermic reaction to produce flammable hydrogen gas.

Not all concentrations of flammable gas or vapor in air will burn or explode. The lower explosive limit (LEL) is the lowest concentration of fuel in air that will burn, and for most flammable gases, it is less than 5% by volume. So high risk of explosion can be posed even when relatively small concentrations of gas or vapor escape into the atmosphere.

LEL levels for gases and vapors are defined in various international standards. The original long-established standards listed LEL levels that had been determined by use of a static concentration of gas. More recent European and international standards list LEL levels measured by use of a stirred gas mixture: some substances are more volatile when in motion and pose an explosive risk at lower concentrations than indicated by results of previous "static" tests. Methane is the most commonly occurring flammable gas in industry: the long-established LEL is 5% in air, while the new LEL recognized in Europe and other territories is 4.4%, and calibration practices have changed accordingly.

The propane vapor LEL is affected to an even greater degree: the old LEL value was 2-2.2% in air (depending on which standard is referenced), while the new LEL is 1.7% in air. A more comprehensive list of affected gases and vapors is accessible at www.talkinggas.co.uk'.

Toxic Gas Risk

Gases and vapors released from oil, gas, and petrochemical processing activities can, under many circumstances, exert harmful effects on workers exposed to them via inhalation, absorption through the skin, or via swallowing. People exposed to harmful substances may develop illnesses such as cancer many years after first exposure. Many toxic substances are dangerous to health at low concentrations in parts per million (ppm) or even parts per billion (ppb).

Given that 10,000 ppm is equivalent to 1% volume of any space, evidently an extremely low concentration of some toxic gases can present a hazard to health. Notably, most flammable gas hazards occur when concentration of gases or vapors exceed 10,000 ppm (1% or higher of air volume). In contrast, toxic gases typically must be detectable at sub-100 ppm (0.01% of air volume) to protect personnel.

Gaseous toxic substances are especially dangerous because they are often invisible and/or odorless. Their physical behavior is not always predictable: ambient temperature, pressure, and ventilation patterns significantly influence behavior of a gas leak. Hydrogen sulfide, for example, is particularly hazardous; although it has a very distinctive "bad egg" odor at concentrations above 0.1 ppm, exposure to concentrations of 50 ppm or higher will lead to paralysis of the olfactory glands, rendering the sense of smell inactive. This in turn may result in an assumption that the danger has cleared. Prolonged exposure to concentrations above 50 ppm will result in paralysis and death.

Definitions of maximum exposure concentrations of toxic gases vary according to country. Limits are generally time-weighted, as exposure effects are cumulative: the limits stipulate maximum exposure during a normal working day.

Pipeline Hazards

Source: Pipeline Operators Safety Partnership, 2015

Pipelines are the safest mode of transportation. Despite this, pipeline releases can create hazards for workers, communities, responders, and the environment. A pipeline release can result in:

- Fire or explosion;
- Vapor cloud;
- Toxic or combustible fumes;
- Asphyxiation; and
- Contamination of the environment.

Pipelines can carry many different types of products ranging from gaseous material to thick crude oil. Some of the more common products transported by pipelines are listed below with information on each product's characteristics and hazards.

TABLE 8.1: PIPELINE PRODUCTS, CHARACTERISTICS, AND HAZARD

Product and Description	Characteristics	Hazard
Natural Gas Colorless, odorless gas used as a fuel source. Odorized when being transported to an end user.	• Vapors are lighter than air • Dissipates rapidly into air • Odorless, tasteless, and colorless • May contain hydrogen sulfide	Natural gas is flammable and can ignite when it comes into contact with an ignition source. In confined spaces, exposure can cause asphyxiation. Natural gas can contain hydrogen sulfide, which is toxic.
Liquid Petroleum Gas (LPG) and Natural Gas Liquids (NGL) NGLs include a range of hydrocarbon compounds, including butane, iso-butane, propane, ethane, and natural gas condensate. These compounds are extracted from the gas stream during processing.	• Highly volatile liquid • Vapors are heavier than air • Vapors will seek low areas • Odorless, tasteless, and colorless • Will travel long distances and form a vapor cloud • Toxic	NGL is combustible. Exposure can cause moderate irritation including headaches and dizziness. NGLs can also contain hydrogen sulfide, which is toxic.
Crude Oil Crude oil occurs naturally in liquid form ranging from a water-like substance to a very thick tar.	• Ranges from fluid to thick liquid consistency • Vapors are heavier than air • Can travel long distances to ignition source	Crude oil is combustible. Exposure can cause moderate irritation including headaches and dizziness. Crude oil can

Product and Description	Characteristics	Hazard
Color can range from amber to black.	• Extremely flammable and toxic	also contain hydrogen sulfide, which is toxic.
Refined Liquid Petroleum Products Refined products derived from crude oil include gasoline, jet fuel, diesel, and chemicals.	• Vapors are heavier than air • Explosive in confined area • Extremely flammable, and hydrogen sulfide may be released	Gasoline is flammable; distillates are combustible. Exposure can cause moderate irritation including headaches and dizziness. Exposure to refined fuels may also cause eye and skin irritation.

Source: Pipeline Operators Safety Partnership, 2012

Physical Hazards

Noise and vibration can both independently pose significant health risks (e.g., from drill floors, shakers, sack rooms, generators, compressors, and mixers). Use of hand-held vibrating tools is widespread on offshore installations (e.g., grinders, needle guns, impact wrenches, air drills, and chipping hammers). This creates the possibility of hand-arm vibration syndrome in workers who use these tools routinely. Various forms of radiation and thermal extremes are also relatively common on offshore platforms. Exposure to extreme heat and direct sunlight in tropical areas and to extreme cold at high latitudes can become significant sources of health risk, depending on the geographical region of the world (Niven and McLeod, 2009).

Noise

Source: Amendments to Noise Requirements in the Regulations for Industrial Establishments & Petroleum-Offshore: Health and Safety Guidelines, Ontario.

Noise is a serious hazard in many workplaces. Over time, if exposure to noise from machinery, processes, and equipment is not properly eliminated or controlled, it may cause permanent hearing loss in workers. Exposure to high levels of noise in the workplace may also create physical and psychological stress, reduce productivity, interfere with communication, and contribute to accidents and injuries by making it difficult to hear moving equipment, other workers, and warning signals.

Environmental noise caused by petroleum drilling activities is often overlooked entirely or rejected as a minor, temporary nuisance by industry and regulators alike—despite the fact that drilling and other activities at well sites are very noisy and can be close to homes. Indeed, public health experts have identified noise as a ubiquitous health threat to communities near petroleum development sites, and studies have found noise levels above safety thresholds, noting that insufficient steps have been taken to reduce noise levels in impacted communities.

Primary sources of noise during the drilling/development phase are items of equipment, especially bulldozers, drill rigs (Tribal Energy and Environmental Information. n.d.), and diesel engines/generators. Other sources of noise include vehicular traffic, fracturing, blasting (particularly in areas where the terrain is hilly and bedrock shallow), well pumps, compressors, and gas flaring. Noise from drilling has been measured as 115 decibels (dBA) at the source to above 55 dBA at distances 1,800 feet (549 meters) to 3,500 feet (1,067 meters) from the well. Exploratory wells that become production wells often continue to generate noise during the production phase.

In offshore operations, petroleum exploration and tanker traffic are the most significant sources of noise pollution. The petroleum industry undertakes "seismic surveying" to examine sea bed geology in order to identify potential petroleum reserves. This involves bursts of sound called "airgun arrays" that refract off rock formations and can be used to build a picture of geology below the sea bed. Noise from seismic surveys travels so far through the oceans that it remains the loudest background noise more than 3000 km from the loudest location. Noise from seismic surveys and naval sonar can be fatal to whales, including some of the rarest species, because it leads to strandings.

Once petroleum reserves are identified, they must be extracted—a lengthy process often involving huge drilling operations. Drilling generates noise of loudness comparable to airgun arrays, but noise from drilling lasts much longer. Over time, exposure to this can cause marine mammals and other marine species to abandon habitat.

Radiation

Radioactive materials, sealed sources, and radiation generators are used extensively by the petroleum industry, and various solid and liquid wastes containing naturally occurring radioactive material (NORM) are produced. Presence of these radioactive materials and radiation generators results in need to control occupational and public exposures to ionizing radiation.

Various radioactive wastes are produced in the petroleum industry, including the following:

- Discrete sealed sources, e.g., spent and disused sealed sources;
- Unsealed sources, e.g., tracers;
- Contaminated items; and
- Wastes arising from decontamination activities, e.g., scales and sludges.

These wastes are generated predominantly in solid and liquid forms, and may contain radionuclides of artificial or natural origin with a wide range of half-lives (International Atomic Energy Agency [IAEA], n.d.).

Geologic formations (U.S. Environmental Protection Agency, n.d.) that contain oil and gas deposits also contain NORM, which can include:

- Uranium;
- Thorium;
- Radium; and
- Lead-210.

Geologists have recognized presence of these since the early 1930s, and apply it to a method for finding deposits. Much of the petroleum in the earth's crust was created at the site of ancient seas by decay of sea life. As a result, petroleum deposits often occur in aquifers containing brine (salt water). Radionuclides, along with other minerals dissolved in the brine, precipitate (separate and settle), forming various wastes at the surface:

- Mineral scales inside pipes,
- Sludges,
- Contaminated equipment or components, and
- Produced waters.

Because the extraction process concentrates naturally occurring radionuclides and exposes them to the surface environment and human contact, these wastes are classified as technologically enhanced naturally occurring radioactive material (TENORM).

The briney solution contained in reservoirs of petroleum is known as "formation water." During drilling, a mixture of oil, gas, and formation water is pumped to the surface. The water is separated from the petroleum into tanks or pits, where it is referred to as "produced water." As the petroleum in the reservoir is removed, more of what is pumped to the surface is formation water. Consequently, declining oil fields generate more produced water.

While uranium and thorium are not soluble in water, their radioactive decay product, radium, and some of its decay products are somewhat soluble. Radium and its decay products may dissolve in the brine. They may remain in solution or settle out to form sludges, which accumulate in tanks and pits, or mineral scales, which form inside pipes and drilling equipment.

How Much Radiation is in the Wastes?

Because radium levels in the soil and rocks vary greatly, so do their concentrations in scales and sludges. Radiation levels may vary from background soil levels to as high as several hundred nanocuries per gram. The variation depends on several factors:

- Concentrations and identities of the radionuclides,
- Chemistry of the geologic formation, and
- Characteristics of the production process.

Waste Types and Amounts

Each year the petroleum industry generates around 150,000 cubic meters (260,000 metric tons) of waste, including produced water, scales, sludges, and contaminated equipment. The amount produced at any one oil reserve varies and depends on several factors:

- Geological location;
- Formation conditions;
- Type of production operation; and
- Age of the production well.

An estimated 30 percent of domestic petroleum wells produce some TENORM. In surveys of production wells in 13 states in the United States, the percent reporting high concentrations of radionuclides in wells ranged from 90 percent in Mississippi to none or only a few in Colorado, South Dakota, and Wyoming (CRCPD, 1988). However, 20 to 100% of the facilities in every state reported some TENORM in heater/treaters.

Produced Waters

Radioactivity levels in produced waters are generally low, but the volumes are large. The ratio of produced water to oil is approximately 10 barrels of produced water per barrel of oil. According to the American Petroleum Institute (API), more than 18 billion barrels of waste fluids from petroleum production are generated annually in the United States.

Produced waters contain levels of radium and its decay products that are concentrated, but concentrations vary from site to site. In general, produced waters are reinjected into deep wells or are discharged into non-potable coastal waters.

Scale

Scale is composed primarily of insoluble barium, calcium, and strontium compounds that precipitate from the produced water due to changes in temperature and pressure. Radium is chemically similar to these elements, and as a result, is incorporated into the scales. Concentrations of radium-226 (Ra-226) are generally higher than those of Ra-228.

Scales are normally found on the inside of piping and tubing. The API found that highest concentrations of radioactivity are in the scale in wellhead piping and in production piping near the wellhead. Concentrations were as high as tens of thousands of picocuries per gram. However, the largest volumes of scale occur in three areas:

- Water lines associated with separators (which separate gas from the oil and water);

- Heater treaters (which divide the oil and water phases); and
- Gas dehydrators, where scale deposits as thick as 4 inches may accumulate.

Chemical scale inhibitors may be applied to piping complexes to prevent scales from slowing the oil extraction process. If the scales contain TENORM, the radiation will remain in solution and eventually be passed on to the produced waters.

Approximately 100 tons of scale per oil well are generated annually in the United States. As the oil in a reservoir dwindles and more water is pumped out with the oil, the amount of scale increases. In some cases, brine is introduced into the formation to enhance recovery; this also increases scale formation.

Average radium concentration in scale has been estimated at 480 picocuries per gram (pCi/g). It can be much higher (as high as 400,000 pCi/g) or lower depending on regional geology.

Sludge

Sludge is composed of dissolved solids that precipitate from produced water as its temperature and pressure change. Sludge generally consists of oily, loose material often containing silica compounds, but may also contain large amounts of barium. Dried sludge, with a low oil content, looks and feels similar to soil.

Oil production processes generate an estimated 230,000 million tons or 5 million cubic feet (141 cubic meters) of TENORM sludge each year. The API has determined that most sludge settles out of the production stream and remains in the oil stock and water storage tanks.

As does contaminated scale, sludge contains more Ra-226 than Ra-228. Average concentration of radium in sludges is estimated to be 75 pCi/g. This may vary considerably from site to site. Although concentration of radiation is lower in sludges than in scales, sludges are more soluble and therefore more readily released to the environment. As a result, they pose a higher risk of exposure.

Concentration of lead-210 is usually relatively low in hard scales, but may be more than 27,000 pCi/g in lead deposits and sludge.

Contaminated Equipment

TENORM contamination levels in equipment varied widely among types of equipment and geographic region. The geographic areas with the highest equipment readings were northern Texas and the Gulf Coast crescent from southern Louisiana and Mississippi to the Florida panhandle. Very low levels of TENORM were found in California, Utah, Wyoming, Colorado, and northern Kansas.

According to an API industry-wide survey, approximately 64 percent of the gas producing equipment and 57 percent of the oil production equipment showed radioactivity at or near background levels. TENORM radioactivity levels tend to be highest in water handling equipment. Average exposure levels for this equipment were between 30 to 40 micro Roentgens per hour (μR/hr), which is about five times background. Gas processing equipment with the highest levels includes the reflux pumps, propane pumps and tanks, other pumps, and product lines. Average radiation levels for this equipment are between 30 and 70 μR/hr. Exposures from some oil production and gas processing equipment exceeded 1 mR/hr.

Gas plant processing equipment is generally contaminated on the surface by lead-210**.** However, TENORM may also accumulate in gas plant equipment from radon-222 gas decay. Radon gas is highly mobile. It originates in underground formations and dissolves in the organic petroleum areas of the gas plant. It concentrates mainly in the more volatile propane and ethane fractions of the gas.

Gas plant scales differ from oil production scales, typically consisting of radon decay products, which accumulate on the interior surfaces of plant equipment. Radon itself decays quickly (its half-life is 3.8 days). As a result, the only radionuclides that affect disposal are the radon decay products polonium-210 and lead-210. Polonium-210 is an alpha emitter with a half-life of 140 days. Pb-210 is a weak beta and gamma emitter with a half-life of 22 years.

Workers can be exposed to naturally occurring radioactive material (NORM) through exposure to an external source (irradiation) or when radioactive material is taken into the body (for example, through inhalation, ingestion, or absorption). Health effects of exposure depend on intensity of the radiation, duration of the exposure, and organs affected. Long-term exposure to NORM above exposure limits has been associated with certain forms of cancer (*WorkSafe Bulletin*, n.d.)

Petroleum companies are not experts in every aspect of technology applied in their industry. Frequently, the necessary expertise is provided to the industry by specialized support organizations. Obviously it is in the interests of the petroleum industry to demonstrate an appropriate standard of basic radiation safety, environmental protection, and waste management, and to have a common understanding of requirements and controls to establish efficient and safe operations (IAEA, no date).

Confined Space

Source: SHP Online, 2014.

Confined spaces are common in the petroleum industry, particularly in processing operations. Confined spaces include:

- Storage tanks,
- Process and reaction vessels,
- Boilers,
- Ventilation and exhaust ducts,
- Tunnels and pits, and
- Pipelines.

A confined space is an enclosed or partially enclosed area big enough for a worker to enter. It is not designed for someone to work in regularly, but workers may need to enter the confined space for tasks such as inspection, cleaning, maintenance, and repair. A small opening, a high opening, or a layout with obstructions can make entry and exit difficult and can complicate rescue procedures.

Entry into confined spaces can be very hazardous. Workers must not be allowed to enter such spaces unless proper training, equipment, and procedures are in place. Workers have died because they did not know they were entering a confined space with a hazardous atmosphere, and therefore did not take the necessary precautions

One of the most hazardous situations occurs when crew are required to enter a confined space. The dangers arise because of a number of factors: lack of oxygen, poisonous gas, fume or vapor buildup or entry into the space unexpectedly; liquids and solids that can suddenly fill the space or release gases; fire and explosions; residues left in tanks or vessels; high concentrations of dust and hot conditions. Over 60 percent of workers who die in confined spaces are attempting to rescue other workers who have gotten into difficulty themselves.

A hazard assessment must be conducted for every confined space on a worksite. Before workers can enter a confined space, the employer must prepare and implement a confined space program that includes written safe work procedures for entry into and work in each of the confined spaces.

Before entry into a confined space, the atmosphere of the space must be tested by use of suitable instruments, ideally a multi-gas monitor that tests for presence of oxygen, hydrocarbons, carbon monoxide, and hydrogen sulfide. If the atmosphere proves hazardous, Self-contained Breathing Apparatus (SCBA) will be required. Even if the atmosphere is deemed safe, an escape set such as

Scott's renowned Emergency Life Support Apparatus (ELSA), must be provided in case the situation suddenly deteriorates and the atmosphere becomes irrespirable. The ELSA provides 10 or 15 minutes supply of air, allowing the wearer to make an emergency escape from a hazardous atmosphere. Importantly, an escape set like the ELSA is designed only to enable escape from a hazardous situation and not as a means to enable entry.

Biological Hazards

Food-poisoning outbreaks are typical manifestations of biological hazards in the offshore workplace. They tend to occur more commonly in less developed areas, often related to poor hygiene associated with water dispensers, ice makers, and ice cream machines. Also, galley space can be limited, so cold storage can be deficient. Airborne diseases can spread rapidly through ventilation systems on offshore installations because accommodation is pressurized and living space is usually at a premium.

Robust health risk management is required to control health risk from potential Legionella contamination of water pipes, particularly in showers of accommodation blocks and air-conditioning plants (Niven and McLeod, 2009).

Viruses account for most food poisoning cases where a specific contaminant is found. Noroviruses are the most common viral cause of food poisoning and can be transmitted from water, shellfish, vegetables contaminated by feces, and person-to-person contact. Outbreaks are more common in densely populated areas, and present a significant risk to offshore installations.

These may not be directly related to operational tasks in the petroleum industry, but biological hazards could be present in buildings or other areas. Hantavirus can be carried in the droppings, urine, or saliva of rodents (particularly deer mice). Buildings, sheds, and other areas where rodents may nest should be considered as potential sources of Hantavirus. Human exposure can result when contaminated dust and dirt become airborne. The virus could also enter the body through broken skin or through eye contact. Although Hantavirus is not frequently transmitted to humans, its effects can be serious when transmitted. Severe respiratory illnesses and deaths have been caused by Hantavirus.

Various species of mold can flourish in wet or moist environments. Buildings affected by condensation, flooding, water leaks, or excessive humidity may develop mold problems. People with asthma, mold sensitivity, or other immune disorders are most susceptible to the ill effects of mold exposure (Guzzardi and Associates, 2010).

Algae and fungi are significant groups of biological hazards in workplaces. These are often overlooked because they are not necessarily obvious in the working environment or because they are not considered biological hazards.

Psychosocial Hazards and Risks

Source: IPIECA, 2013.

Expatriation can present complex psychosocial issues and risks for both employees and employers in the petroleum industry. Failure to understand and address them can adversely affect the wellbeing of expatriate employees, their families, and operations and businesses in which they work.

Expatriation is common practice in the petroleum industry as a result of increasing globalization, the changing nature of work, and significant demographic changes within the industry. To be at the forefront in a competitive market, it is imperative for large multinational organizations to ensure both good and effective global staffing and expatriate assignments. In general, expatriation is recognized as a development opportunity for both the employee and the organization, and in many cases provides a positive career experience. However, when moving to a foreign country, or within a country, expatriates (or migrants) and their families are often faced with a variety of new and challenging work-related circumstances, some of which may be linked to psychosocial risks, e.g., work-related stressors and difficulties associated with cultural adjustment for families.

Psychosocial risks linked to the experience of work-related stress have been reported to be the second most prevalent work-related health problem, affecting 22% of workers in the EU. As such, there is strong evidence of an association between exposure to psychosocial risks and an array of health outcomes at both the individual and organizational levels.

From a broader perspective, psychosocial risks are a major occupational health concern and can have grave financial consequences for society and all types of enterprises, including small, medium, and large companies.

In the petroleum industry, psychosocial hazards can cause ill health of individuals or groups exposed to poor working conditions over the longer term. Furthermore, reduction in physical and psychological health through experience of stress can cause suboptimal performance that may lead to accidents. Psychosocial risks for expatriates and migrant workers within a country include cultural differences that may be reflected in areas such as preferred leadership styles, work motivation, willingness to take risk, gender roles, and safety-related attitudes. Numerous studies suggest that stressful life events can cause physical and psychological illnesses, as well as decreased employee performance.

Definitions and Terms

- "Psychosocial risk" is likelihood that psychosocial factors will exert hazardous influence on employees' health through their perceptions and experience, and severity of ill health that can be caused by exposure to these (Behavioral Science Institute [BSI], 2011).
- "Psychosocial hazards" are defined as "those aspects of work design and the organization and management of work, and their social and environmental context, that have the potential for causing psychological, social or physical harm" (Cox and Griffiths, 1995).
- "Stress" commonly refers to external exposures, pressures, and demands that we face, attempts at coping to deal with these, and outcomes. To avoid confusion, the term "stress" will be used as the overall description of the subject, while "stressor" and "distress" denote causes (exposures, input) and responses and outcomes (effects, outputs), respectively.
- "Stressor" denotes pressures, challenges, or demands that produce adaption responses and are known to have potential to cause distress and health problems.
- "Distress" refers to negative emotional, behavioral or physical reactions.

Reasonable consensus in the literature on the nature of psychosocial hazards is evident; these can be organized into 10 broad categories, as listed in Table 8.2 below.

TABLE 8.2: EXAMPLES OF PSYCHOSOCIAL HAZARDS

Category	Description
Job content	• Lack of variety or short work cycles • Perception of fragmented or meaningless work • Under-use of skills • High uncertainty • Continuous exposure to people through work
Workload and pace of work	• Work overload or under load - Machine pacing - High levels of time pressure - Continually subject to deadlines
Work schedule	• Shift working: - Night shifts - Inflexible work schedules - Unpredictable, long or unsociable hours
Control	• Low participation in decision making • Lack of control over workload - Shift working
Environment and equipment	• Inadequate equipment availability • Suitability or maintenance • Poor environmental conditions such as lack of space, poor lighting, excessive noise
Organizational culture and function	• Poor communication • Low levels of support for problem solving and personal development • Lack of definition of, or agreement on, organizational objectives
Interpersonal relationships at work	• Social or physical isolation - Lack of social support • Poor relationships with superiors - Interpersonal conflict
Role in organization	• Role ambiguity • Role conflict, and responsibility for people
Career development	• Career stagnation and uncertainty - Under promotion or over promotion - Poor pay - Job insecurity • Low social value to work
Home-work interface	• Conflicting demands of work and home - Low support at home - Dual career problems

Source: Leka, Griffiths, and Cox, 2003

Psychosocial risks can alter the way a person feels, thinks, and behaves, and can also produce changes in his/her physiological function. Under some circumstances, this may translate into poor performance at work, psychological and social problems, and poor physical health.

Potential Triggers of Psychosocial Consequences

Due to the nature of psychosocial risks, it is important understand potential triggers, which fall into the following three categories:

- Individual factors
- Cultural factors
- Organizational factors.

Individual Factors

Individual factors include both physical and mental aspects of the individual:

Physical Health

General poor physical health, or untreated chronic diseases or other physical aspects (e.g., lifestyle-related issues) can trigger psychological reactions. For example, an individual with diabetes may find the disease becomes harder to control after moving to a new country with different food and eating habits. Moreover, the physical condition of a person affects the psychological state of that individual.

Psychological Resilience

Psychological resilience of an individual is an important factor influencing his/her psychological reaction and ability to cope in difficult situations. Resilience is ability to bounce back in difficult situations, and to be adaptive in times of change, e.g., by demonstrating flexible behavior. This does not mean that the individual does not experience distress or difficulties; however, individuals with high levels of resilience have coping strategies that will decrease the likelihood of experiencing severe psychological symptoms or being diagnosed with psychiatric disorders. A higher level of psychological resilience has a protective effect on these psychiatric disorders. On the other hand, low levels of resilience and a lack of ability to cope with stressful situations are potential triggers of negative reactions and dysfunction in a new environment. Experiences associated with expatriation, such as moving to a different country, and changes in climate, culture, job, family structure, and language can, alone or in combination, constitute a life-changing event—i.e., an event that alters a person's life or circumstances in a substantial way. Such events can potentially evolve into triggers of underlying mental vulnerability, e.g., depression or anxiety. However, the risk is difficult to quantify, as it depends on the level of psychological resilience of the individual.

Relationships

Single expatriates or migrant nationals travelling to remote locations are potentially more at risk because they will not have the same level of support in terms of daily contact with family members. However, as described above, the individual's level of psychological resilience is an important factor here as well. (See also *Poor Family Integration* below.)

Cultural Factors

A variety of cultural factors relating to the new environment, either alone or in combination, can trigger reactions in an individual, described as follows:

Unfamiliar Cultural Practices

Unfamiliar cultural practices can act as potential triggers. For example, differences in gender roles can be an issue, and it can be difficult to integrate into a local community that has few other international citizens. Language is another important factor, both in the workplace and in society in general. These factors can be stressful and may, for example, activate feelings of loneliness, posing risk of depression.

Poor Family Integration

If the expatriate is accompanied by his or her family, the family's ability to integrate into the new society is a key factor influencing successful expatriation. (See also the paragraph on ***Relationships*** above). Dysfunction within the family is a potential trigger for psychological reactions and is one of the most common reasons for early return, often more than dysfunction in the employee himself/herself.

Social Conditions and Country Infrastructure

Limited infrastructure in a foreign country and quality of hospitals, schools, and housing facilities—together with security concerns and hardship factors—can all function as potential triggers of stress.

Extreme Environmental Conditions:

Employees mobilized to locations extreme or markedly different climates than their countries of origin may find this experience stressful, particularly in remote or isolated locations such as the Arctic.

Organizational Factors

Organizational factors include poor communication, low levels of support for problem solving and personal development, weak management, and lack of definition of or agreement on organizational objectives. These important psychosocial factors pose a risk of triggering underlying vulnerabilities within the individual.

Adjustment to the New Function/Role

Expatriation also involves the usual challenges associated with job changes, i.e., adapting to a new role, new tasks, new manager and new colleagues, and perhaps even a new location. The combined effect of these challenges with those of moving to an unfamiliar country and working environment may trigger a psychological reaction.

Adjustment to the Work Environment (Physical and Social Aspects)

Both the physical and social aspects of the new working environment should be considered as potential triggers. For example, differences in dress code, the main language used at work, a move to an open office, offshore visits, etc., could all fall into this category.

Ergonomic Hazards

Source: Roth, 2006.

The term "ergonomic hazards" generally refers to health problems due to interaction between (1) postures people are forced to adopt to reach, act on, or operate the objects and equipment with which they work; and (2) the nature and time history of application of force on those objects.

Whether a U.S.-based refinery and storage facility or a research and recovery operation off the Niger Delta, the petroleum industry has many built-in environmental, health and safety risk factors. Work is performed in restricted spaces, open fields, and other outdoor environments such as off-shore rigs and platforms. Complications arise from heat, noise, slippery surfaces, and a myriad of manual material handling exposures of lifting, lowering, carrying, pushing, and pulling tasks. Electrical issues and fall protection challenges exist, as well increase in force risks to employees during repetitive tasks such as valve turning.

As in many industries, ergonomic hazards such as awkward postures and high forces are present in the petroleum industry. Ergonomic hazards may include:

- Exerting high force when operating valves or servicing wells
- Limited accessibility to valves and equipment in a refinery
- Extremely high forces while setting up drilling rigs
- Improper working heights due to poor scaffolding during a turnaround in an oil refinery.

The offshore oil platform can be particularly challenging regarding ergonomics. This environment includes its own additional hazards:

- Manual material handling (lifting, lowering, pushing, pulling, or carrying) during deck operations and drilling activities
- Tight spaces with limited hand, arm, tool, and visual access during maintenance tasks (Humantech, no date).

2. IMPACTS OF SPECIALIZED HAZARDS

As with any industrial activity, petroleum operations pose many hazards that may negatively impact the health of industry workers, nearby communities, the environment, and animal populations.

Overview

Vulnerability

(State of North Dakota, 2014)

Impacts on people are often greater than structural impacts as a result of a hazardous material incident. Depending on the hazardous material, health impacts on humans can be long and short term. A hazardous material incident could exert greater effects on areas with higher population concentrations such as cities, special needs facilities, and businesses, than on more rural areas. In a hazardous material release, those in the immediate isolation area would have little to no warning, whereas the population farther away along the dispersion path may have some time to evacuate, depending on weather conditions, material released, and public notification.

Surface waters, such as rivers and reservoirs, and underground aquifers used as drinking water sources could be threatened by releases from fixed facilities, pipelines, and transportation. A single incident that affects a regional water system could affect many counties and cities.

Significant losses can also occur to the environment and other ecological values. Cleanup efforts may mitigate the effects, but some losses may occur. Sensitive habitats could be damaged or air and water quality reduced.

The Concept of Exposure

(Enform Program, 2012)

For a chemical to adversely affect workers and present a health hazard, exposure must occur. To establish the kind and level of hazard presented by a work site chemical, the following questions must be addressed:

- What types of exposures are harmful? Inhaling chemical fumes? Inhaling chemical particles? Skin contact? Eye contact? Swallowing?
- What are the effects of exposure? Short-term skin or eye irritation? Long-term lung damage? Is it cancer-causing (carcinogenic)? Are there potential long-term effects on the reproductive system (reprotoxicity)?
- At what level of exposure does a chemical become harmful? How much exposure to the chemical (in volume and time) must a worker experience before the chemical presents a real hazard? A momentary whiff? Hours of direct contact with the skin? Only high concentrations? And what level is "high"?
- Finally, where at the work site might a worker be exposed at a sufficient level to produce harmful effects? And how will we know?

Occupational Exposure Limit (OEL)

This refers to legally defined limits of exposure to a substance by a worker, measured both in concentration and time. For example, in Alberta, over an 8-hour shift, the minimum-to-maximum average concentration of hydrogen sulfide to which a worker can be exposed is 10 to 15 ppm.

For an environmental hazard (University of Colorado Boulder, 2015) to pose a risk to public health, a vulnerable human population must come into contact with (be exposed to) the hazard. Workers may have direct contact with chemical, physical, and biological hazards. Chemical hazards originating from petroleum operations can also be transported off site to nearby communities via air and possibly water. Communities can be exposed to physical hazards associated with petroleum operations due to proximity (e.g., noise, light, or vibration) or through use of shared infrastructure (e.g., roads). Communities also can also be exposed to a range of psychosocial stressors that result from competition for resources (e.g., water and housing) and changes in social structure (e.g., jobs and influx of workers).

FIGURE 8.1: SCALE OF EXPOSURE

Source: Adgate, 2014.

As illustrated on Figure 8.1 above, health risks to a community or subpopulation within a community (e.g., children, the elderly) will depend on proximity to a particular petroleum operation, as well as frequency and duration of exposure. Petroleum workers likely are at highest risk for short-term (acute), as well as some longer term (chronic) health effects due to the numerous hazards and higher occupational exposures they experience. Applications of personal protective equipment, safety training, and other procedures are designed to protect workers from hazards and exposures present on petroleum sites. While chemical concentrations typically decline with distance from petroleum development sites, residents living near drill sites and related infrastructure may be at increased risk in some cases because they may be exposed for longer durations than worker populations that work on site but reside elsewhere.

Communities near petroleum development sites may be at higher risk for accidents or malfunctions because of their proximity; however, the risk typically declines with distance from a hazard. Similarly, risks from chemical emissions, noise levels, and light pollution typically decline with increasing distance. Distance at which chemical exposures, noise, light, and vibration become a concern to health varies by hazard and is not known in all cases. While noise, light, and vibrations typically decline with distance from the source, chemical and physical concentrations vary by rate or intensity of release into the environment. For example, chemical concentrations at worksites or in communities are affected by wind speed and direction, human activities that affect exposure, such as breathing rates, and the number of hours spent at work or home. More broadly, populations living in regions with oil and natural gas development may experience degraded air (e.g., increased ozone levels) or water quality (e.g., due to spills or leaks), or quantity (e.g., due to localized use of a locally scarce resource).

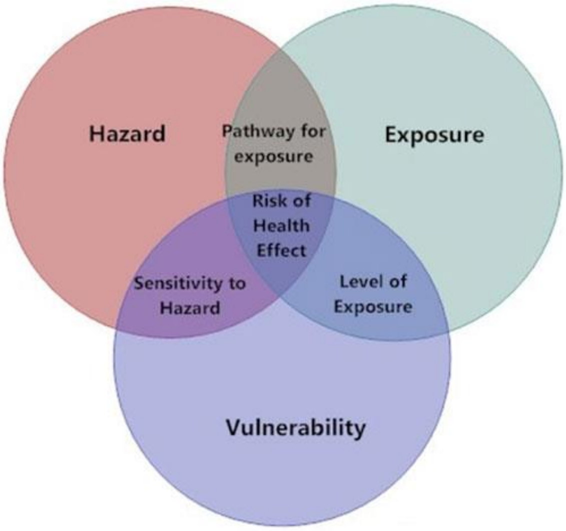
Human Health and Safety

Health and safety have been a priority for the petroleum industry for many years. However, occupational hygiene exposures are often not properly assessed to determine true risk to workers.

This lesson unit describes some of the occupational disease hazards (and other hazards) about which workers in the petroleum industry should be aware. Workers exposed to chemicals produced and used in the petroleum industry may develop occupational diseases of the lungs, skin, and other organs, depending on amount and length of time of exposures. Workers exposed to hazardous noise levels may develop noise-induced hearing loss. Other dangers include confined spaces, in which untrained workers have been seriously injured or killed (WorkSafe Bulletin, no date).

As shown in Figure 8.2 below, whether or not an environmental stressor poses a risk to public health depends on the hazard(s), the exposure, and the vulnerability of the affected population(s). A hazard is anything in an environment with the potential to harm human health, and an exposure is the contact between the hazard and workers or nearby community populations. In this context vulnerability is susceptibility in worker or community populations due to work practices, age, genetics or other factors.

FIGURE 8.2: COMPONENTS OF HEALTH RISK



Source: University of Colorado Boulder, 2015.

As of 2014, most studies addressing public health implications of petroleum development have been hypothetically predictive and/or descriptive. The few completed analytic studies have been preliminary and do not provide enough evidence to conclusively determine if petroleum operations cause health effects in nearby populations. Studies have provided evidence that hazards are present in and around petroleum operations, and that populations are frequently exposed to these hazards. People living near petroleum operations have reported that petroleum operations affect their health and quality of life, particularly through traffic accidents, air and water pollution, and social disruption expressed as psychosocial stress.

Chemical Hazards and Health Effects

Chemical Exposure Routes of Entry

(Enform Program, 2012)

- **Inhalation:** Inhalation is the most common type of chemical exposure at the work site. When products or chemicals are stored, transported, or used, there is potential for workers to breathe in airborne vapors, gases, mist, or dust. The inhalation hazard increases if chemicals or products are circulated or stored in an open system. Increases in temperature of the product or outside air, as well as agitation or turbulence, may increase the level of vapors or mist.
- **Skin or Eye Contact:** Chemicals that contact the skin or eyes may enter the body through absorption or cause an adverse health effect at the point of contact. Potential for this type of exposure increases when products are dispensed, mixed, or circulated. Exposure is not limited to hands and forearms, but can extend to all parts of the body. Skin exposure can occur not just from direct contact with the liquid product, but also from skin contact with airborne concentrations.

- **Ingestion:** Ingestion occurs when a hazardous chemical is taken into the mouth and swallowed. Workers may ingest materials when eating, drinking, chewing tobacco, or smoking in a contaminated work area or without first following proper hygiene procedures.
- **Other Routes of Exposure:** While much less common, other routes of exposure are possible, including introduction of the hazardous chemical directly into the bloodstream, from a cut or through injection of high-pressure fluids through the skin.

Potential Health Impacts

(Niven and McLeod, 2009)

Published exposure data from systematic sampling of hazardous agents on upstream operations are limited or had been published some years ago. Because benzene is a natural component of crude oil and natural gas, a few studies have reported data on benzene exposure. Substances such as hydrogen sulfide are usually well controlled through sealed systems, permit to work systems, gas purging, area and personal monitoring, training, emergency plans, etc.

In the past, the composition of drilling mud had considerable toxicity for both humans and the environment. However, the composition has changed over the years, with a general trend to materials of lower toxicity. Other potentially toxic and suspected carcinogenic agents or mixtures exist, such as mineral oil mist and vapor, asbestos fibers, formaldehyde, tetrachloroethene, welding/cutting fumes, acids, coatings, etc. Many epidemiological studies of workers in the petroleum industry have been conducted to help determine whether excess of mortality from cancers exists. The vast majority of these have been limited to oil refinery workers (i.e., downstream). Only four cohort studies and one case-control study (Sathiakumar, Delzell, and Cole, 1995) have examined the petroleum exploration and production segment of the industry (i.e., upstream).

The weight of the evidence, based on the results of these studies, suggests an increased risk of mortality from leukemia among upstream petroleum workers who started working before 1940 and who had a long duration of employment (over 30 years).

An increased incidence of hematopoietic cancers, especially acute myeloid leukemia (AML) and multiple myeloma, has been found among Norwegian offshore operators. However, the possible causes are not clear at this time and require further study. Possibly, some non-occupational factors, such as smoking or exposure to radiation arising from industrial or natural sources unassociated with employment, could have played a role. The conclusion drawn by the Norwegian investigators that the increased incidence of AML was most probably associated with benzene exposure was speculative.

Upstream petroleum workers' exposure levels to benzene, toluene, ethylbenzene, and xylenes (BTEX), based on personal air monitoring data, are generally regarded as low during regular activities (Whitely and Plant, 1999). Higher exposures, usually over less than a full-shift duration, may be encountered during maintenance tasks (e.g., when containment is broken or vessels must be entered for cleaning). Speculatively, dermal exposures during early years of operations could be high, but such exposure has not been routinely assessed.

Workers exposed to chemicals produced and used in the petroleum industry may develop occupational diseases of the lungs, skin, and other organs, depending on amounts and lengths of time of exposures. Examples of health impacts of some selected chemicals are as follows (WorkSafe Bulletin, no date):

- **Hydrogen Sulfide:** Hydrogen sulfide is often found in oil and natural gas deposits, and in some mineral rock. Petroleum workers are likely to find hydrogen sulfide at oil and natural gas wells, in refineries (where hydrogen sulfide is removed from natural gas and oil), and in pipelines used to carry unrefined petroleum.

Hydrogen sulfide is a very toxic gas that has no color and smells like rotten eggs. The gas can irritate the eyes, nose, throat, and lungs. At high levels of hydrogen sulfide, poisoning can be swift and deadly—with little warning. A worker not wearing protective equipment may pass out quickly. The body may tremble, and death may follow within seconds or minutes as a result of breathing failure. It may be possible to revive the victim, but only if first aid occurs quickly following exposure.

If a hydrogen sulfide leak occurs, the area must be evacuated; only workers wearing appropriate protective equipment may enter to correct the problem. Employers must develop and implement effective evacuation/rescue and exposure control plans, including training for workers and supervisors.

- **Hydrofluoric Acid:** Hydrofluoric acid, used in refineries as an additive to gasoline, is also highly toxic (Purvis and Herman) and thus poses many acute consequences for human health, as well as ability "to kill people on the spot." Even slight contact with hydrofluoric acid may cause a variety of acute symptoms, including skin burns and deep tissue burns, which may not be felt for up to 24 hours after exposure. In addition, hydrofluoric acid exposure commonly causes eye irritation and can lead to permanent damage. If inhaled, the acid can cause irritation of the nose, throat, and lungs, causing coughing and dyspnea, or shortness of breath. Severe exposure can cause cyanosis, an indicator of hypoxemia, lung injury, and buildup of fluid in the lungs, known as pulmonary edema.

  Once hydrofluoric acid penetrates body tissue, it can react with calcium and magnesium in the blood stream, causing abnormally low calcium concentrations and a condition known as hypocalcemia. Case studies have shown hydrofluoric acid to be fast acting, reporting instances of respiratory irritation in less than 1 minute after acute inhalation of 122 ppm. The USA Occupational Safety and Health Administration estimates that the lowest lethal concentrations range from 50-250 ppm after a 5-minute exposure.

- **Drilling Fluids:** *(WorkSafe Bulletin, no date)* During drilling, a large volume of drilling fluids circulates through the well and into open, partially enclosed, or completely enclosed systems at elevated temperatures. When these fluids are agitated, as during part of the recirculation process, potential for significant worker exposure and subsequent health effects results. These health effects include dizziness, headaches, drowsiness, and nausea (typically associated with exposure to hydrocarbons), as well as dermatitis and sensitization from repeated skin contact with the drilling fluids. In addition, exposure to oil mists can cause irritation and inflammation of the respiratory system. Some of the mildly refined base oils have also been associated with cancer, as a result of the aromatic compounds in the oil mists.

  Workers who spend a significant portion of their shifts in the following areas may be overexposed to hydrocarbons and oil mist:

  - Drilling floor;
  - Chemical mixing station/room;
  - Mud pits/tanks (where treated drilling fluids are retained prior to pumping to the drill hole); and
  - Shale shakers (where drill cuttings are "shaken" from the drilling fluids that return from the drill hole).

  An Exposure Control Plan (ECP) for drilling fluids should include engineering controls, as well as safe work procedures and use of personal protective equipment.

- **Silica:** Silica is the basic component of sand and rock. Some common silica-containing materials include:

- Concrete, concrete block, cement, and mortar;
- Granite, sand, fill dirt, and top soil;
- Asphalt (containing rock or stone);
- Abrasive used for blasting; and
- Hydraulic fracturing sand (contains up to 99% silica).

Workers performing the following activities are at risk of breathing silica dust:

- Abrasive blasting using silica-containing products;
- Cementing operations;
- Drilling using dry product additives that contain quartz;
- Maintaining shale dryers (dry particulate may contain quartz);
- Hydraulic fracturing (loading, unloading, moving, or storing sand); and
- Sweeping or moving sand or gravel containing silica.

Silicosis is a disease caused by prolonged breathing of fine crystalline silica dust. The particles are deposited in the lungs, causing thickening and scarring of lung tissue. Initially, workers with silicosis may have no symptoms; however, as the disease progresses, they may experience shortness of breath, severe cough, and weakness. These symptoms can worsen over time and lead to death. Crystalline silica exposure has also been linked to lung cancer.

Because of the low occupational exposure limit for airborne silica dust, an ECP would likely include an appropriate respirator for all work activities that involve silica.

- **Mercury:** Mercury, in a number of chemical forms, is a natural component of petroleum and may be present at high concentrations in some formations. The mercury was likely liberated from geological deposits by heat and pressure, and then migrated as a vapor to petroleum "traps."

When these gas reservoirs are produced and the processed fluids are cooled, liquid mercury can condense within heat exchangers, separators, coolers, valves, and piping. When this equipment (particularly components made from magnesium or aluminum alloys) is taken apart for maintenance or repair, workers can be exposed to mercury vapor.

Work activities that may carry a risk of exposure to mercury in gas processing facilities include:

- Vessel cleaning;
- Welding, grinding, buffing, and polishing;
- Machining;
- Pipefitting;
- Installing and removing components or infrastructure;
- Hydro excavating; and
- Electrical work.

Chronic (long-term) exposure to high concentrations of mercury vapor affects the central nervous system and can cause stupor, tremors, nervousness, personality changes, and vision and hearing problems. Contact with mercury can also affect the kidneys and cause irritation and burns to the skin and eyes.

Petroleum facility operators must conduct a hazardous materials survey and a risk assessment for mercury at their facilities. This information must be kept on site and communicated to all contractors who will be performing work at these locations. Employers must also develop and implement an effective written ECP for mercury.

Air Emissions Hazards and Health Effects

(Adgate, Goldstein, and McKenzie. No date)

Petroleum development and production workers are at risk from air pollution exposure because they work in and around major emission sources. Air pollution from petroleum development originates from (1) direct and fugitive emissions of methane and non-methane hydrocarbons from the well and associated infrastructure (e.g., production tanks, valves, pipelines, and collection and processing facilities); (2) diesel engines that power equipment, trucks, and generators; (3) drilling muds, fracturing fluids, and flowback water; and (4) deliberate venting and flaring of gas and related petroleum products.

Hydrogen Sulfide

As indicated above, hydrogen sulfide, which is naturally occurring in natural gas reserves, is an explosion risk and arguably the greatest acute toxicity hazard for natural gas workers. Significant irritant and other central nervous system health effects occur at or above 100 ppm, and these effects gradually increase in severity with duration of exposure, with immediate death occurring at 1000 ppm. Little data exist on the frequency of occupational exposure to hydrogen sulfide, but many companies require use of alarmed personal monitors to prevent fatalities.

Silica Dust

Among the hundreds of chemicals used to drill and fracture wells, silica is the most common additive to the process. Silica is also one of the key occupational hazards for workers because mechanical handing of crystalline silica, which is used as a proppant during hydraulic fracturing, creates large clouds of respirable dust. Respirable silica can cause silicosis and lung cancer, and has been associated with tuberculosis, chronic obstructive pulmonary disease (COPD), kidney disease, and autoimmune disease. Exposure to silica dust also poses a hazard to workers in industries supporting shale gas development, such as sand mining and transport.

Hydrocarbons

Workers also may be exposed to petroleum hydrocarbons, such as aromatics (e.g., BTEX) and aliphatic compounds during well development and production. Health effects most often associated with benzene include acute and chronic non-lymphocytic leukemia, acute myeloid leukemia, chronic lymphocytic leukemia, non-Hodgkins lymphoma, anemia, and other blood disorders and immunological effects. Occupational exposure to petroleum compounds is also associated with increased risk of eye irritation and headaches, asthma symptoms, and multiple myeloma and non-Hodgkins lymphoma.

Carbon Monoxide

Carbon monoxide is one of the most insidious of the poisonous gases encountered in the oil industry. It is produced in burning of carbon containing materials such as natural gas, coal, coke, wood, or gasoline, whenever the supply of air is not sufficient for complete combustion. Because the oil industry operates largely outdoors, and disposal of waste from furnaces and engines occurs properly, significant concentrations of this gas are not likely to occur (Jewett, no date). It burns in air with a characteristic blue flame and combines directly with chlorine in sunlight to produce highly toxic phosgene. Liquid carbon monoxide in the presence of nitrous oxide poses blast hazard. Its main health hazards are its extreme toxic effects that stem from its ability to complex with hemoglobin (with which it has an affinity 300 times that of oxygen), resulting in chemical asphyxiation (Carson and Mumford, 2002).

Sulfur Dioxide

(Jewett, no date)

Sulfur dioxide is a product of combustion when sulfur or any fuel containing sulfur or sulfides is burned, and is the chief irritant present in flue gases when natural gas or any gas containing hydrogen sulfide is used as a fuel. It also forms when coal is burned, and when lubricating oils are treated with sulfuric acid. It is used as a treating agent for purification of gasoline, naphtha, kerosene, and lubricating oils, so is primarily used in refineries. It is so irritating to the eyes and lungs in small concentrations that a person coming in contact with some of the escaped gas will get out of it before he/she experiences any poisonous effects. It can be detected at about 3.5 ppm, and the irritating effects would preclude anyone from suffering prolonged exposure at high concentrations unless unconscious, or trapped. Exposure to high concentrations (1000 ppm), for example when accidental leaks occur at a refinery, lead to pulmonary edema and eventually respiratory paralysis. Liquid sulfur dioxide may cause eye and skin burns resulting from freezing effects upon evaporation (Carson and Mumford, 2002). Additional health effects from daily exposure to outdoor levels of sulfur dioxide are tight chests, worsening of asthma and lung disease, and narrowing of air passages in the throat and chest. People with asthma are more sensitive to sulfur dioxide. Exposure to sulfur dioxide can provoke asthma attacks (*groundWork*, n.d.)

Diesel Exhaust

(WorkSafe Bulletin, no date)

Diesel engines provide power to many types of vehicles, heavy equipment, diesel generators, and other machinery used in the petroleum industry. The exhaust from these engines contains a mixture of gases (including carbon monoxide and oxides of nitrogen) and small particles that can affect worker health. Some of these particles have cancer-causing chemicals, known as aromatic hydrocarbons, attached to their surfaces. Short-term exposure to diesel exhaust can cause eye and upper respiratory (nose and throat) irritation. Long-term health issues can include respiratory disease, cardiovascular problems, and lung cancer.

Engineering controls are the best strategy for controlling worker exposure to diesel exhaust. Possible controls include the following:

- Carry out routine maintenance on diesel engines and engine emission systems.
- Install oxidation catalysts and exhaust filters.
- Use low-sulfur fuels or special fuel additives.
- Extend stacks so the exhaust is directed away from workers.
- Restrict the amount of diesel-powered equipment in a given work area, and designate areas that are off limits for vehicle and engine operation.

The IARC has classified diesel exhaust as a human carcinogen, while U.S. EPA classifies it as likely to be carcinogenic in humans (Adgate, Goldstein, and McKenzie, no date).

Gas Flaring and Health Effects

Air pollution associated with gas flaring and venting poses a significant health risk to local communities and to people who work in oil fields. Residents in nearby communities have experienced chronic health problems, including bronchial, chest, rheumatic, and eye complaints. Flaring emits a mixture of particulate matter (smoke) combustion byproducts (carbon dioxide, sulfur dioxide, nitrogen dioxides, and others), dioxin and other toxins, as well as unburned fuel components (benzene, toluene, xylene, hydrogen sulfide). Flaring can cause acid rain locally that damages crops (as well as roofing materials); this has negative knock-on effects on health and livelihoods (Living Earth, n.d.) It is estimated that in one region alone in the Niger Delta, flaring is statistically likely to cause 49 premature deaths, 5,000 respiratory illnesses among children, and some 120,000 asthma attacks and 8 additional causes of cancer each year (Oil Exchange International, 2017).

Physical Hazards Effects

Noise and Health Impacts

Noise exposure is a significant hazard due to presence of multiple sources, including heavy equipment, compressors, and diesel-powered generators. Loud continuous noise exerts health effects in working populations. Exposure to noise likely is substantial for many workers.

Exposure to high levels of noise in the workplace may also create physical and psychological stress, reduce productivity, interfere with communication, and contribute to accidents and injuries by making it difficult to hear moving equipment, other workers, and warning signals. Hearing loss can significantly impact quality of life for workers and their families. In 2006, the Workplace Safety and Insurance Board (WSIB) estimated that average cost of equipment (a set of hearing aids and batteries) for workers with noise-induced hearing loss can reach $11,000 every 4 years, payable from time of claim approval until death of a worker. For a 55-year-old worker who lives until the age of 83, equipment costs could reach $100,000. Workers with approved claims may also be eligible for future economic loss and non-economic loss awards, in addition to hearing aids and batteries.

Adverse physical and mental effects are caused by noise. For example, prolonged periods of exposure to 65 dBA can cause mental and bodily fatigue. Furthermore, noise can affect quantity and quality of sleep; cause permanent hearing damage; contribute to development or aggravation of heart and circulatory diseases; and transform a person's initial annoyance into more extreme emotional responses and behavior.

Unfortunately, many health effects of noise due to petroleum operations have not been scientifically documented. Lack of scientific study does not mean, however, that noise issues related to petroleum operations are insignificant. Loud continuous noise during the drilling phase; loud short-term noises from flaring or hydraulic fracturing; the intermittent whine of poorly maintained pump jacks and other equipment; and loud or low-frequency noise from compressors are common complaints related to petroleum development. Numerous workers have reported disruption of sleep and increased anxiety caused by noise from petroleum developments (Earthworks, n.d.).

Radiation

Source: WorkSafe Bulletin, n.d.

NORM are radioactive elements that have always been present in the earth's crust and are found naturally in the environment. These include uranium, thorium, radium, and radon. Background concentration of NORM is typically low; however, higher levels may arise as the result of human activities.

In the petroleum industry, NORM may be present in liquids and gases from some geological formations. Scale from oil recovery brine, for example, may contain radium at much higher concentrations than in the original water source. Sludge and drilling fluids may also contain elevated levels of NORM. Special precautions are needed for handling, transporting, and disposing of these materials.

NORM can be found in many components of operating petroleum facilities, including:

- Piping runs, including down-hole piping;
- Well heads;
- Production manifolds;

- Gas/oil separator flow lines;
- Dehydrators and desalinators;
- Valves; and
- Storage tanks.

Workers can be exposed to NORM through exposure to an external source (irradiation) or when radioactive material is taken into the body (for example, via inhalation, ingestion, or absorption). NORM exposures are generally quite low; however, all radiation exposures must be kept as low as reasonably achievable. Health effects of exposure depend on intensity of radiation, duration of exposure, and organs affected. Long-term exposure to NORM above exposure limits has been associated with certain forms of cancer.

In general, amount and duration of exposure to radiation (EPA, n.d.) affect severity or type of health effect. Two broad categories of health effects are stochastic and non-stochastic:

- **Stochastic Health Effects:** Stochastic effects are associated with long-term, low-level (chronic) exposure to radiation. ("Stochastic" refers to likelihood that something will happen.) Increased levels of exposure render these health effects more likely to occur, but do not influence type or severity of the effect.

  Cancer is considered by most people the primary health effect from radiation exposure. Simply put, cancer is uncontrolled growth of cells. Ordinarily, natural processes control the rate at which cells grow and replace themselves. They also control the body's processes for repairing or replacing damaged tissue. Damage occurring at the cellular or molecular level, can disrupt the control processes, permitting uncontrolled growth of cancer cells. This is why ionizing radiation's ability to break chemical bonds in atoms and molecules makes it such a potent carcinogen.

  Other stochastic effects also occur. Radiation can cause changes in deoxyribonucleic acid (DNA), the "blueprints" that ensure cell repair and replacement produce a perfect copy of the original cell. Changes in DNA are called mutations.

  Sometimes the body fails to repair these mutations or even creates mutations during repair. The mutations can be teratogenic or genetic. Teratogenic mutations are caused by exposure of the fetus in the uterus and affect only the individual exposed. Genetic mutations are passed on to offspring.

- **Non-Stochastic Health Effects:** Non-stochastic effects appear in cases of exposure to high levels of radiation, and become more severe as exposure increases. Short-term, high-level exposure is referred to as "acute" exposure. Many non-cancerous health effects of radiation are non-stochastic. Unlike cancer, health effects from acute exposure to radiation usually appear quickly. Acute health effects include burns and radiation sickness. Radiation sickness is also called "radiation poisoning." It can cause premature aging or even death. If the dose is fatal, death usually occurs within 2 months. Symptoms of radiation sickness include nausea, weakness, hair loss, skin burns, or diminished organ function. Medical patients receiving radiation treatments often experience acute effects, because they are receiving relatively high "bursts" of radiation during treatment.

  To protect workers who clean and maintain equipment potentially contaminated by NORM, or who may enter contaminated tanks or vessels, a written NORM management program should be developed and implemented (WorkSafe Bulletin, no date).

  Health physicists generally agree on limiting a person's exposure beyond background radiation to about 100 millirems (mrem) per year from all sources. Exceptions are occupational, medical, or accidental exposures. (Medical X-rays generally deliver less than 10 mrem). U.S. EPA and other regulatory agencies generally limit exposures from specific source to the public to levels well under 100 mrem. This is far below exposure levels that cause acute health effects.

Biological Hazards Health Effects

Biological hazards refer to organisms or organic matters produced by these organisms that are harmful to human health. These include parasites, viruses, bacteria, fungi, and protein. The three general major routes of entry for these micro-organisms into our bodies are via the respiratory system, contact with body fluids of the infected, and contact with contaminated objects. Harmful effects posed to human health by these biological hazards are mainly of three types: infection, allergy, and poisoning.

A substance considered a biological hazard is any micro-organism, cell culture, or human endoparasite, whether or not genetically modified, which may cause infection, allergy, toxicity, or otherwise create a hazard to human health. Biological agents (hazards) of concern to public health include pathogenic strains of bacteria, viruses, helminths, protozoa, algae, and certain toxic products these may produce. Of these hazards, presence of pathogenic bacteria in foods currently presents the most significant problems internationally.

Biological hazards may act through two general mechanisms in causing human illness. One mode of action is to produce toxins that may cause effects ranging from mild symptoms of short duration to severe intoxications which can have long-term or life-threatening consequences. The second mode of action is to produce pathological responses that result from ingestion of viable organisms capable of infecting the host. Threshold levels for concern are easier to quantify in the former case. In that case, as with certain other biological agents, a quantitative risk assessment may be possible. When considering hazards from pathogenic bacteria, however, a qualitative risk assessment may be the only feasible method currently available to derive an assessment of severity and likelihood of harm associated with exposure through ingestion of a food.

Poor food safety controls (Guzzardi and Associates, 2010) on offshore installations can lead to cases of food poisoning. Food poisoning is a common, usually mild, but sometimes deadly illness. Typical symptoms may include nausea, vomiting, stomach pain, and diarrhea after eating contaminated food or drink. Harmful bacteria are the most common cause of food poisoning, but other contaminants include viruses, parasites, and toxins. Symptoms and severity of food poisoning vary, depending on which bacteria or virus has contaminated the food.

Bacteria can cause food poisoning in two different ways. Some bacteria infect the intestines, causing inflammation and difficulty in absorbing nutrients and water, leading to diarrhea. Other bacteria produce toxins in food that are poisonous to the human digestive system. When eaten, these chemicals can lead to nausea and vomiting, kidney failure, and even death.

Fungal diseases manifest themselves as an allergic or immune response in the form of asthmatic and/or influenza-type symptoms from inhalation of dust or air contaminated by fungi, such as dry rot in roofs.

In petroleum operations close to large water bodies, algal blooms can be toxic to humans, e.g., in the form of neuro-toxins, hepatotoxins (which cause liver damage), and can also give rise to contact dermatitis, asthma, eye irritation, abdominal pain, etc. The main routes of entry into the human body are through skin/eye contact and ingestion.

Legionella is caused by the bacterium *Legionella Pneumophila*, which may be present under certain conditions in cooling towers, water systems, and air-conditioning systems. The bacterium may be spread by sprays of mist from the contaminated water source. It affects the lungs and is deposited in the alveoli, and can be fatal (RRC Training, n.d.)

Psychosocial Hazards and Health Impacts

Source: IPIECA, 2013.

Substantial scientific evidence indicates a clear relationship between psychosocial risks and an expatriate's physical, mental, and social health: a range of different illnesses, such as depression, cardiovascular diseases, and musculoskeletal diseases may result (EU-OSHA, 2012).

Psychosocial risks can alter the way a person feels, thinks, and behaves, and can produce changes in his/her physiological function. Under some circumstances, this may translate into poor performance at work, psychological and social problems, and poor physical health.

Fatigue, depression, anxiety, stress, and burnout overlap. Mental health difficulties are now one of the three leading causes of disability, along with cardiovascular disease and musculoskeletal injuries (International Labor Organization [ILO], 2016).

Psychological and Social Health Effects

Psychosocial risks can detrimentally affect mood, leading to depression, distress, burnout, impaired cognition (thinking) and decision making, and inattention.

Although no universally accepted definition of burnout has been established, most researchers define it as a state of physical, emotional, and mental exhaustion that results from long-lasting workload exceeding an individual's capacity. Burnout is the result of chronic stress (at the workplace) which has not been successfully dealt with.

Non work-related circumstances, e.g., financial strain or work-family conflict, can be significant in development of burnout.

Burnout is a problem specific to work context; in contrast, depression tends to pervade every domain of a person's life. Psychosocial risks have been found associated with the risk of depression among expatriates, resulting in poor health functioning, anxiety, distress, fatigue, and job dissatisfaction.

Psychosocial risks, work-related stress, job strain, and associated depression constitute a substantial, preventable, and inequitably distributed public health problem.

Furthermore, post-traumatic stress disorder must be considered as a potential psychological reaction following a major incident. This applies not only to expatriates but to the entire workforce in the petroleum industry, and should be addressed, for example, through provision of critical incident support and planned processes involving occupational health, and health and safety departments.

Exposure to psychosocial risks among expatriates has been associated with a variety of unhealthy lifestyle factors such as physical inactivity (overweight), excessive drinking (alcohol dependence) and smoking, poor diet, and poor sleep (insomnia). Poor psychosocial working conditions can contribute to an increase in detrimental health behaviors, with possible direct or indirect impact on development or exacerbation of physical health conditions (e.g., coronary heart disease) and psychological health (e.g., depression).

Expatriates and their family members may experience a culture shock when they return home, as they readjust to life in their home country having assimilated what they enjoyed and learned abroad. This process of "reintegration" into society can also carry the risk of triggering underlying psychological vulnerabilities.

Physiological and Physical Health Effects

Increasing evidence indicates that the most common physical effects related to psychosocial risk exposure are hypertension, coronary heart diseases, musculoskeletal disorders, gastrointestinal disorders, peptic ulcers, ulcerative colitis, thyroid disorders, diabetes, obesity, skin diseases, headaches, and migraine.

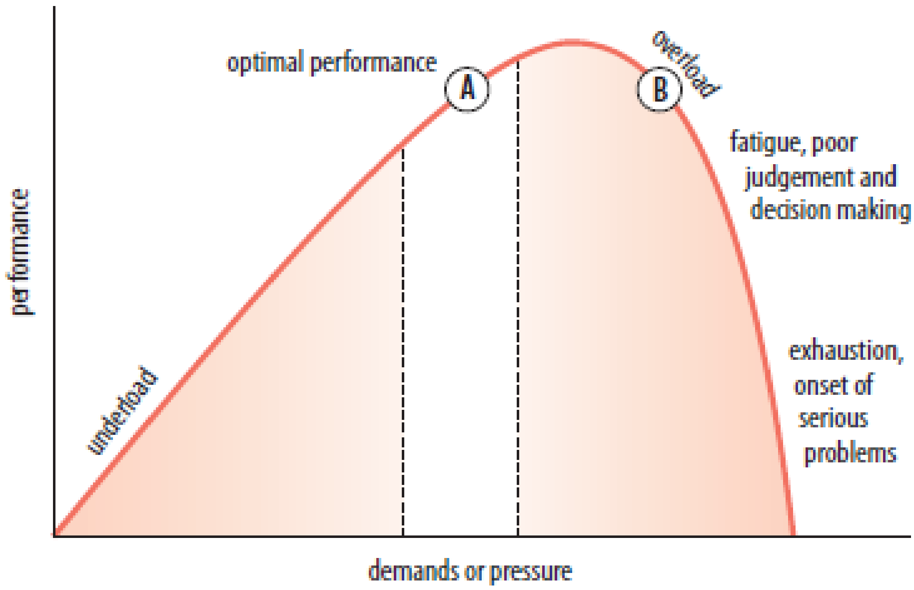
Negative emotional states (e.g., depression, anger and hostility, and anxiety), chronic and acute psychosocial stressors, and social ties including social support and social conflict, are associated with increased risk of cardiovascular morbidity and mortality. Evidence shows that the relationship between work-related psychosocial factors and development of ischemic heart disease (IHD) has been increasing.

Furthermore, exposure to physical and psychosocial hazards in combination exerts greater impact on musculoskeletal disorders than either factor alone. Both physical and psychosocial work characteristics are associated with lower back pain, upper limb disorder, and neck pain. Psychosocial work stress is recognized to be an independent predictor of type-2 diabetes.

How Do Stressors Affect Workers?

The way we think alters the way in which a stressor affects us. What is stressful to one individual may not be to another. What is stressful to an individual today may not be tomorrow. Distress is related to perception of loss of control that results from an imbalance between pressures exerted and resources of the individual. When pressures and demands rise to a level at which the person feels out of control, the way an individual thinks, feels, and behaves is altered. As a result, changes in physiological functions occur which, if unresolved, can lead to health problems. However, people tend to perform better when under a moderate amount of pressure (see Figure 8.3 below).

FIGURE 8.3: DEMAND VERSUS PERFORMANCE



Source: Skye Solutions, n.d.

In Figure 8.3, A and B both represent high performing individuals or teams. However, A is working comfortably within the optimum zone while B is working distressed and is at high risk of developing adverse reactions.

Working at peak performance (high point on graph) is acceptable for short periods, but it is beyond the optimum zone, the level at which people can comfortably work continuously. The risk of remaining at the peak for long periods is likelihood of additional events adding to pressure and pushing the individual into the overload zone.

Once an individual has moved past the peak, into the overload zone, movement down the slope can be sudden and unexpected. Without intervention, this can result in illness. A low level of perceived control of the work situation (procedures, work pacing, and decisions) seems to increase risk of health problems. Furthermore, a low level of support and feedback from supervisors and co-workers may increase risk of poor health.

How to Recognize the Signs of Distress

A sustained change in behavior and performance can be an early sign that an employee is suffering distress. Look out for deteriorating relationships with colleagues, irritability, indecisiveness, absenteeism, or reduced performance. Distress will not always be recognizable in signs noticeable to others, and initial changes may be quite subtle (see also examples in Table 8.3.

TABLE 8.8: EXAMPLES OF VARIOUS SIGNS AND SYMPTOMS OF DISTRESS

Emotional	Intellectual
• confusion • loss of sense of proportion • lack of confidence • forgetfulness • mental block • lack of enthusiasm • feeling victimized • negativity • depression	• lack of concentration and focus • missing the point • unable to make decisions/plans • can't see the forest for the trees • short on ideas • thinking about the past all the time • decreased work performance • missed deadlines
Social	**Physical**
• more accidents • carelessness • overreacting • angry outbursts • can't keep still or settle down • confused speech • withdrawing from people and events • aggressive driving	• perspiring • looking flushed • increased dependence on smoking, drinking or drugs • eating too much or too little • clumsiness • minor ailments, headaches • insomnia

Source: Skye Solutions, n.d.

Ergonomic Health Effects

Source: Niven and McLeod, 2009.

Ergonomic health issues are usually associated with the musculoskeletal system and principally the upper limbs, neck, and lower back. They can also be associated with impaired visual function arising from working on visually demanding tasks over extended durations with inappropriate task lighting.

The critical factor that identifies a health issue as ergonomic is that the injury arises because arrangement of the environment and equipment requires people to adopt postures and movements, apply force, and read material under conditions potentially damaging to health in order to complete what is expected of them in the normal course of their work.

A widespread view among health practitioners involved in offshore operations is that upper limb disorders arising from poor workplace ergonomics are relatively common. Accurate and reliable data are, however, difficult to find.

A recent study by the UK Health & Safety Executive (Health and Safety Executive, 2006) investigated root causes behind 126 manual handling injuries in the UK sector of the North Sea. The study concluded that in 23% of the cases, the root cause was due to either poor workplace design or poor equipment design. A further 9% were due to workers using the wrong equipment for the job (usually because the correct equipment was not readily available). Most of these can probably be considered due to genuinely ergonomic hazards in the workplace. They provide support to the view that ergonomic issues are a significant source of health hazard in the offshore work environment.

Hazards and Impacts on Environment, Animals/Wildlife, and Biodiversity

Hazards in the petroleum industry can exert a variety of impacts on the environment. These impacts depend on the stage of the process, size and complexity of the industrial operation, nature and sensitivity of the surrounding environment, nature and magnitude of the hazard (contaminant emissions, discharges, spills, etc.), and effectiveness of planning, pollution prevention, mitigation, and control techniques (United Nations Environment Program [UNEP], 1997).

Hazards in oil production and/or transportation (Corbett Dabbs, 1996) can disrupt the human population and the animal and fish life of a region. Oil waste dumping, production pollution, and spills wreak havoc on surrounding wildlife and habitat. These activities threaten extinction of several plants, and have already harmed many land, air, and sea animal and plant species.

Effects of petroleum hazards on marine life are caused by either the physical nature of oil (physical contamination and smothering) or its chemical components (toxic effects and accumulation leading to tainting). Marine life may also be affected by cleanup operations or indirectly through physical damage to habitats in which plants and animals live. Animals and plants most at risk are those that could come into contact with a contaminated sea surface: marine animals and reptiles, birds that feed by diving or form flocks on the sea, marine life on shorelines, and animals and plants in mariculture facilities.

Runoffs from petroleum processing and petrochemical plants discharge tons of toxic wastes into nearby waters. Gas and oil pipelines have stanched many creeks and rivers, swamping prime pastures and cropland. Furthermore, entire bays and lagoons along coasts have been fouled by oil spills and runoff of toxic chemicals.

The environmental damage that results from oil retraction and production can also directly affect human life in the region. Damage can include pollution of water resources and contamination of soil. Humans are affected by environmental devastation because of damage to vegetation, livestock, and health of the human body. Oil spills can interfere with normal working of power stations and desalination plants that require a continuous supply of clean seawater, and with safe operation of coastal industries and ports.

Environmental damage can also be a result of conflict over oil-producing regions. Environmental harm associated with oil resources can either be attributed to a side effect of conflict, or, in some cases, associated with military aggression intended to damage the natural resources of a region (Corbett Dabbs, 1996).

Table 8.4 below lists petroleum development hazards and potential impacts on biodiversity.

TABLE 8.4: SUMMARY OF IMPACTS ON BIODIVERSITY

PROJECT STAGE	PROJECT ACTIVITY	POTENTIAL BIODIVERSITY IMPACTS
Exploration: seismic, drilling, etc.	**Onshore:** • Provision of access (airstrips, temporary roads) • Set up and operation of camps and fly camps • Use of resources (water, aggregate) • Storage of fuel • Clearing of lines and layout geophones • Shot hole drilling • Use of explosives • Closure of shot holes, mud pits, camps and access infrastructure • Mobilization of drill rig • Drilling operations • Well testing/flaring	• Footprint impacts to habitats/flora • Disturbance of fauna • Noise impacts on animal populations • Physical disturbance of soils and watercourses • Contamination of soils, surface and groundwater • Landscape modification, visual impact
	Marine • Vessel mobilization and movement • Vessel emissions and discharges • Seismic operation • Anchor rig/lower legs • Use of chemicals • Mud and cuttings discharge • Fuelling and fuel handling • Blow-out risk	• Impact on fish • Disturbance of marine mammals • Disturbance of sediment and benthic populations • Contamination of sediment • Impact on seabirds, coastal habitats, etc. in event of oil spill
Construction	**Onshore** • Set-up and operation of construction camps • Provision of construction access • Resource use (water, timber, aggregate) • Import of heavy plant and machinery • Vehicle movements • Earthmoving, foundations, excavation • Storage/use of fuel and construction materials • Generation of construction wastes	• Temporary and permanent loss of habitat and component ecological populations due to temporary and permanent footprint • Soil erosion and reduction in productivity • Contamination of soils, surface and groundwater • Damage to cultural heritage
	Marine • Mobilization and movement of vessels • Vessel emissions and discharges • Anchoring, piling	• Disturbance to sediment, benthic fauna and other seabed flora and fauna • Loss of seabed habitat • Disturbance to marine mammals
Operation/ Production	**Onshore** • Footprint • Visible presence • Import and export of materials and products • Product handling, storage, use of chemicals and fuel • Solid wastes arising • Liquid effluent • Emissions to atmosphere • Noise • Light	• Long-term landtake effects on ecology • Effects on landscape and visual amenity • Soil and groundwater contamination • Effects on water quality, aquatic ecology and resource users • Effects on air quality, ecology and human health • Global warming
	Marine • Direct footprint • Chemicals storage, handling and use • Emissions to atmosphere • Operational noise, helicopter supply and standby vessel movement • Discharges to sea • Oil spill risk • Light	• Loss of seabed habitat • Interruption of fishing effort • Disturbance to seabirds and marine mammals • Effects on water quality and marine ecology • Effects on air quality and global warming • Risk to marine and coastal resources in event of spill

[a]Adapted from Shell's draft *Integrated Impact Assessment: Environmental Impact Assessment Module*, EP 95-0370, May 2002.

Source: IPIECA/IOGP, 2016.

Aquatic Impacts

Principal aqueous waste streams resulting from petroleum exploration and production operations are:

- Produced water;

- Drilling fluids, cuttings, and well treatment chemicals;
- Process wash and drainage water;
- Sewerage, sanitary, and domestic waste;
- Spills and leakages; and
- Cooling water.

Volumes of waste produced depend on the stage of exploration and production process. During seismic operations, waste volumes are minimal and relate mainly to camp or vessel activities. In exploratory drilling, the main aqueous effluents are drilling fluids and cuttings, while in production operations after completion of development wells, the primary effluent is produced water.

Water-based drilling fluids have been demonstrated to exert only limited effect on the environment. The major components are clay and bentonite, which are chemically inert and non-toxic. Some other components are biodegradable, while others are slightly toxic after dilution. Effects of heavy metals associated with drilling fluids (barium, cadmium, zinc, and lead) have been shown to be minimal because metals are bound in minerals and hence have limited bioavailability. Oil-base drilling fluids and oily cuttings, on the other hand, have an increased effect due to toxicity and oxidation-reduction potential. Oil content of the discharge is probably the main factor governing these effects.

Ocean discharges of water-based mud and cuttings have been shown to affect benthic organisms through smothering to a distance of 25 meters from the discharge, and to affect species diversity to 100 meters from the discharge. Oil-based muds and cuttings affect benthic organisms through elevated hydrocarbon levels to up to 800 meters from the discharge. Physical effects of water-based muds and cuttings are often temporary. For oil-based mud and cuttings, the threshold criteria for gross effects on community structure has been suggested at a sediment base oil concentration of 1000 ppm, although individual species have shown effects between 150 and 1000 ppm.

Produced water is the largest volume aqueous waste arising from production operations, and some typical constituents may include, in varying amounts, inorganic salts, heavy metals, solids, production chemicals, hydrocarbons, benzene, polycyclic aromatic hydrocarbons (PAH), and on occasions, NORM. In the North Sea environment, the impact of produced water has been demonstrated to range from minor to non-existent, particularly given rapid dilution factors of 200 within 1 minute, 500 within 5 minutes, and 1000 in an hour at a distance corresponding to 1 km from the source.

The environmental impact of produced water disposed of to receiving waters other than open ocean, depends highly on the quantity, the components, the receiving environment, and its dispersion characteristics. Extent of impact can be judged only via an EIA (UNEP, 1997).

Surface Water and Groundwater Contamination

Intense public interest has focused on possible contamination of drinking water sources with chemicals and other pollutants associated with petroleum drilling and production. Potential pathways of surface and groundwater contamination from petroleum development are transportation spills, well casing leaks, migration through fractured rock, abandoned wells, discharges from production and processing facilities, and wastewater disposal.

Current scientific consensus is that accidents and malfunctions, such as well blowouts, leaking casings, and spills of drilling fluids or wastewater, are more likely to contaminate surface and groundwater supplies than the processes of high-volume drilling and hydraulic fracturing (Adgate, Goldstein, and McKenzie, no date).

Impacts of petroleum industry pollution in a given region are a function of multiple factors including amount and type of fossil fuel produced, extraction methods applied, physical and geological conditions, and regulatory requirements (Mielke, Anadon, and Narayanamurti, 2010). In some cases, social conditions such as political instability also influence the links between water and energy. In

Nigeria, for example, political corruption and social tensions have contributed to a high incidence of oil spills because oil companies are often not held accountable for polluting, and because of vandalism of oil pipelines.

Contamination of surface water and groundwater can result in poor drinking water quality, loss of water supply, degraded surface water systems, high cleanup costs, high costs for alternative water supplies, and/or potential health problems. The consequences of contaminated groundwater or degraded surface water are often serious. For example, estuaries that have been impacted by high nitrogen from groundwater sources have lost critical shellfish habitats. In terms of water supply, in some instances, groundwater contamination is so severe that the water supply must be abandoned as a source of drinking water.

In other cases, groundwater can be cleaned up and used again, if the contamination is not too severe and if the jurisdiction is willing to spend a good deal of money. Follow-up water quality monitoring is often required for many years. Because groundwater generally moves slowly, contamination often remains undetected for long periods of time. This renders cleanup of a contaminated water supply difficult, if not impossible. If cleanup is undertaken, it can cost thousands to millions of dollars. Once the contaminant source has been controlled or removed, the contaminated groundwater can be treated in one of several ways:

- Containing the contaminant to prevent migration;
- Pumping the water, treating it, and returning it to the aquifer;
- Leaving the groundwater in place and treating either the water or the contaminant; and
- Allowing the contaminant to attenuate (reduce) naturally (with monitoring), following implementation of an appropriate source control.

Selection of the appropriate remedial technology is based on site-specific factors and often takes into account cleanup goals based on potential risk that are protective of human health and the environment.

Ecological Impacts

Although physical alteration from oil exploration is difficult to quantify, fishermen and environmentalists alike consider this to exert greater environmental impact than large oil spills. Drilling structures, discharge cuttings, artificial islands, and pipelines all affect coastal habitats. Canalization of land surfaces for pipeline routing and navigation in coastal wetlands is extremely disruptive to ecosystems, often allowing saltwater intrusion into brackish ecosystems.

Media images of dead and dying oil-covered marine wildlife have sparked considerable public concern over the effect of offshore oil development. Massive kill events do occur, but the long-term impacts of leaks and chronic discharges may be of greater significance for animal populations (especially endangered) and migratory sites for birds and marine mammals. Over the past 15 years, studies indicate oil fouling as a cause of mortality in seals, sea otters, several species of whales, and sea turtles (Boesch and Rabalais, 1987). Bioaccumulation of oil and other products in mammals and fish consumed by humans is a further concern. Livelihoods can be at risk; reduction of fishery stocks due to mortality of eggs and larvae as a result of oil leaks and spills imposes economic burdens on fishing communities (Epstein et al., 2002).

Plant and animal communities may also be directly affected by changes in their environment through variations in water, air, and soil/sediment quality. Some changes may directly affect the ecology—for example, habitat, food and nutrient supplies, breeding areas, migration routes, and vulnerability to predators or changes in herbivore grazing patterns (which may then have secondary effects on predators). Soil disturbance and removal of vegetation and secondary effects such as erosion and siltation may impact ecological integrity, and may lead to indirect effects by upsetting nutrient balances and microbial activity in soil. If not properly controlled, a potential long-term effect is loss of habitat that would affect both fauna and flora, and may induce changes in species composition and primary production cycles (UNEP, 1997).

In Nigeria (Otokunefor and Obiukwu, no date), the Niger Delta is host to three of the country's four refineries that generate large quantities of effluents daily. These effluents are discharged into natural water bodies after treatment. Phenol is one of the major pollutants found in refinery effluents. Phenols have been found very toxic to fish and other aquatic organisms, and has a nearly unique property of tainting the taste of fish if present in marine environment in concentration ranges of 0.1 to 1.0 milligram per liter (mg/L). The toxic concentration for fishes may range from <0.1 to >100 mg/L, depending on the fish species and the developmental stage, with embryo-larval stages being many times more susceptible than adults. Verbal evidence from local fishermen suggests that the area around the point of discharge of the effluents is devoid of fishes, and hence no fishing activity occurs there anymore. Unpublished data also show a dramatic reduction in the number of viable microorganisms found in both water and sediment at the point of impact. The high oil and grease concentration observed in the effluent receiving water body in the Niger Delta, in combination with other pollutants, is also thought responsible for depletion of fish and other aquatic life at the point of impact of the effluent.

Atmospheric Impacts

Atmospheric issues are attracting increasing interest from the petroleum industry and government authorities worldwide. To examine potential impacts from petroleum operations, it is important to understand sources and nature of emissions and their relative contribution to atmospheric effects both locally and globally (e.g., stratospheric ozone depletion and climate change).

The primary sources of atmospheric emissions from petroleum operations are:

- Flaring, venting, and purging of gases
- Combustion processes such as diesel engines and gas turbines
- Fugitive gases from loading operations and tankage, and losses from process equipment
- Airborne particulates from soil disturbance during construction and from vehicle traffic
- Particulates from burning sources, such as ell testing.

Principal emission gases include carbon dioxide, carbon monoxide, methane, volatile organic compounds (VOC), and nitrogen oxide. Emissions of sulfur dioxide and hydrogen sulfide can occur, depending on the sulfur content of the hydrocarbon and diesel fuel, particularly when used as a power source.

Volumes of atmospheric emissions and their potential impacts depend on the process under consideration (UNEP, 1997).

Potential for emissions from exploration activities to cause atmospheric impacts is generally considered low. However, during production, with more intensive activity, increased levels of emissions occur in the immediate vicinity of the operations. Emissions from production operations should be viewed in the context of total emissions from all sources, and for the most part, these fall below 1% of regional and global levels.

Flaring and venting waste potentially valuable resources and produce emissions that affect human health, livestock, and the environment. Effects depend on magnitude, duration, and frequency of exposure, as well as susceptibility of the individual organism or environment (Bott, 2007).

Flaring of produced gas is the most significant source of air emissions, particularly where no infrastructure or market is available for the gas. However, wherever viable, gas is produced and processed as an important commodity. Thus, through integrated development and provision of markets for all products, need for flaring will decrease significantly.

Flaring, venting, and combustion are the primary sources of carbon dioxide emissions from production operations, but other gases should also be considered. For example, methane emissions primarily arise from process vents and to a lesser extent from leaks, flaring, and combustion.

Acid Rain

Source: Epstein et al., 2002.

Gaseous emissions from petroleum activities accumulate in the atmosphere and return in the form of acid rain, which causes an array of problems now known to be much more complex and diverse than previously believed. Impacts of acid rain are no longer considered isolated effects, but are recognized to affect entire ecosystems. Sulfur dioxide and nitrogen oxides released from combustion of fossil fuels have been found to be the leading contributors to acid rain production. As both sulfur dioxide and nitrogen oxides enter the atmosphere, they become oxidized into sulfuric acid and nitric acid, respectively. The reactions are enhanced in areas of increased pollution, as ammonia and ground-level ozone act as catalysts. These acids dissolve readily into water and help form acidic water droplets, returning to the earth in the form of acidic rain, snow, or fog. Natural rainwater has an inherent acidic pH of 5.6. But acid rain commonly reaches pH levels as low as 4, about 40 times the acidity of natural rainwater.

Once acid rain returns to the surface, it begins a cascade of harmful environmental effects. The consequences of acidic precipitation are complicated by relationships within ecosystems. From terrestrial to aquatic environments, each individual effect is detrimental.

- **Terrestrial Effects of Acid Rain:** Upon reaching the ground, acid rain begins to immediately affect soils. Natural rainwater's slight acidity is normally countered by soil buffering capacity. This buffering capacity plays an integral part in the ecosystem, allowing for tolerance within a range of fluctuating conditions. Acid rain overwhelms soil's buffering capacity, disrupting carefully established pH balances. One consequence has been leaching of base cations from soil, leading to mineral and nutrient deficiencies in the soil. Beyond changes in soil chemistry, acid rain negatively impacts growth of trees.

- **Aquatic Effects of Acid Rain:** Once acid precipitation saturates the soil's buffering capacity, runoff and drainage play a large role in spread of acidification. Aquatic systems such as lakes, streams, and groundwater are all susceptible.

  Soil runoff not only lowers pH levels of aquatic bodies, but also exposes them to increased levels of aluminum.

  Acidification of bodies of water affects the vast array of aquatic organisms that live in aquatic systems. Changes in pH, nitrate concentration, and aluminum concentration shift natural balances established within an ecological system. While some organisms are able to flourish under such conditions, others are harmed. Susceptibility of fish in these changing environments has been clearly documented. Studies show that both low pH and aluminum are toxic to fish (Baker and Schofield, 1982). Acid-sensitive species are at greatest risk and are the first to be eliminated in aquatic environments. Studies have shown significantly fewer species of fish in lakes with decreased pH (Schindler et al., 1985). Episodic acidification has been particularly associated with larger amounts of fish loss in streams and rivers. Episodic acidification also impacts fish mortality, migration, and reproductive failure, further reducing fish populations (Baker et al., 1996).

  Although many species suffer effects of acid rain, some "weedy species" thrive in it. Changes in environmental chemistry and biodiversity have given some organisms a window of opportunity to flourish. Harmful algal blooms (HAB) have disrupted marine environments such as the Chesapeake Bay, Indian Ocean, and Bay of Bengal. The explosion of algae, the algal "bloom," can exert a variety of environmental effects. Overgrowth clouds the water, decreasing sunlight penetration, harming aquatic vegetation and animals that need sunlight to survive. Once algae die, they settle to the bottom where they decay, a process that consumes vital oxygen. This causes so-called "dead zones." Eutrophication contributes to HABs that lead to shellfish poisoning, and algae and zooplankton can harbor pathogens (Epstein, Ford, and Colwell, 1993).

Environmental Impacts of Oil Spills

Source: Center for Health and the Global Environment, 2002.

Physical Characteristics of Oil in the Environment

Oil is less dense than water, causing it to float on the surface of water after a spill. Typically, 1 ton of oil covers approximately 12 square km of water. Beyond that, a slick begins to fragment. Size of a spill, type of oil spilled, and timing of the spill all affect how much ecological damage the spill will incur. Impacts also depend on the type of ecosystem in which the spill occurs and its vulnerability or resilience to the oil spilled.

A large spill can extensively damage large areas of ocean (or land), smothering small microorganisms that comprise the bottom of the food chain. In smaller spills, neighboring organisms often recolonize relatively quickly. But after a very large spill, recolonization and replenishment of microorganisms from surrounding areas can be greatly delayed. Notably, because of effects of oil spills on vegetation, water, and fish, effects of even small spills can ripple into surrounding ecosystems and affect communities beyond the immediate spill area.

Type of oil spilled also determines effects on an ecosystem. All oil contains both heavy and light chain hydrocarbons. Oil with a high proportion of light chain hydrocarbons will exert less impact on an ecosystem, because those molecules are volatile and evaporate more easily than do heavy-chain molecules. Oil composed of more heavy chain hydrocarbons spreads, and clings to plants, rocks, sand, and boulders.

After oil enters the environment, it undergoes a process called "weathering" or degradation. Weathering consists of the following stages:

1. **Spreading:** Spilled oil immediately begins to spread over the sea surface initially as a single slick covering extensive areas. The slick later begins to break up, forming narrow bands parallel to direction of the wind. Rate of oil spread depends on viscosity of the oil and prevailing conditions, including sea surface temperature, water currents, tidal streams, and wind speeds.

2. **Evaporation:** Lighter components of the oil evaporate into the atmosphere, with the amount and speed of evaporation depending on the oil's volatility. The most toxic components, toluene and benzene, are also the most soluble and flammable, and these evaporate in the first 24-48 hours.

3. **Natural Dispersion:** Waves and turbulence at the sea surface cause all or part of a slick to break up into fragments and droplets of varying sizes. Speed of dispersion depends on the nature of the oil, and varies with weight and volatility of the oil and local conditions. Addition of chemical dispersants accelerates the process of natural dispersion.

4. **Emulsification:** Emulsification refers to suspension of seawater droplets in oil. The emulsion formed can be very viscous, and is more persistent than the original oil spilled. It is referred to as "chocolate mousse" because of its appearance. The emulsion expands the volume of the pollutants three- to four-fold. If concentration of asphaltene in the oil exceeds 0.5%, the emulsion will be very stable and can persist for months.

5. **Dissolution:** Water-soluble compounds in oil may dissolve into the surrounding water, especially if the oil is finely dispersed in the water. When light aromatic hydrocarbon compounds like benzene and toluene are the primary components, these are lost through evaporation, and dissolution is limited.

6. **Oxidation:** Oils react slowly with atmospheric oxygen, creating soluble degradation products or forming compounds called tars (with an outer protective coating of heavy compounds that increase the oil's persistence). This process is promoted by sunlight.
7. **Sedimentation/Sinking:** Heavy, refined products with densities greater than 1 will sink in fresh or brackish water. Sinking usually occurs due to addition of sediment particles or organic matter.
8. **Biodegradation:** In this process, microorganisms in seawater partially or completely degrade oil into water-soluble compounds and eventually to carbon dioxide and water. Microbes that biodegrade oils are specific to the compounds, and some compounds such as degraded tars and asphaltene are highly resistant to attack. The process occurs at the oil-water interface. Creation of oil droplets by natural or chemical dispersion increases surface area of the oil, and therefore the area accessible to biodegradation. Deficiency of the process depends on levels of nutrients (nitrogen and phosphorus) in the water, sea surface temperature, and level of oxygen present.

Ecosystem Effects

The main victims of oil spills are animals and plants that inhabit coastal and oceanic environments. The acute toxicity of oil is such that many animals die as a result of oil ingestion. Viscosity of oil also poses a threat to mammals and avians; oil coats the fur of sea otters and the feathers of birds, preventing these outer layers from insulating against hypothermia. The hydrocarbons that comprise oil are also carcinogenic to fish, birds, and mammals, and there is evidence that oil is immunotoxic to sea birds (Briggs, Yoshida, and Gershwin, 1996). Seals and sea lions suffer cancerous lesions from ingestion of oil, and may drown because of the extra weight of oil on their coats. Evidence also suggests that oil spills and exposure to chronic low levels of oil in the sea decrease the reproductive rate of seals (Jenssen, 1996).

Oil spills can cause widespread mortality in fish populations, with cascading impacts of other species—especially birds, marine mammals, and human populations—that depend highly on fish for subsistence.

Fiddler Crabs – Key Indicators

The coastal subtidal zone (underwater at all times) and intertidal zone (covered only during high tide) are inhabited by multiple small invertebrates. The fiddler crab, a species that inhabits the intertidal zone, is regarded as the "canary in a coal mine" for oil spills. This invertebrate is present in the estuarine habitats around the world and is therefore a universal indicator for impact of oil spills on coastal ecosystems. As with other organisms, fiddler crabs exhibit dose-response mortality due to oil toxicity. Thus the status of the fiddler crab population in an area after an oil spill is a sensitive marker of severity of the spill.

Oil spills can affect plant life in subtle but sometimes profound ways. Each coastal ecosystem has different susceptibilities to contamination. In temperate regions, salt marshes are most vulnerable. Salt marsh plants are relatively short, measuring up to three feet in height. Because they are low, salt marshes can be completely covered by oil after a spill.

In tropical regions, mangrove swamps are susceptible to damage from oil spills, as their roots are above ground. An unimpeded interface between roots and air is required for the plant to "breathe" and exchange salt. Thus, oil spills have killed extensive swaths of mangroves. Mangrove swamps are an ecological lynchpin. They protect shoreline integrity and are the nurseries for many shellfish and finfish, providing nutrition and protection from predation. Death of a large portion of a mangrove system can threaten the organisms dependent on them for survival.

Humans can be affected by oil spills from damage to surrounding plants and animals, and perhaps by direct contamination. Most information on direct effects is anecdotal (Campbell et al., 1993). One Scottish study found an increase in reports of nausea, headache, throat irritation, and itchy eyes in local populations following spills. But long-term effects are unknown. Rigorous clinical studies are needed to assess direct effects of oil spills on human beings.

Oil Spills on Land

Oil spills that occur on land, primarily from pipeline leaks and accidents, can contaminate surrounding soils and groundwater. A large oil spill can render contaminated land uncultivable, placing subsistence farmers at risk for food insecurity, and eliminate the safe drinking water supply for a community.

Oil Spills Effect on Wildlife

Source: IPIECA, n.d.

Despite a steady reduction in frequency and volume of oil spills over the past decade, an oiling incident may occur, without warning, anywhere in the world. Resulting problems can be acute (e.g., from a damaged oil tanker) or chronic (resulting from an ongoing release and accumulation of oil). Regardless of the source or size of the incident, wildlife casualties are virtually inevitable. In some instances, a warning about the impending threat can occur; in others, no warning, and the first evidence that something is wrong is appearance of oiled wildlife casualties on beaches. Whether the numbers of oiled casualties are few or counted in tens of thousands, the problem must be addressed both from humanitarian and conservation perspectives.

Accidental oil spills, including oil tanker spills, non-tanker ship spills, and spills from pipelines, oil production platforms, and tank farms, may cause serious problems for coastal and marine wildlife, especially birds, mammals, and reptiles. On a worldwide scale, oiled wildlife incidents occur less frequently than oil spill incidents, just because not every oil spill causes a wildlife problem. However, if a wildlife problem does occur as a consequence of an oil spill incident, success of oiled wildlife rehabilitation and an adequate assessment of environmental impacts will depend on implementation of a comprehensive wildlife response plan.

When oil spills occur, impact on the environment and wildlife present is likely to be immediate. Birds may be perceived by the media as the highest priority for response attention, but other groups of animals, including invertebrates, fish, reptiles, and mammals, can also be affected. Currently, active rescue and rehabilitation efforts are considered only for birds, mammals, and reptiles.

Specific effects of oil on wildlife vary depending on species vulnerability, chemistry of the specific petroleum product or mixture, weather, time of contact, weathering of oil, and many other factors. Generally, however, effects can be divided into those due to toxicity of the various components of the specific oil and those due to physical effects resulting from contact with the product.

Across species, direct contact with oil may cause burns and irritation of skin, eyes, and mucous membranes. Ingestion may cause disruption of the gastro-intestinal and immune response systems along with damage to organs such as the liver and kidneys. Inhalation may lead to respiratory and neurological damage/disorders. Secondary effects related to captivity should not be overlooked and may include pressure sores, damage to feathers or skin, lack of appetite, and spread of infectious diseases. Every effort should be made to avoid these secondary effects and minimize the time animals spend in captivity.

Noise Effect on Animals/Wildlife

Noise affects wildlife in a variety of ways. It can lead to temporary or permanent displacement of animals and birds, and may interfere with mating, feeding and other critical functions (Nature Sounds Society, n.d.).

Human activity in the oceans generates a lot of noise. Many species of marine mammals (including whales and dolphins) and fish depend on noise to communicate, navigate, and hunt prey. Seismic surveys can also lead to the Benz (decompression sickness) by causing marine mammals to panic and move to the surface too quickly. This can also lead to heart and brain hemorrhaging (Weilgart, 2008). Oil companies are constantly seeking pristine territory to seek petroleum reserves. Greenpeace, for example, is focusing a campaign on oil drilling in the Arctic.

Sound has different properties in water than air, travelling much faster and farther. Many marine mammals have poor vision and rely on sound as a primary sense. As well as marine mammals, fish also use and respond to underwater sound. Noise pollution can cause deafness and interference with fish communication, schooling, and habitat utilization (Weilgart, 2008). Marine mammal's ability to catch prey can be interrupted and blocked through noise pollution, which also affects communication between group members. This can cause navigational errors, which have been shown to lead to mass strandings. It can be difficult for whales to distinguish between some noises derived from ships and natural sounds, and confusion borne from this can lead to accidental collisions.

3. REGULATIONS AND CONTROL MEASURES – ENVIRONMENTAL, HEALTH, AND SAFETY GUIDELINES

Overview

The text in this topic derives from the Environment, Health and Safety Guidelines developed by the World Bank Group/International Finance Corporation (IFC) (IFC, 2007). Sections below provide some guidance for use together with the General Environmental Health and Safety (EHS) Guidelines document (IFC, 2013), which provides guidance to users on common EHS issues potentially applicable to all industry sectors. For complex projects, use of multiple industry-sector guidelines may be necessary.

Application of the EHS Guidelines should be tailored to hazards and risks established for each project on the basis of results of an environmental assessment that considered site-specific variables such as host country context, assimilative capacity of the environment, and other project factors.

When host country regulations differ from levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures than those provided in these EHS Guidelines are appropriate, in view of specific project circumstances, a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that choice of any alternate performance levels is protective of human health and the environment.

Applicability

EHS Guidelines for Onshore Oil and Gas Development include information relevant to seismic exploration; exploration and production drilling; development and production activities; transportation activities including pipelines; tanker loading and unloading; other facilities including pump stations, metering stations, pigging stations, compressor stations, and storage facilities; ancillary and support operations; and decommissioning. The *EHS Guidelines* also address potential onshore impacts that may result from offshore petroleum activities associated with onshore petroleum facilities near the coast (e.g., coastal terminals, marine supply bases, loading/offloading terminals); additional guidance is provided in the *EHS Guidelines* for ports, harbors, and terminals.

Environment

The following environmental issues should be considered as part of a comprehensive assessment and management program that addresses project-specific risks and potential impacts. Potential environmental issues associated with petroleum development projects include the following:

- Air emissions;
- Light pollution;
- Wastewater/effluent discharges;

- Solid and liquid waste management;
- Noise generation;
- Terrestrial impacts and project footprint; and
- Spills.

Air Emissions

The main sources of air emissions (continuous or non-contiguous) resulting from onshore activities are combustion sources from power and heat generation, and use of compressors, pumps, and reciprocating engines (boilers, turbines, and other engines); emissions resulting from flaring and venting of hydrocarbons; and fugitive emissions.

Principal pollutants from these sources include nitrogen oxides, sulfur oxides, carbon monoxide, and particulates. Additional pollutants can include hydrogen sulfide, VOCs, methane and ethane, BTEX, glycols, and PAHs.

Significant (>100,000 tons carbon dioxide equivalent per year) greenhouse gas (GHG) emissions from all facilities and support activities should be quantified annually as aggregate emissions in accordance with internationally recognized methodologies and reporting procedures.

All reasonable attempts should be made to maximize energy efficiency and design facilities to minimize energy use. The overall objective should be to reduce air emissions and evaluate cost-effective options for reducing emissions that are technically feasible. Additional recommendations on management of GHGs and energy conservation are addressed in the *General EHS Guidelines*.

Air quality impacts should be estimated by use of baseline air quality assessments and atmospheric dispersion models to establish potential ground-level ambient air concentrations during facility design and operations planning as described in the *General EHS Guidelines*. These studies should ensure that no adverse impacts on human health and the environment result.

Exhaust Gases

Exhaust gas emissions produced by combustion of gas or liquid fuels in turbines, boilers, compressors, pumps, and other engines for power and heat generation, or for water injection or petroleum export, can be the most significant source of air emissions from onshore and offshore facilities. Air emission specifications should be considered during all equipment selection and procurement.

Guidance for management of small combustion source emissions with capacity of up to 50 megawatt hours thermal (MWth), including air emission standards for exhaust emissions, is provided in the *General EHS Guidelines*. For combustion source emissions with capacity exceeding 50 MWth, refer to the *EHS Guidelines for Thermal Power* (IFC, 2013).

Venting and Flaring

Associated gas brought to the surface with crude oil during oil production is sometimes disposed of at petroleum facilities by venting or flaring to the atmosphere. This practice is now widely recognized to be a waste of a valuable resource, as well as a significant source of GHG emissions. However, flaring or venting are also important safety measures used at petroleum facilities to ensure gas and other hydrocarbons are safely disposed of in the event of an emergency, power or equipment failure, or other plant upset condition.

Measures consistent with the Global Gas Flaring and Venting Reduction Voluntary Standard (part of the World Bank Group's Global Gas Flaring Reduction [GGFR] Public-Private Partnership [World Bank Group, 2004]) should be adopted when considering flaring and venting options for onshore activities. The standard provides guidance on how to eliminate or achieve reductions in flaring and venting of natural gas.

Continuous venting of associated gas is not considered current good practice and should be avoided. The associated gas stream should be routed to an efficient flare system, although continuous flaring of gas should be avoided if feasible alternatives are available. Before flaring is adopted, feasible alternatives for use of the gas should be evaluated to the maximum extent possible and integrated into production design.

Alternative options may include gas utilization for on-site energy needs, export of the gas to a neighboring facility or to market, gas injection for reservoir pressure maintenance, enhanced recovery using gas lift, or gas for instrumentation. An assessment of alternatives should be adequately documented and recorded. If none of the alternative options is currently feasible, measures to minimize flare volumes should be evaluated and flaring should be considered as an interim solution, with elimination of continuous-production associated gas flaring as the preferred goal.

If flaring is necessary, continuous improvement of flaring through implementation of best practices and new technologies should be demonstrated. The following pollution prevention and control measures should be considered for gas flaring:

- Implementation of source gas reduction measures to the maximum extent possible;
- Use of efficient flare tips, and optimization of size and number of burning nozzles;
- Maximizing flare combustion efficiency by controlling and optimizing flare fuel/air stream flow rates to ensure correct ratio of assist stream to flare stream;
- Minimizing flaring from purges and pilots, without compromising safety, through measures including installation of purge gas reduction devices, flare gas recovery units, inert purge gas, soft seat valve technology where appropriate, and installation of conservation pilots;
- Minimizing risk of pilot blow-out by ensuring sufficient exit velocity and providing wind guards;
- Use of a reliable pilot ignition system;
- Installation of high-integrity instrument pressure protection systems, where appropriate, to reduce over-pressure events and avoid or reduce flaring situations;
- Minimizing liquid carryover and entrainment in the gas flare stream with a suitable liquid separation system;
- Minimizing flame lift-off and/or flame lick;
- Operating flare to control odor and visible smoke emissions (no visible black smoke);
- Locating flare at a safe distance from local communities and the workforce, including workforce accommodation units;
- Implementing burner maintenance and replacement programs to ensure continuous maximum flare efficiency; and
- Metering flare gas.

In the event of an emergency or equipment breakdown, or plant upset conditions, excess gas should not be vented but should be sent to an efficient flare gas system. Emergency venting may be necessary under specific field conditions where flaring of the gas stream is not possible, or where a flare gas system is not feasible, such as lack of sufficient hydrocarbon content in the gas stream to support combustion or lack of sufficient gas pressure to allow it to enter the flare system. Justification for excluding a gas flaring system should be fully documented before an emergency gas venting facility is considered.

To minimize flaring events as a result of equipment breakdowns and plant upsets, plant reliability should be high (>95 percent) and provision should be made for equipment sparing and plant turndown protocols.

Flaring volumes for new facilities should be estimated during the initial commissioning period so that fixed volume flaring targets can be developed. Volumes of gas flared for all flaring events should be recorded and reported.

Fugitive Emissions

Fugitive emissions at onshore facilities may be associated with cold vents, leaking pipes and tubing, valves, connections, flanges, packings, open-ended lines, pump seals, compressor seals, pressure relief valves, tanks or open pits / containments, and hydrocarbon loading and unloading operations.

Methods for controlling and reducing fugitive emissions should be considered and implemented in design, operation, and maintenance of facilities. Selection of appropriate valves, flanges, fittings, seals, and packings should consider safety and suitability requirements, as well as their capacity to reduce gas leaks and fugitive emissions. Additionally, leak detection and repair programs should be implemented. Vapor control units should be installed, as needed, for hydrocarbon loading and unloading operations.

Use of open vents in tank roofs should be avoided by installing pressure relief valves. Vapor control units should be installed, as needed, for loading and unloading ship tankers. Vapor processing systems may consist of different units, such as carbon adsorption, refrigeration, thermal oxidation, and lean oil absorption units. Additional guidance for prevention and control of fugitive emissions from storage tanks is in *EHS Guidelines for Crude Oil and Petroleum Product Terminals* (IFC, 2013).

Well Testing

During well testing, flaring of produced hydrocarbons should be avoided wherever practical and possible, and especially near local communities or in environmentally sensitive areas. Feasible alternatives should be evaluated for recovery of hydrocarbon test fluids (considering the safety of handling volatile hydrocarbons) for transfer to a processing facility or other alternative disposal options. An evaluation of disposal alternatives for produced hydrocarbons should be adequately documented and recorded.

If flaring is the only option available for disposal of test fluids, only the minimum volume of hydrocarbons required for the test should be flowed, and well test durations should be reduced to the extent practical. An efficient test flare burner head equipped with an appropriate combustion enhancement system should be selected to minimize incomplete combustion, black smoke, and hydrocarbon fallout. Volumes of hydrocarbons flared should be recorded.

Wastewaters

The *General EHS Guidelines* provide information on wastewater management, water conservation and reuse, along with wastewater and water quality monitoring programs. The guidance below pertains to additional wastewater streams specific to the onshore petroleum sector.

Produced Water

Petroleum reservoirs contain water (formation water) produced when brought to the surface during hydrocarbon production. The produced water stream can be one of the largest waste products, by volume, managed and disposed of by the onshore petroleum industry. Produced water contains a complex mixture of inorganics (dissolved salts, trace metals, suspended particles) and organics (dispersed and dissolved hydrocarbons, organic acids), and in many cases, residual chemical additives (e.g., scale and corrosion inhibitors) added into the hydrocarbon production process.

Feasible alternatives for management and disposal of produced water should be evaluated and integrated into production design. The main disposal alternatives may include injection into the reservoir to enhance oil recovery, and injection into a dedicated disposal well drilled to a suitable receiving subsurface geological formation. Other possible uses such as irrigation, dust control, or use by other industry, may be appropriate to consider if the chemical nature of the produced water is compatible with these options. Produced water discharges to surface waters or to land should be the last option considered, and only if no other option is available.

Produced water treatment technologies depend on the final disposal alternative selected and particular field conditions. Technologies to consider may include gravity and/or mechanical separation and chemical treatment, and may involve a multistage system implementing a number of technologies in series to meet injection or discharge requirements. Sufficient treatment system backup capability should be in place to ensure continual operation, and/or an alternative disposal method should be available.

To reduce the volume of produced water for disposal, the following should be considered:

- Adequate well management during well completion activities to minimize water production;
- Recompletion of high water producing wells to minimize water production;
- Application of downhole fluid separation techniques, where possible, and water shutoff techniques, when technically and economically feasible; and
- Shutting in high water producing wells.

To minimize environmental hazards related to residual chemical additives in the produced water stream where surface disposal methods are applied, production chemicals should be selected carefully by taking into account their volume, toxicity, bioavailability, and bioaccumulation potential.

Disposal into evaporation ponds may be an option for produced waters. Construction and management measures included in the *General EHS Guidelines* for surface storage or disposal pits should also apply to produced water ponds.

Hydrostatic Testing Water

Hydrostatic testing of equipment and pipelines involves pressure testing with water to detect leaks and verify equipment and pipeline integrity. Chemical additives (corrosion inhibitors, oxygen scavengers, and dyes) may be added to the water to prevent internal corrosion or to identify leaks. For pipeline testing, installation of test manifolds onto sections of newly constructed pipelines should occur outside of riparian zones and wetlands.

Water sourcing for hydrotesting purposes should not adversely affect the water level or flow rate of a natural water body, and the test water withdrawal rate (or volume) should not exceed 10 percent of stream flow (or volume) of the water source. Erosion control measures and fish-screening controls should be implemented as necessary during water withdrawals at intake locations.

Disposal alternatives for test waters following hydrotesting include injection into a disposal well if one is available or discharge to surface waters or land surface. If a disposal well is unavailable and discharge to surface waters or land surface is necessary, the following pollution prevention and control measures should be considered:

- Reduce need for chemicals by minimizing time that test water remains in the equipment or pipeline.
- If chemical use is necessary, carefully select chemical additives in terms of dose concentration, toxicity, biodegradability, bioavailability, and bioaccumulation potential.
- Conduct toxicity testing as necessary applying recognized test methodologies. A holding pond may be necessary to provide time for toxicity of the water to decrease. Holding ponds should meet the guidance for surface storage or disposal pits as discussed in the *General EHS Guidelines*.

- Use the same hydrotest water for multiple tests.
- If significant quantities of chemically treated hydrostatic test waters are required to be discharged to a surface water body, water receptors both upstream and downstream of the discharge should be monitored. Post-discharge chemical analysis of receiving water bodies may be necessary to demonstrate that no degradation of environmental quality has occurred.
- If discharged to water, the volume and composition of the test water, as well as stream flow or volume of the receiving water body, should be considered in selecting an appropriate discharge site to ensure that water quality will not be adversely affected outside of the defined mixing zone.
- Use break tanks or energy dissipaters (e.g., protective riprap, sheeting, tarpaulins) for the discharge flow.
- Use sediment control methods (e.g., silt fences, sandbags or hay bales) to protect aquatic biota, water quality, and water users from potential effects of discharge, such as increased sedimentation and reduced water quality.
- If discharge to land is to occur, the discharge site should be selected to prevent flooding, erosion, or lowered agriculture capability of the receiving land. Avoid direct discharge on cultivated land and land immediately upstream of community/public water intakes.
- Water discharge during cleaning pig runs and pretest water should be collected in holding tanks and should be discharged only after water-quality testing.

Cooling and Heating Systems

Water conservation opportunities provided in the *General EHS Guidelines* should be considered for petroleum facility cooling and heating systems. If cooling water is used, it should be discharged to surface waters at a location allowing maximum mixing and cooling of the thermal plume to ensure that the temperature is within 3 degrees Celsius of ambient temperature at the edge of the defined mixing zone or within 100 meters of the discharge point.

If biocides and/or other chemical additives are used in the cooling water system, consider a risk-based assessment of residual effects at discharge.

Other Waste Waters

Other waste waters routinely generated at onshore petroleum facilities include sewage waters, drainage waters, tank bottom waters, fire waters, equipment and vehicle wash waters, and general oily water. Pollution prevention and treatment measures that should be considered for these waste waters include:

- Sewage waters: Grey and black water from showers, toilets, and kitchen facilities should be treated as described in the *General EHS Guidelines*.
- Drainage and stormwaters: Separate drainage systems for drainage water from process areas that could be contaminated with oil (closed drains) and drainage water from non-process areas (open drains) should be available to the extent practical. All process areas should be bunded to ensure drainage water flows into the closed drainage system and that uncontrolled, contaminated surface water runoff is avoided. Drainage tanks and slop tanks should be designed with sufficient capacity for foreseeable operating conditions, and systems to prevent overfilling should be installed. Drip trays, or other controls, should be used to collect runoff from equipment not contained within a bunded area and the contents routed to the closed drainage system. Stormwater flow channels and collection ponds installed as part of the open drainage system should be fitted with oil-water separators. Separators may include baffle type or coalescing plate type, and should be regularly maintained. Stormwater runoff should be treated through an oil-water separation system able to achieve an oil and grease concentration of 10 mg/L. Additional guidance on management of stormwater is in the *General EHS Guidelines*.

- Tank bottom waters: Accumulation of tank bottom waters should be minimized by regular maintenance of tank roofs and seals to prevent rainwater infiltration. Consider routing these waters to the produced water stream for treatment and disposal, if available. Alternatively, these waters should be treated as hazardous waste and disposed of in accordance with the facility waste management plan. Tank bottom sludges should also be periodically removed and recycled, or disposed of as hazardous waste.
- Firewater: Firewater from test releases should be directed to the facility drainage system.
- Wash waters: Equipment and vehicle wash waters should be directed to the closed drainage system.
- General oily water: Oily water from drip trays and liquid slugs from process equipment and pipelines should be routed to the closed drainage system.

Surface Storage or Disposal Pits

If surface pits or ponds are used for wastewater storage or for interim disposal during operations, the pits should be constructed outside environmentally sensitive locations.

Wastewater pit construction and management measures should include:

- Installation of a liner so that the bottom and sides of the pit have a coefficient of permeability of no greater than 1 x 10-7 centimeters per second (cm/sec). Liners should be compatible with the material to be contained and of sufficient strength and thickness to maintain the integrity of the pit. Typical liners may include synthetic materials, cement/clay type or natural clays, although hydraulic conductivity of natural liners should be tested to ensure integrity.
- Construction to depth of typically 5 meters above the seasonal high water table.
- Installation of measures (e.g., careful siting, berms) to prevent natural surface drainage from entering the pit or breaching during heavy storms.
- Installation of a perimeter fence around the pit or installation of a screen to prevent access by people, livestock, and wildlife (including birds).
- Regular removal and recovery of free hydrocarbons from the pit contents surface.
- Removal of pit contents upon completion of operations, and disposal in accordance with the waste management plan.
- Reinstatement of the pit area following completion of operations.

Waste Management

Typical non-hazardous and hazardous wastes (other than permitted effluents and emissions) routinely generated at onshore facilities include general office and packaging wastes, waste oils, paraffins, waxes, oil-contaminated rags, hydraulic fluids, used batteries, empty paint cans, waste chemicals and used chemical containers, used filters, fluorescent tubes, scrap metals, and medical waste, among others.

Waste materials should be segregated into non-hazardous and hazardous wastes for consideration for re-use, recycling, or disposal. Before generation of any wastes, waste management planning should establish a clear strategy for wastes to be generated, including options for waste elimination, reduction, or recycling or treatment and disposal. A waste management plan documenting the waste strategy, storage (including facilities and locations), and handling procedures should be developed and should include a clear waste tracking mechanism to track waste consignments from the originating location to the final waste treatment and disposal location. Guidance for waste management of these typical waste streams is in the *General EHS Guidelines*.

Significant additional waste streams specific to onshore petroleum development activities may include:

- Drilling fluids and drilled cuttings;
- Produced sand;
- Completion and well workover fluids; and
- Naturally occurring radioactive material.

Drilling Fluids and Drilled Cuttings

Primary functions of drilling fluids in petroleum field drilling operations include removal of drilled cuttings (rock chippings) from the wellbore and control of formation pressures. Other important functions include sealing permeable formations, maintaining wellbore stability, cooling and lubricating the drill bit, and transmitting hydraulic energy to the drilling tools and bit. Drilled cuttings removed from the wellbore and spent drilling fluids are typically the largest waste streams generated during petroleum drilling activities. Numerous drilling fluid systems are available, but they can generally be categorized into one of two fluid systems:

- Water-Based Drilling Fluids (WBDF): The continuous phase and suspending medium for solids (or liquid) is water or a water-miscible fluid. The many WBDF variations include gel, salt-polymer, salt-glycol, and saltsilicate fluids; and
- Non-aqueous Drilling Fluids (NADF): The continuous phase and suspending medium for solids (or liquid) is a water-immiscible fluid that is oil-based, enhanced mineral oil-based, or synthetic-based.

Diesel-based fluids are also available, but use of systems that contain diesel as the principal component of the liquid phase is not considered current good practice.

Typically, the solid medium used in most drilling fluids is barite (barium sulfate) for weight, with bentonite clays as a thickener. Drilling fluids also contain a number of added chemicals identities of which depend on downhole formation conditions.

Drilling fluids are circulated downhole and routed to a solids control system at surface facilities where fluids can be separated from cuttings so that fluids may be recirculated downhole, leaving the cuttings behind for disposal. These cuttings contain a proportion of residual drilling fluid. Volume of cuttings produced will depend on depth of the well and the diameter of hole sections drilled. Drilling fluid is replaced when its rheological properties or density can no longer be maintained, or at the end of the drilling program. These spent fluids are then contained for reuse or disposal (NADFs are typically reused).

Feasible alternatives for treatment and disposal of drilling fluids and drilled cuttings should be evaluated and included in planning for the drilling program. Alternative options may include one or a combination of the following:

- Injection of the fluid and cuttings mixture into a dedicated disposal well;
- Injection into the annular space of a well;
- Storage in dedicated storage tanks or lined pits prior to treatment, recycling, and/or final treatment and disposal;
- On-site or off-site biological or physical treatment to render the fluid and cuttings non-hazardous prior to final disposal via application of established methods such as thermal desorption in an internal thermal desorption unit to remove NADF for reuse, bioremediation, landfarming, or solidification with cement and/or concrete. Final disposal routes for the nonhazardous cuttings solid material should be established, and may include use in road construction material,

construction fill, or disposal through landfill, including landfill cover and capping material where appropriate. Regarding landfarming, demonstration should be necessary that subsoil chemical, biological, and physical properties are preserved and water resources are protected; and

- Recycling of spent fluids back to the vendors for treatment and re-use.

Consider minimizing volumes of drilling fluids and drilled cuttings requiring disposal by:

- Using high-efficiency solids control equipment to reduce need for fluid changeout, and minimizing the amount of residual fluid on drilled cuttings;
- Using slim-hole multilateral wells and coiled tubing drilling techniques, when feasible, to reduce the amount of fluids and cuttings generated;
- Implementing pollution prevention and control measures for spent drilling fluids and drilled cuttings that should include:
  - Minimizing environmental hazards related to residual chemicals additives on discharged cuttings by careful selection of the fluid system;
  - Careful selection of fluid additives taking into account technical requirements, chemical additive concentration, toxicity, bioavailability, and bioaccumulation potential; and
  - Monitoring and minimizing concentrations of heavy metal impurities (mainly mercury and cadmium) in barite stock used in the fluid formulation.

Construction and management measures included in the EHS Guidelines for surface storage or disposal pits should also apply to cuttings and drilling fluid pits. For drilling pits, pit closure should be completed as soon as practical, but no longer than 12 months after the end of operations. If drilling waste is to be buried in the pit following operations (the Mix-Bury-Cover disposal method), the following minimum conditions should be met:

- Pit contents should be dried out as far as possible;
- If necessary, the waste should be mixed with an appropriate quantity of subsoil (typically three parts of subsoil to one part of waste by volume);
- A minimum of 1 meter of clean subsoil should be placed over the mix;
- Topsoil should be placed over the subsoil to fully reinstate the area; and
- Pit waste should be analyzed, and maximum lifetime loads should be calculated. A risk-based assessment may be necessary to demonstrate that internationally recognized thresholds for chemical exposure are not exceeded.

Produced Sand

Produced sand originating from the reservoir is separated from formation fluids during hydrocarbon processing. Produced sand can be contaminated with hydrocarbons, but oil content can vary substantially depending on location, depth, and reservoir characteristics. Well completion should aim to reduce production of sand at source via application of effective downhole sand control measures.

Produced sand should be treated as an oily waste, and may be treated and disposed of along with other oil-contaminated solid materials (e.g., with cuttings generated when NADFs are used or with tank bottom sludges).

If water is used to remove oil from produced sand, it should be recovered and routed to an appropriate treatment and disposal system (e.g., the produced water treatment system when available).

Completion and Well Workover Fluids

Completion and well workover fluids (including intervention and service fluids) can typically include weighted brines, acids, methanol and glycols, and other chemical systems. These fluids are used to clean the wellbore and stimulate flow of hydrocarbons, or just used to maintain downhole pressure. Once used, these fluids may contain contaminants including solid material, oil, and chemical additives. Chemical systems should be selected with consideration of their volume, toxicity, bioavailability, and bioaccumulation potential. Feasible disposal options should be evaluated for these fluids. Alternative disposal options may include one or a combination of the following:

- Collection of the fluids if handled in closed systems and shipping to the original vendors for recycling;
- Injection to a dedicated disposal well, where available;
- Inclusion as part of the produced water waste stream for treatment and disposal. Spent acids should be neutralized before treatment and disposal;
- On-site or off-site biological or physical treatment at an approved facility in accordance with the waste management plan.

NORM

Depending on field reservoir characteristics, NORM may precipitate as scale or sludges in process piping and production vessels. Where NORM is present, a NORM management program should be developed so that appropriate handling procedures are followed.

If removal of NORM is required for occupational health reasons, disposal options may include canister disposal during well abandonment, deep well or salt cavern injection, injection into the annular space of a well, or disposal to landfill in sealed containers.

Sludge, scale or NORM-impacted equipment should be treated, processed, or isolated so that potential future human exposures to the treated waste would be within internationally accepted risk-based limits. Recognized industrial practices should be applied for disposal. If waste is sent to an external facility for disposal, the facility must be licensed to receive such waste.

Hazardous Materials Management

General guidance for management of hazardous materials is in the *General EHS Guidelines*. The following additional principles should be followed regarding chemicals used in the onshore petroleum sector:

- Apply chemical hazard assessment and risk management techniques to evaluate chemicals and their effects. Selected chemicals should have been tested for environmental hazards.
- Select chemicals with least hazard and lowest potential environmental and/or health impact, whenever possible.
- Avoid use of substances that deplete ozone.

Noise

Petroleum development activities can generate noise during all phases, including seismic surveys, construction activities, drilling and production, aerial surveys, and air or road transportation. During operations, the main sources of noise and vibration pollution are likely to emanate from flaring and rotating equipment. Noise sources include flares and vents, pumps, compressors, generators, and heaters. Noise prevention and control measures are described in the *General EHS Guidelines*, along with recommended daytime and night time noise level guidelines for urban or rural communities.

Noise impacts should be estimated via baseline noise assessments of developments close to local human populations. Regarding significant noise sources, such as flare stacks at permanent processing facilities, noise dispersion modeling should occur to establish that noise level guidelines can be met and to assist in design of facility siting, stack heights, engineered sound barriers, and sound insulation on buildings.

Field-related vehicle traffic should be reduced as far as possible, and access through local communities should be avoided when not necessary. Flight access routes and low flight altitudes should be selected and scheduled to reduce noise impacts without compromising aircraft and security. Propagation of sound and vibration arising from seismic operations may result in impacts on human populations or wildlife. In planning seismic surveys, consider the following to minimize impacts:

- Minimize seismic activities in the vicinity of local populations wherever possible.
- Minimize concurrent operations on closely spaced survey lines.
- Use the lowest practicable vibrator power levels.
- Reduce operation times, to the extent practical.
- When shot-hole methods are employed, select charge size and hole depth appropriately to reduce noise levels. Proper backfill or plugging of holes will also help reduce noise dispersion.
- Identify areas and time periods sensitive to wildlife, such as feeding and breeding locations and seasons, and avoid these when possible.
- If sensitive wildlife species are present in the area, monitor their presence before onset of noise creating activities, and throughout the seismic program. In areas where significant impacts on sensitive species are anticipated, utilize the expertise of wildlife observers. Slowly build up activities at sensitive locations.

Terrestrial Impacts and Project Footprint

Project footprints resulting from exploration and construction activities may include seismic tracks, well pads, and temporary facilities, such as workforce base camps, material (pipe) storage yards, workshops, access roads, airstrips and helipads, equipment staging areas, and construction material extraction sites (including borrow pits and quarries).

Operational footprints may include well pads; permanent processing treatment, transmission, and storage facilities; pipeline right-of-way corridors; access roads; ancillary facilities; communication facilities (e.g., antennas); and power generation and transmission lines. Impacts may include loss of or damage to terrestrial habitat, creation of barriers to wildlife movement, soil erosion, disturbance to water bodies (including possible sedimentation), establishment of non-native invasive plant species, and visual disturbance. The extent of disturbance will depend on activity, location and characteristics of existing vegetation, topographic features, and waterways.

The visual impact of permanent facilities should be considered in design so as to minimize impacts on the existing landscape. The design should take advantage of existing topography and vegetation, and should specify low-profile facilities and storage tanks if technically feasible and if the overall facility footprint is not significantly increased. In addition, consider suitable paint color for large structures that can blend with the background. General guidance on minimizing the project footprint during construction and decommissioning activities is in the *General EHS Guidelines*.

Additional prevention and control measures to minimize the footprint of onshore petroleum developments may include the following:

- Site all facilities at locations that avoid critical terrestrial and aquatic habitat, and plan construction activities to avoid sensitive times of the year.
- Minimize land requirements for aboveground permanent facilities.

- Minimize areas to be cleared. Use hand cutting where possible, avoiding use of heavy equipment such as bulldozers, especially on steep slopes, at water and wetland crossings, and within forested and ecologically sensitive areas.
- Use a central processing/treatment facility for operations, when practical.
- Minimize well pad size for drilling activities, and consider maximum use of satellite/cluster, directional, extended-reach drilling techniques at sensitive locations.
- Avoid construction of facilities in a floodplain, whenever practical, and within a distance of 100 meters of the normal high-water mark of a water body or a water well used for drinking or domestic purposes.
- Consider use of existing utility and transport corridors for access roads and pipeline corridors to the extent possible.
- Consider routing access roads to avoid unwanted impacts such as increased access for poaching.
- Minimize widths of pipeline rights of way or access roads during construction and operations as much as possible.
- Limit the amount of pipeline trench left open during construction at any one time. Construct safety fences and apply other methods to prevent people or animals from falling into open trenches at sensitive locations and within 500 meters of human populations. In remote areas, install wildlife escape ramps from open trenches (typically every 1 km where wildlife is present).
- Consider use of animal crossing structures such as bridges, culverts, and over crossings along pipeline and access road rights of way.
- Bury pipelines along the entire length to a minimum of 1 meter to top-of-pipe, wherever this is possible.
- Carefully consider all feasible options for construction of pipeline river crossings, including horizontal directional drilling.
- Following construction activities, clean up and fully reinstate to the pre-existing topography and drainage contours (and appropriately revegetate using native plant species) the following: pipeline rights of way and temporary sites such as workforce accommodation camps, storage yards, access roads, helipads, and construction workshops.
- Reinstate off-site aggregate extraction facilities including borrow pits and quarries (opened specifically for construction or extensively used for construction).
- Implement repair and maintenance programs for reinstated sites.
- Consider application of low-impact seismic techniques (e.g., minimize seismic line widths [typically no wider than 5 meters], and limit line of sight along new cut lines in forested areas [approximately 350 meters]).
- Consider shot-hole methods in place of vibroseis where preservation of vegetation cover is required and when access is limited. In areas of low cover (e.g., deserts or tundra with snow cover in place), select vibroseis machinery, but carefully assess soft soil locations to prevent excessive compaction.
- Install temporary and permanent erosion and sediment control measures, slope stabilization measures, and subsidence control and minimization measures at all facilities, as necessary.
- Regularly maintain vegetation growth along access roads and at permanent aboveground facilities, and avoid introduction of invasive plant species. In controlling vegetation, apply biological, mechanical, and thermal vegetation control measures, and avoid use of chemical herbicides as much as possible.

Following demonstration that herbicides will be required to control vegetation growth along access roads or at facilities, personnel must be trained in their use. Herbicides to be avoided include those listed under the WHO-recommended Classification of Pesticides by Hazard Classes 1a and 1b, the WHO-recommended Classification of Pesticides by Hazard Class II (except under conditions as noted in IFC Performance Standard 3: Pollution Prevention and Abatement [2006, available at www.ifc.org/envsocstandards]), and Annexes A and B of the Stockholm Convention on Persistent Organic Pollutants (2001), except under conditions noted in the convention.

Spills

Spills from onshore facilities, including pipelines, can occur due to leaks, equipment failure, accidents, and human error, or as a result of third-party interference. Guidelines for release prevention and control planning are in the *General EHS Guidelines*, including the requirement to develop a spill prevention and control plan.

Additional spill prevention and control measures specific to onshore petroleum facilities include:

- Conduct a spill risk assessment of facilities, and design drilling, process, and utility systems to reduce risk of major uncontained spills.
- Ensure adequate corrosion allowance for the lifetimes of facilities, or install corrosion control and prevention systems in all pipelines, process equipment, and tanks.
- Install secondary containment around vessels and tanks to contain accidental releases.
- Install shutdown valves to allow early shutdown or isolation in the event of a spill.
- Develop automatic shutdown actions through an emergency shutdown system for significant spill scenarios so that the facility may be rapidly brought into a safe condition.
- Install leak detection systems. On pipelines, consider measures such as telemetry systems, Supervisory Control and Data Acquisition (SCADA),[11] pressure sensors, shut-in valves, and pump-off systems, Develop corrosion maintenance and monitoring programs to ensure integrity of all field equipment. Maintenance programs for pipelines should include regular pigging to clean pipelines, and intelligent pigging should be considered as required.
- Ensure adequate personnel training in oil spill prevention, containment, and response.
- Ensure spill response and containment equipment is deployed or available for a response.

All spills should be documented and reported. Following a spill, a root cause investigation should occur, and corrective actions should be undertaken to prevent reoccurrence. A Spill Response Plan should be prepared, and capability to implement the plan should be in place. The Spill Response Plan should address potential oil, chemical, and fuel spills from facilities, transport vehicles, loading and unloading operations, and pipeline ruptures. The plan should include:

- A description of operations, site conditions, logistic support, and oil properties
- Identification of persons responsible for managing spill response efforts, including their authority, roles, and contact details
- Documentation of cooperative measures with government agencies as appropriate
- Spill risk assessment, defining expected frequency and size of spills from different potential release sources
- Oil spill trajectory in potentially affected surface water bodies, with oil fate and environmental impact prediction for a number of credible most-probable spill simulations (including a worst-case

[11] SCADA may be used in oil and gas and other industrial facilities to assist in monitoring and control of plants and equipment.

scenario, such as blowout from an oil well) applying an adequate and internationally recognized computer model

- Clear demarcation of spill severity, according to size of spill, following a clearly defined Tier I, Tier II, and Tier III approach
- Strategies and equipment for managing Tier I spills at a minimum
- Arrangements and procedures to mobilize external resources for responding to larger spills, and strategies for deployment
- Full list, description, location, and use of on-site and off-site response equipment, and response time estimates for deploying equipment
- Sensitivity mapping of the environment at risk, with information that should include soil types; groundwater and surface water resources; sensitive ecological and protected areas; agricultural land; residential, industrial, recreational, cultural, and landscape features of significance; seasonal aspects of relevant features; and oil spill response types to be deployed
- Identification of response priorities, with input from potentially affected or concerned parties
- Cleanup strategies and handling instructions for recovered oil, chemicals, fuels, or other recovered contaminated materials, including transport of these, temporary storage, and treatment/disposal.

Occupational Health and Safety

Occupational health and safety issues should be considered as part of a comprehensive hazard or risk assessment, including, for example, a hazard identification study [HAZID], hazard and operability study [HAZOP], or other risk assessment studies. Results should be used in health and safety management planning, design of the facility and safe working systems, and preparation and communication of safe working procedures.

Facilities should be designed to eliminate or reduce potential for injury or risk of accident, and should take into account prevailing environmental conditions at the site location (including potential for extreme natural hazards such as earthquakes or hurricanes).

Health and safety management planning should demonstrate that a systematic and structured approach to managing health and safety will be adopted, and that controls will be in place to reduce risks to as low as reasonably practical; that staff are adequately trained; and that equipment is maintained in a safe condition. Formation of a health and safety committee for the facility is recommended.

A formal Permit to Work (PTW) system should be developed for the facilities. The PTW will ensure that all potentially hazardous work will proceed safely, and will ensure effective authorization of designated work, effective communication of work to be carried out (including hazards involved), and safe isolation procedures to be followed before commencement of work. A lockout/tagout procedure for equipment should be implemented to ensure isolation of all equipment from energy sources before servicing or removal.

Facilities should be equipped, at a minimum, with specialized first aid providers (industrial pre-hospital care personnel) and the means to provide short-term remote patient care. Depending on the number of personnel present and complexity of facilities, provision of an on-site medical unit and medical professional should be considered. In specific cases, telemedicine facilities may be an alternative option.

General facility design and operation measures to manage principal risks to occupational health and safety are in the *General EHS Guidelines*. General guidance specific to construction and decommissioning activities is also provided, along with guidance on health and safety training, personal protective equipment, and management of physical, chemical, biological, and radiological hazards common to all industries.

Occupational health and safety issues for further consideration in onshore petroleum operations include:

- Fire and explosion;
- Air quality;
- Hazardous materials;
- Transportation;
- Well blowouts; and
- Emergency preparedness and response.

Fire and Explosion

General guidance on fire precautions and prevention and control of fire and explosions is in the *General EHS Guidelines*.

Onshore petroleum development facilities should be designed, constructed, and operated according to international standards[12] for prevention and control of fire and explosion hazards. The most effective ways of preventing fires and explosions at petroleum facilities are to prevent release of flammable material and gas, and to detect leaks early and interrupt them.

Potential ignition sources should be kept to a minimum, and adequate separation distance should exist between potential ignition sources and flammable materials, and between processing facilities and adjacent buildings.[13] Facilities should be classified into hazard areas, based on international good practice,[14] and in accordance with the likelihood of release of flammable gases and liquids.

Facility fire and explosion prevention and control measures should also include:

- Provision of passive fire protection to prevent spread of fire in the event of an incident, including:
  - Passive fire protection on load-bearing structures, fire-rated walls, and fire-rated partitions between rooms;
  - Design of load-bearing structures taking into account explosion load, or blast-rated walls;
  - Design of structures against explosion and need for blast walls based on an assessment of likely explosion characteristics; and
  - Specific consideration of blast panel or explosion venting, and fire and explosion protection for wellheads, safe areas, and living areas.
- Prevention of potential ignition sources such as:
  - Proper grounding to avoid static electricity buildup and lightning hazards (including formal procedures for use and maintenance of grounding connections); and
  - Use of intrinsically safe electrical installations and non-sparking tools.
- A combination of automatic and manual fire alarm systems that can be heard across the facility.

[12] An example of good practice includes the United States National Fire Protection Association (NFPA). Further guidance to minimize exposure to static electricity and lightening is American Petroleum Institute (API), 2003.

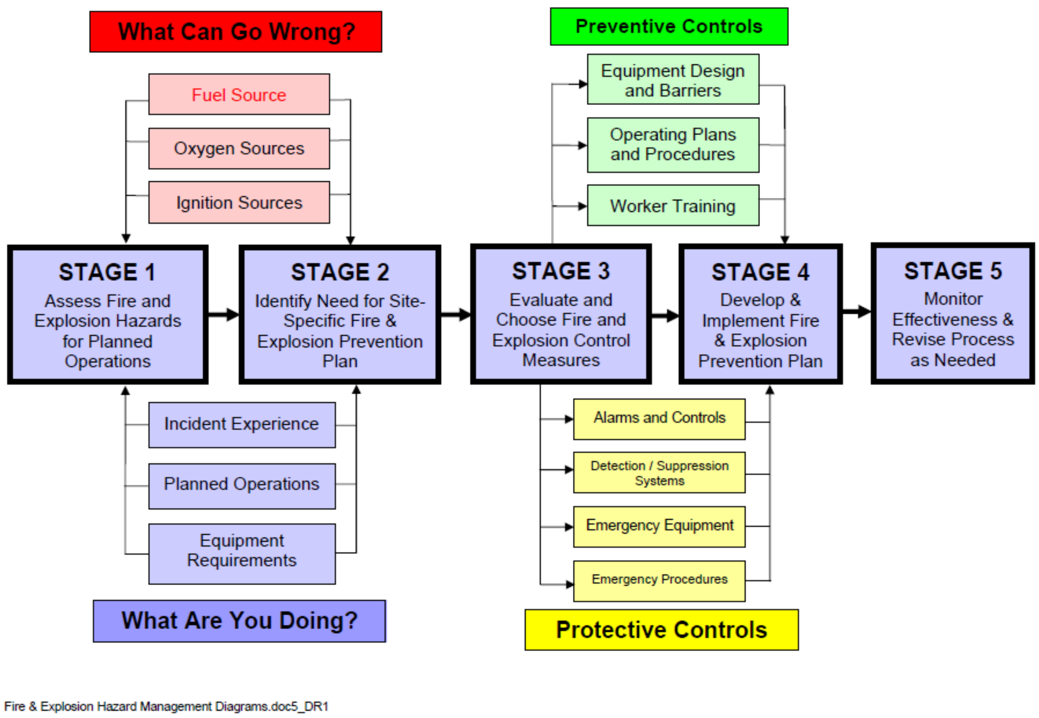
[13] Further information on safe spacing is available in US NFPA Code 30.

[14] See API RP 500/505 task group on electrical area classification, International Electro-technical Commission, or British Standards (BS).

- Active fire protection systems strategically located to enable rapid and effective response. The fire suppression equipment should meet internationally recognized technical specifications for type and amount of flammable and combustible materials at the facility. A combination of active fire suppression systems can be used, depending on the type of fire and the fire impact assessment (for example, fixed foam system, fixed fire water system, carbon dioxide extinguishing system, portable equipment such as fire extinguishers, and specialized vehicles). Installation of halon-based fire systems is not considered current good practice and should be avoided. Firewater pumps should be available and designed to deliver water at an appropriate rate. Regular checks and maintenance of firefighting equipment is essential.
- Location of all fire systems in a safe area of the facility, protected from fire by distance or by fire walls. If the system or piece of equipment is within a potential fire area, it should be passive fire protected or failsafe.
- Avoidance of explosive atmospheres in confined spaces by rendering spaces inert.
- Protection of accommodation areas by distance or by fire walls. Ventilation air intakes should prevent smoke from entering accommodation areas.
- Implementation of safety procedures for loading and unloading of product to transport systems (e.g., ship tankers, rail and tanker trucks, and vessels), including use of failsafe control valves and emergency shutdown equipment.
- Preparation of a fire response plan, supported by the necessary resources to implement the plan.
- Implementation of training in fire safety and response as part of workforce health and safety induction/training, including training in use of fire suppression equipment and evacuation, with advanced fire safety training provided to a designated firefighting team.

See Figure 8.4 below, which lays out a fire and explosion hazard management process.

FIGURE 8.4: STAGES OF A FIRE AND EXPLOSION HAZARD MANAGEMENT PROCESS



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Air Quality

Guidance for maintenance of air quality in the workplace and for provision of a fresh air supply with required air quality levels, is in the *General EHS Guidelines*. Facilities should be equipped with a reliable system for gas detection that allows isolation of the source of release and reduction of inventory of gas that can be released. Equipment isolation or blowdown of pressure equipment should be initiated to reduce system pressure and consequently reduce the release flow rate. Gas detection devices should also be used to authorize entry and operations into enclosed spaces.

Wherever hydrogen sulfide gas may accumulate, the following measures should be considered:

- Development of a contingency plan for hydrogen sulfide release events, including all necessary aspects from evacuation to resumption of normal operations.
- Installation of monitors set to activate warning signals whenever detected concentrations of hydrogen sulfide exceed 7 milligrams per cubic meter. Number and locations of monitors should be determined based on an assessment of plant locations prone to hydrogen sulfide emission and occupational exposure.
- Provision of personal hydrogen sulfide detectors to workers at locations of high risk of exposure, along with self-contained breathing apparatus and emergency oxygen supplies conveniently located to enable personnel to safely interrupt tasks and reach a temporary refuge or safe haven.
- Provision of adequate ventilation of occupied buildings to avoid accumulation of hydrogen sulfide gas.
- Workforce training in safety equipment use and response in the event of a leak.

Hazardous Materials

The design of onshore facilities should reduce exposure of personnel to chemical substances, fuels, and products containing hazardous substances. Use of substances and products classified as very toxic, carcinogenic, allergenic, mutagenic, teratogenic, or strongly corrosive should be identified, and substitutions for these by less hazardous alternatives should occur wherever possible. For each chemical used, a Material Safety Data Sheet (MSDS) should be available and readily accessible at the facility. A general hierarchical approach to prevention of impacts from chemical hazards is in the *General EHS Guidelines*.

A procedure for control and management of any radioactive sources used during operations should be prepared, along with a designated and shielded container for storage when the source is not in use.

NORM

At locations where NORM may precipitate as scale or sludges in process piping and production vessels, facilities and process equipment should be monitored for presence of NORM at least every five years, or whenever equipment is to be taken out of service for maintenance. Where NORM is detected, a NORM management program should be developed so that appropriate handling procedures are followed. Procedures should determine the classification of the area where NORM is present and the level of supervision and control required. Facilities are considered impacted when surface levels exceed 4.0 Becquerels per square centimeter (Bq/cm2) for gamma/beta radiation and 0.4 Bq/cm2 for alpha radiation (U.S. EPA, no date). The operator should determine whether to leave the NORM in-situ, or clean and decontaminate by removal for disposal.

Well Blowouts

A blowout can be caused by uncontrolled flow of reservoir fluids into a wellbore, which may result in an uncontrolled release of hydrocarbons. Blowout prevention measures during drilling should focus on maintaining wellbore hydrostatic pressure by effectively estimating formation fluid pressures and strength of subsurface formations. This can be achieved via techniques such as proper pre-well planning, drilling fluid logging, use of sufficient density drilling fluid or completion fluid to balance pressures in the wellbore, and installation of a Blow Out Preventer (BOP) system that can be rapidly closed in the event of an uncontrolled influx of formation fluids, and which allows the well to be circulated to safety by venting the gas at surface and routing oil so that it may be contained. The BOP should be operated hydraulically and triggered automatically, and tested at regular intervals. Facility personnel should conduct well control drills at regular intervals, and key personnel should attend a certified well control school periodically.

During production, wellheads should be regularly maintained and monitored for corrosion control, and pressure should be monitored. Blowout contingency measures should be included in the facility Emergency Response Plan.

Transportation

Incidents related to land transportation are main causes of injury and fatality in the petroleum industry. Traffic safety measures for industries are in the General EHS Guidelines.

Petroleum projects should develop a road safety management plan for the facility during all phases of operations. Measures should be in place to train all drivers in safe and defensive driving methods, and safe transportation of passengers. Speed limits for all vehicles should be implemented and enforced. Vehicles should be maintained in an appropriate road-worthy condition, and include all necessary safety equipment.

Specific safety procedures for air transportation (including helicopter) of personnel and equipment should be developed, and a safety briefing for passengers should be systematically provided along with safety equipment. Helicopter decks at or near facilities should comply with the requirements of the International Civil Aviation Organization (ICAO).

4. EMERGENCY PREPAREDNESS AND RESPONSE

Guidance under this section relating to emergency preparedness and response, including emergency resources, is also derived from the *General EHS Guidelines* (IFC, 2013). Onshore petroleum facilities should establish and maintain a high level of emergency preparedness to ensure effective responses to incidents without delay. Potential worst-case accidents should be identified by risk assessment, and appropriate preparedness requirements should be designed and implemented. An emergency response team should be established for the facility, trained to respond to potential emergencies, rescue injured persons, and perform emergency actions. The team should coordinate actions with other agencies and organizations that may be involved in emergency response.

Personnel should be provided with adequate and sufficient equipment located appropriately for evacuation of the facility, and should be provided with escape routes to enable rapid evacuation to a safe refuge. Escape routes should be clearly marked, and alternative routes should be available. Exercises in emergency preparedness should occur at a frequency commensurate with project risk. At a minimum, the following practice schedule should be implemented:

- Quarterly drills without equipment deployment.
- Evacuation drills and training for egress from facilities under different weather conditions and times of day.
- Annual mock drills with deployment of equipment.
- Updating training, as needed, based on continuous evaluation.
- Preparation of an Emergency Response Plan that contains the following measures, at a minimum:
  - Description of the response organization (structure, roles, responsibilities, and decision makers);

- Description of response procedures (details of response equipment and locations, procedures, training requirements, duties, etc.);
- Descriptions and procedures for alarm and communications systems;
- Precautionary measures for securing wells;
- Relief well arrangements, including description of equipment, consumables, and support systems to be utilized;
- Description of on-site first aid supplies and available backup medical support;
- Description of other emergency facilities such as emergency fueling sites;
- Description of survival equipment and gear, alternate accommodation facilities, and emergency power sources;
- Evacuation procedures;
- Emergency Medical Evacuation (MEDIVAC) procedures for injured or ill personnel; and
- Policies defining measures for limiting or stopping events, and conditions for termination of action.

Community Health and Safety

Community health and safety impacts during construction and decommissioning of facilities are common to those of most other industrial facilities, and are discussed in the *General EHS Guidelines*.

Physical Hazards

Community health and safety issues specific to petroleum facilities may include potential exposure to spills, fires, and explosions. To protect nearby communities and related facilities from these hazards, the location of project facilities and an adequate safety zone around the facilities should be established based on a risk assessment. A community emergency preparedness and response plan that considers the role of communities and community infrastructure should also be developed. Additional information on elements of emergency plans is in the *General EHS Guidelines*.

Communities may be exposed to physical hazards associated with the facilities, including wells and pipeline networks. Hazards may result from contact with hot components, equipment failure, and presence of operational pipelines or active and abandoned wells and abandoned infrastructure that may generate confined space or falling hazards. To prevent public contact with dangerous locations and equipment and hazardous materials, access deterrents such as fences and warning signs should be installed around permanent facilities and temporary structures. Public training to warn of existing hazards, along with clear guidance on access and land use limitations in safety zones or pipeline rights of way should be provided.

Community risk management strategies associated with transport of hazardous materials by road are in the *General EHS Guidelines* (IFC, 2007, refer specifically to the sections on "Hazardous Materials Management" and "Traffic Safety"). Guidance applicable to transport by rail is in *EHS Guidelines for Railways,* while guidance for transport by sea is in the *EHS Guidelines for Shipping*.

Hydrogen Sulfide

Potential for exposure of members of the community to facility air emissions should be carefully considered during the facility design and operations planning process. All necessary precautions in the facility design, facility siting, and/or working systems and procedures should be implemented to ensure no health impacts on human populations and the workforce would result from activities.

When risk of community exposure to hydrogen sulfide from activities is posed, the following measures should be implemented:

- Installation of a hydrogen sulfide gas monitoring network, with the number and locations of monitoring stations determined through air dispersion modelling, taking into account locations of emissions sources and areas of community use and habitation.
- Continuous operation of the hydrogen sulfide gas monitoring systems to facilitate early detection and warning.
- Emergency planning involving community input to allow for effective response to monitoring system warnings.

Security

Unauthorized access to facilities should be avoided by installation of perimeter fencing surrounding the facility and controlled access points (guarded gates). Public access control should be applied. At property boundaries, adequate signs and postings designating closed areas should indicate the areas where security controls begin. Vehicular traffic signs should clearly designate the separate entrances for trucks/deliveries and visitor/employee vehicles. Means for detecting intrusion (for example, closed-circuit television) should be considered. To maximize opportunities for surveillance and minimize possibilities for trespassers, the facility should have adequate lighting.

Performance Indicators and Monitoring

Environment

Emissions and Effluent Guidelines

TABLE 8.5: EFFLUENT LEVELS FROM OFFSHORE OIL AND GAS DEVELOPMENT

PARAMETER	GUIDELINE
Drilling Fluids and Cuttings – NADF	1) NADF: Reinject or ship-to-shore, no discharge to sea 2) Drilled cuttings: Reinject or ship-to-shore, no discharge to sea except: • Facilities located beyond 3 miles (4.8 km) from shore; • For new facilities:[a] Organic Phase Drilling Fluid[b] concentration lower than 1% by weight on dry cuttings; • For existing facilities[c]: Use of Group III non-aqueous base fluids and treatment in cutting dryers. Maximum residual Non Aqueous Phase Drilling Fluid[d] (NAF) 6.9% (C_{16} -C_{18} internal olefins) or 9.4% (C_{12}-C_{14} ester or C_8 esters) on wet cuttings; • Hg: max 1 mg/kg dry weight in stock barite • Cd: max 3 mg/kg dry weight in stock barite • Discharge via a caisson (at least 15 m below surface is recommended whenever applicable; in any case, a good dispersion of the solids on the seabed should be demonstrated)
Drilling Fluids and Cuttings – WBDF	1) WBDF: Reinject or ship-to-shore, no discharge to sea except: • In compliance with 96 hr. LC-50 of Suspended Particulate Phase (SPP)-3% vol. toxicity test first for drilling fluids or alternatively testing based on standard toxicity assessment species[e] (preferably site-specific species) 2) WBDF cuttings: Reinject or ship-to-shore, no discharge to sea except: • Facilities located beyond 3 miles (4.8 km) from shore; • Hg: 1 mg/kg dry weight in stock barite • Cd: 3 mg/kg dry weight in stock barite • Maximum chloride concentration must be less than four times the ambient concentration of fresh or brackish receiving water • Discharge via a caisson (at least 15 m below sea surface is recommended whenever applicable; in any case, a good dispersion of the solids on the seabed should be demonstrated)

Produced Water	Reinject. Discharge to sea is allowed if oil and grease content does not exceed 42 mg/l daily maximum; 29 mg/L monthly average
Flow-Back Water	Reinject or reuse. Discharge to sea is allowed if oil and grease content does not exceed 42 mg/L daily maximum; 29 mg/L monthly average. An environmental risk assessment to determine the maximum site-specific allowable concentrations should be conducted for all other chemicals
Completion and Well Work-Over Fluids	Ship-to-shore or reinject. No discharge to sea except: • Oil and grease content does not exceed 42 mg/L daily maximum; 29 mg/L monthly average • Neutralize to attain a pH of 5 or more • In compliance with 96 hr. LC-50 of SPP-3% vol. toxicity test first for drilling fluids[e] or alternatively testing based on standard toxicity assessment species (preferably site-specific species)
Produced Sand	Ship-to-shore or reinject: No discharge to sea except when oil concentration lower than 1% by weight on dry sand
Hydrotest Water	• Send to shore for treatment and disposal. • Discharge offshore following environmental risk analysis, careful selection of chemicals[g] • Reduce use of chemicals.
Cooling Water	The effluent should result in a temperature increase of no more than 3°C at edge of the zone where initial mixing and dilution take place. Where the zone is not defined, use 100 m from point of discharge.
Desalination Brine	Mix with other discharge waste streams, if feasible.
Sewage	Compliance with MARPOL 73/78[h]
Food Waste	Compliance with MARPOL 73/78[h]
Storage Displacement Water	Compliance with MARPOL 73/78[h]
Bilgewater	Compliance with MARPOL 73/78[h]
Deck Drainage (nonhazardous and hazardous drains)	Compliance with MARPOL 73/78[h]

[a] New facilities include offshore drilling rigs which have been newly designed or structurally modified for the project.

[b] As defined by OSPAR (2000) Decision 2000/3.

[c] Applicable to existing offshore drilling rigs deployed for development well drilling programs. Applicable to exploratory well drilling programs. Technically and financially feasible techniques, including installation of thermo-mechanical cutting cleaning systems, to meet the guidelines for new facilities should be considered for implementation, in relation to the number of wells (including producers and injectors) included in development drilling programs, and/or to potential impacts on critical habitats.

[d] As defined in US EPA (2013a).

[e] 96-hr LC-50: Concentration in parts per million or percent of the SPP from sample that is lethal to 50 percent of the test organism exposed to that concentration for a continuous period of 96 hours. See also: http://www.epa.gov/nrmrl/std/qsar/TEST-user-guide-v41.pdf.

[f] Consistent with US EPA (2013a); OSPAR (2011); IOGP (2005).

[g] In accordance with OSPAR (2010a) "Recommendation 2010/4 on a Harmonised Pre-screening Scheme for Offshore Chemicals" or other applicable process

[h] In nearshore waters, carefully select discharge location based on environmental sensitivities and assimilative capacity of receiving waters.

Source: IFC, 2015.

Table 8.5 lists effluent and waste guidelines for onshore petroleum development. When one or more members of the World Bank Group are involved in a project, the *Environmental, Health, and Safety Guidelines* (IFC, 2013) are applied as required by their respective policies and standards. The guidelines are assumed achievable under normal operating conditions in appropriately designed and operated facilities through application of pollution prevention and control techniques discussed in the preceding sections of this document.

Effluent guidelines are applicable for direct discharges of treated effluents to surface waters for general use. Site-specific discharge levels may be established based on availability and conditions in use of publicly operated sewage collection and treatment systems or, if discharged directly to surface waters, on the receiving water use classification as described in the *General EHS Guidelines*.

Combustion source emissions guidelines associated with steam- and power-generation activities from sources with capacity equal to or lower than 50 MWth are addressed in the *General EHS Guidelines*, with larger power source emissions addressed in the *EHS Guidelines for Thermal Power*

(IFC, 2013). Guidance on ambient considerations based on total load of emissions is in the *General EHS Guidelines*.

Environmental Monitoring

Environmental monitoring programs for this sector should be implemented to address all activities identified to exert potentially significant impacts on the environment during normal operations and upset conditions. Environmental monitoring activities should be based on direct or indirect indicators of emissions, effluents, and resource use applicable to the particular project.

Monitoring frequency should be sufficient to provide representative data regarding the monitored parameter. Monitoring should be conducted by trained individuals following monitoring and record-keeping procedures and using properly calibrated and maintained equipment. Monitoring data should be analyzed and reviewed at regular intervals, and compared to operating standards so that any necessary corrective actions can be taken. Additional guidance on applicable sampling and analytical methods for emissions and effluents is in the *General EHS Guidelines*.

Occupational Health and Safety

Occupational Health and Safety Guidelines

Occupational health and safety performance should be evaluated against internationally published exposure guidelines, e.g., the Threshold Limit Value (TLV®) occupational exposure guidelines and Biological Exposure Indices (BEI®) published by American Conference of Governmental Industrial Hygienists (ACGIH),[15] the *Pocket Guide to Chemical Hazards* published by the U.S. National Institute for Occupational Health and Safety (NIOSH),[16] Permissible Exposure Limits (PEL) published by the U.S. Occupational Safety and Health Administration (OSHA),[17] and Indicative Occupational Exposure Limit Values published by EU member states,[18] or other similar sources.

The occupational exposure guidelines for hydrogen sulfide deserve particular attention. For guidelines on occupational exposure to NORM, readers should consult the average and maximum values published by the Canadian NORM Waste Management Committee, Health Canada, and the Australian Petroleum Production and Exploration Association, or other internationally recognized sources.

Accident and Fatality Rates

Projects should try to reduce the number of accidents among project workers (whether directly employed or subcontracted) to a rate of zero, especially accidents that could result in lost work time, different levels of disability, or even fatalities. Facility rates may be benchmarked against performance of facilities in this sector in developed countries via consultation with published sources (e.g., U.S. Bureau of Labor Statistics and UK Health and Safety Executive).[19]

Occupational Health and Safety Monitoring

The working environment should be monitored for occupational hazards relevant to the specific project. Monitoring should be designed and implemented by accredited professionals[20] as part of an occupational health and safety monitoring program. Facilities should also maintain a record of

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[15] http://www.acgih.org/TLV/ and http://www.acgih.org/store/

[16] http://www.cdc.gov/niosh/npg/

[17] http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDAR DS&p_id=9992

[18] http://europe.osha.eu.int/good_practice/risks/ds/oel/

[19] http://www.bls.gov/iif/ and http://www.hse.gov.uk/statistics/index.htm

[20] Accredited professionals may include Certified Industrial Hygienists, Registered Occupational Hygienists, or Certified Safety Professionals or their equivalent.

occupational accidents and diseases, and dangerous occurrences and accidents. Additional guidance on occupational health and safety monitoring programs is in the *General EHS Guidelines*.

Managing Psychosocial Hazards and Risks

NOTE: The following section focuses on expatriates workers but is equally relevant for workers within Uganda who are transferring from their own communities to work in the oil and gas sector.

Source: IPIECA, 2013.

Information conveyed below derives from IPIECA guidance for managing psychosocial risks pertaining to expatriation in the petroleum industry. The guidance is based on a comparison of 12 petroleum companies, and therefore presents an overall generic approach to managing the described hazards risks. However, each company is advised to establish a program that meets its own specific needs and risks, based on geographical, organizational and cultural characteristics. Further, while the guidance is particularly targeted at expatriate staff, several aspects of the guidance are applicable to national staff who may become vulnerable to triggers of psychosocial hazards and risks inherent in a working environment such as a petroleum operation.

Prevention Strategies

Psychosocial hazards are important in the petroleum industry and must be managed effectively. Minimizing these hazards as much as possible is essential to avoid their impact on an individual's health, wellbeing, and working capacity, not to mention the considerable personal and financial cost involved in an assignment.

Prevention strategies aim to avert, or at least reduce, psychosocial risks at different stages of expatriation. These provide a framework to develop a preventive policy, from selection of candidates through end of expatriation (i.e., the expatriate's return to his or her home country, or a move to the next assignment). Such a policy should cover early identification of situations where additional review or support may be appropriate, management of psychological injury cases, and the decision to terminate expatriation if this should be deemed necessary.

To establish the right prevention and intervention strategies, it is important to understand the potential triggers described above. Given the nature of psychosocial risks, it is not feasible to apply a causal linear response approach as a basis for establishing required control measures. Instead, a multidimensional approach must be applied to comprehend as much as possible the unique combination of triggers and circumstances that may come together in a given case. Information conveyed here does not attempt to provide a comprehensive analysis of such an approach, but suffice to say that every individual is different and each individual's characteristics relating to his/her personal disposition and behavior must be properly taken into account.

Because debate on specific prevention strategies to manage psychosocial risks for expatriates is still in its infancy, and formal guidance is still somewhat limited, prevention strategies described below are based on an industry comparison designed to identify good practice among 12 petroleum companies.

The prevention strategies will target different triggers as described below.

Individual Factors

Individual factors are naturally the most difficult for a company to manage.

- **Physical Health:** A medical fitness assessment prior to expatriation should be considered. This should focus on physical and mental health status, chronic diseases, drug and alcohol abuse, and other physical aspects (e.g., lifestyle-related issues). Following the assessment, a medical fitness certificate for expatriation can be issued.

- **Psychological Resilience:** Psychological resilience of an employee is difficult to quantify. Specific coping strategies should be offered to all employees, with particular focus on at-risk groups (e.g., expatriates, migrants) as applicable. This may involve:
  - Completion of a health questionnaire: if an issue is identified, specialist advice on psychological or psychiatric issues should be requested.
  - A clinical interview: specialist advice may have to be sought, as necessary.
  - Consulting with medical specialists: if substance misuse is possible (e.g., alcohol or drugs), consult the company doctor, contract an independent specialist, and await their reports.
  - Provision of resilience training: this can help raise awareness of symptoms and coping strategies for dealing with work-related demands.
- **Relationships:** Social support is recognized as a preventive factor for psychological dysfunction and mental health problems. Social support may be provided from within the expatriate's family or by significant others. However, the level of support in the workplace can also be important and should be promoted at locations with large numbers of expatriates, (e.g., through employee committees, social events, spouse communities, expatriate-focused employee support programs [EAP]), the human resources department, occupational health services, etc.).

Cultural Factors

Cultural factors relating to the new environment must be taken into account when preparing for expatriation.

- **Informing About New Cultural Practices:** Recommendation is to provide formal socio-cultural awareness information to the expatriate and his or her family members. This should include information on religious practices and the local culture, in case these differ from those in the country of origin.
- **Improving Family Integration:** For successful expatriation, it is important to include the spouse and children in discussions prior to the move, and to ensure that they will be able to get support at the location if needed. A familiarization visit may be helpful in some situations.

  If the family chooses to remain in the home country while the employee goes on assignment, a clear description of frequency of holidays, working hours, etc., should be developed for the expatriate.

  An accompanying partner may not necessarily have a job lined up at the new location, and may therefore have no natural way of integrating into the community.

  These issues should be discussed prior to the expatriation, so the partner can be assured of help coping with the challenges of integration or with finding a job, if required.
- **Social Conditions and Country Infrastructure:** Because infrastructures in certain developing countries are limited, companies should conduct assessments of these factors prior to expatriation, and judge them against international standards.

  Providing the expatriate and his or her family with detailed information on infrastructure and social conditions in the country of assignment is an important preventive action. This should include information on:
  - Health risks, medical coverage, etc.
  - Availability of sports and cultural activities.
  - Hygiene, food, and communication.
  - Schooling issues.

  - Opportunities for the spouse to find a job.
  - Relocation service (to provide help with accommodation, immigration issues, school applications, etc.).
  - Company support for the expatriate's contact with his or her home country, e.g., by providing flights home.
  - Flexible contract types, e.g., rotator schemes (especially for specific offshore positions).

- **Extreme Environmental Conditions:** If an employee is considering an assignment at a location where environmental conditions are extreme, it is vital to ensure that he/she is adequately prepared for such an assignment. Before mobilizing employees to such locations, it is essential that they are provided with awareness training and comprehensive information regarding the location and its environment. Consideration should also be given to familiarization visits. Regarding some extreme remote locations (e.g., the Arctic), special qualifications/competencies and fitness-to-work assessments for suitability may be required.

Organizational Factors

Expatriates often hold positions of strategic and technical importance to the company, and failure to complete an assignment is likely to have a huge impact (e.g., on organizational effectiveness of the company). The following prevention strategies should be considered when developing the company's expatriation policy:

- **Adjustment to the New Function/Role:** Clarity on specific requirements, expectations, and career development opportunities associated with the expatriation plays a key role in individual success. The employer should ensure (e.g., via the human resources department) that the expatriate has clear understanding of his or her responsibilities in the new job position, together with any opportunities for career development. On arrival, the line managers/human resources department should brief the expatriate on the working environment and cultural specifics.

- **Adjustment to the Work Environment (Physical and Social Aspects):** Expatriation should not be considered a burden, but a challenging experience in the normal career development perspective of motivated employees in the petroleum industry. Lack of motivation could become a major cause of failure.

  Adjustment to both physical and social aspects of the work environment should be addressed in the orientation procedure organized by the employer.

  In this context, evaluating desire for expatriation and investigating past history are essential, but not sufficient in all cases. Case-by-case consideration, involving participation of the human resources department, company doctor, line manager, etc., will also be required.

  Desire for expatriation may be assessed by application of different methods, for example, via informal conversations addressing specific concerns from the individual, cross-cultural adaptability, and specific themes associated with the region or culture within the country of expatriation. Some companies think of expatriation as a "stretch assignment" to develop people within the company, and aligned with need for technical expertise in certain parts of the business.

Intervention Strategies

Establishing an effective intervention strategy is instrumental in providing a professional response in the event of an employee suffering from a psychiatric disorder, acute stress, anxiety, etc. Such cases are often referred to as "psychological injury cases." The process of managing these cases can be led by the human resources department, occupational health advisers, or by management, depending on the organizational structure of the company or its culture. However, all parties, including the employee's general practitioner and other relevant external parties, together with input from the company EAP (if available), should be involved.

The process consists of three main steps:

1. Immediate actions.
2. Rehabilitation phase.
3. Reintegration phase.

Whether the process is coordinated by the human resources department or occupational health advisers, it is recommended that the principles described below be followed when managing a psychological injury case.

The principles of handling a psychological injury case are:

- The case should be handled efficiently, and action should be taken involving occupational health expertise as soon as the issue has been reported (any delay should have a valid reason).
- The human resources professionals or occupational health practitioner should conduct any necessary investigation to determine the facts of the case, while supporting the employee and his or her manager in managing the situation.
- Follow-up and monitoring of the situation should be adequate and consistent.
- A reintegration-to-work process should be developed well in advance of the employee's return to work.
- All personal data should be stored and treated with sensitivity and confidentiality.

Immediate actions

A clear procedure regarding necessary immediate actions is important to establish clarity for both the employee and the organization. Furthermore, a consolidated policy and accompanying procedures should define the minimum requirements and competencies for handling psychological injury cases. In some countries, such policies will be established and based on legal requirements.

Immediate actions following a psychological injury should focus on:

- Attaining clarity of the situation, and with regard to the current state of the employee.
- Establishing immediate support for the employee (in some cases, including family); if EAP services are available in the company, a referral should be initiated as soon as possible.

Clear communication of the process and steps involved for the expatriate and family is crucial in creating a safe environment. Furthermore, special attention should focus on establishing a good dialogue with the employee.

At remote locations, establishing the necessary immediate support may be a challenge because of, for example, language difficulties or limited access to expert psychiatric support. It is important that these factors are taken into account in the country entry assessment from a medical perspective. If counselling and expert treatment for, e.g., psychotic symptoms suggestive of mania, are not present in the country, a systematic evacuation process should be established to secure the safety of the expatriate. Furthermore, availability of specific telepsychiatric support from the home country will be useful for expatriates at locations lacking appropriate treatment facilities. The company EAP should also provide expert expatriate services for the employee and his or her family, including advice on cultural differences, cross-cultural adaptation reactions, etc.

Rehabilitation Phase

The purpose of the rehabilitation phase is to stabilize the employee through treatment, e.g., counselling and/or medication. This will, in most cases, require that the employee be off work, either in the home country or in the country of expatriation, depending on the prognosis and severity of the case. During the rehabilitation phase, frequent follow-up meetings with the human resources department, the employee's manager, and the occupational health practitioner should be scheduled and conducted to support the employee's safe return to work as early as possible. During the rehabilitation phase, the employee should undergo a treatment plan that is verified and supported by the occupational health department and/or the employee's general practitioner.

In some severe cases, e.g., psychosis, transfer of the employee to the home country will be necessary as a precaution against potential presence of an underlying risk. Any decision to transfer the expatriate (including his or her family, as appropriate) to the home country should be based on a detailed risk assessment.

Reintegration Phase

A plan to reintegrate the individual into his or her assigned position of work, or into an alternative position, should be initiated quickly after the incident. Such a plan should already have been prepared during the rehabilitation phase.

Research shows that the longer an individual is away from work, the more difficult, or even the more unlikely, will be their ultimate return to work. A reintegration-to-work plan should be developed with input from occupational health department, the company EAP, the employee's manager, the employee, and the human resources department. In some countries, predefined fitness-to-work certificates are available for this purpose.

An assessment should occur about whether the expatriate will be able to return to the role that he or she left, as a result of the incident; in most cases, this will require a graduated approach, considering specific tasks, hours, and environmental factors. If the incident has been due to environmental factors, ability of the employee to stay in the country of expatriation will be unlikely.

Follow up

After the employee has been reintegrated into his or her former position, or into an alternative position, the case owner (either the occupational health services or human resources department) should monitor any changes to the situation over a period of 3-6 months. Changes in performance expectations or in the position itself may be necessary as an outcome of the reintegration to work plan.

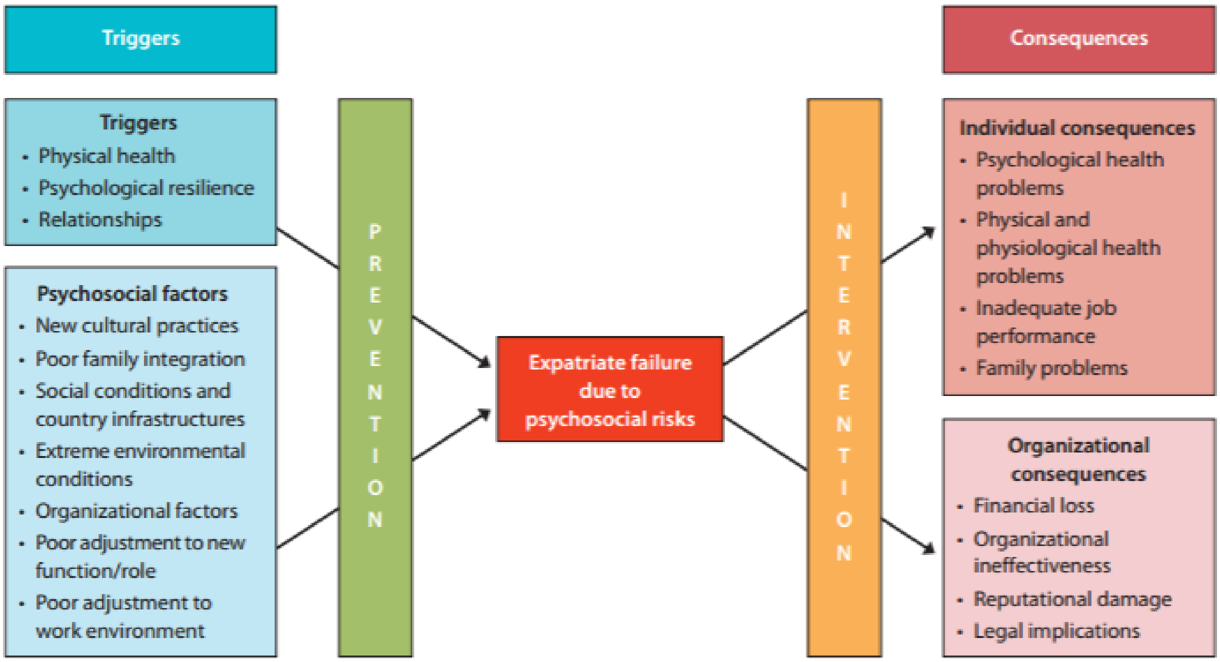
Every case is unique, and the above strategies should reflect the specific context of the situation, taking careful account of the individual's characteristics and circumstances.

Managing Psychosocial Risks

Managing psychosocial risks associated with expatriation requires a strategy for navigating a high level of complexity. The strategy described here is founded on a risk-based approach targeting potential triggers, and applying prevention and intervention strategies to manage potential consequences associated with psychosocial risks.

This strategy is visualized in the model below (Figure 8.5). Developing a prevention program should be based on a comprehensive risk assessment of potential triggers.

FIGURE 8.5: EXAMPLE OF A TYPICAL MODEL FOR MANAGING PSYCHOSOCIAL RISKS



Source: IPIECA, 2013.

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LECTURE 9: HEALTH, SAFETY, AND ENVIROMENTAL MANAGEMENT SYSTEMS

SYLLABUS

Teaching Aims

(i) To introduce trainees to health, safety, and environment (HSE) management systems.

(ii) To introduce trainees to the basic principles of accident investigation including analysis of physical and documentary information.

Learning Objectives

(i) Explain the importance of HSE measures in the petroleum industry.

(ii) Articulate the key elements and processes involved in developing, implementing, and reviewing an HSE management system.

(iii) Assess risks arising from petroleum development activities and appropriate control measures to avoid incidents.

(iv) Outline standard operating procedures for undertaking accident investigation along the value chain.

(v) Demonstrate ability to draft an annotated outline of the accident investigation report including recommendations for risk assessment and avoidance of future accidents.

Outline of Lecture Content

Topic and Subtopic	Suggested Approach, Methods & Equipment
1. Introduction	• Brainstorming. • Equipment:: projector, laptop, whiteboard/flipcharts, markers
2. Key Elements of a Health and Safety (H&S) Management System	• Brainstorming. Practical exercise on designing an H&S system, case study • Equipment: projector, laptop, white board/flip charts, white board duster, marker
3. Leadership and Commitment	Lecture and discussion
4. Policy and Strategic Objectives	
5. Organization, Resources, and Documentation	
6. Communication with HSE MS	Q&A, lecture based on participants' knowledge and experience of communication process.
7. Hazard and Effect Management (HEMP)	• Introduce the topic with a mini lecture mixed with Q&A to build on knowledge and experiences of the trainees. • Practical exercise on the five HEMP steps whereby participants are placed in groups to accomplish the task; discussion on findings of the exercise. • Equipment: projector, laptop, white board/flipcharts, stationary for participants

Topic and Subtopic	Suggested Approach, Methods & Equipment
8. Job Hazard Analysis (JHA)	• Introduce the topic with a mini lecture mixed with Q&A to build on knowledge and experiences of the trainees. • Practical exercise on job hazard analysis procedure. • Equipment: projector, laptop, white board/flipcharts, stationary for participants
9. Emergency Response Measures	• Start with a video on emergency response; followed by a class discussion on emergency response measures • Group exercise on contingency and emergency planning based on a real life case study • Fire drill, video on emergency response • Equipment:: fire extinguishers, fuel, projector, laptop, white board/flipcharts, stationary for participants
10. Implementation and Monitoring	• Brainstorming through Q&A with the teacher filling in gaps in trainees' knowledge and experiences. • Case study of a real-life experience/report/exercise, whichever is available. • Equipment: : projector, laptop, white board/flipcharts • Case study on reactive monitoring and associated risks. • Equipment: projector, laptop, white board/flipcharts
11. Accident Investigation and Reporting: Practical Lessons	Practical lessons and case studies.
12. Field Trip	Transportation to the field

DETAILED NOTES

1. INTRODUCTION

Safety Management Systems

The long-term value of a safety management system is to create step-change improvements in safety without the large-scale disasters to drive them.

Why HSE MS?

- Intense public scrutiny and media attention.
- Threat to significant legal and financial liability.
- Threat to loss of corporate reputation and security.
- Realization that HSE is a good business practice.

HSE MS Approaches in Petroleum Exploration and Production Industry

- HSE management is assessment of risks arising from business activities and implementation of appropriate control measures to avoid incidents.
- Principally drawn from exploration and production forum guidelines for development and applications of HSE MS.
- Based on ISO 9001 Quality Management System (QMS), EMS 14001, and Occupational Health and Safety Standard (OHSAS) 18001 models.
- HSG65: Developed by Health and Safety Executive (UK).
- OHSAS 18001: British standard used globally but yet to be adopted as international standard.

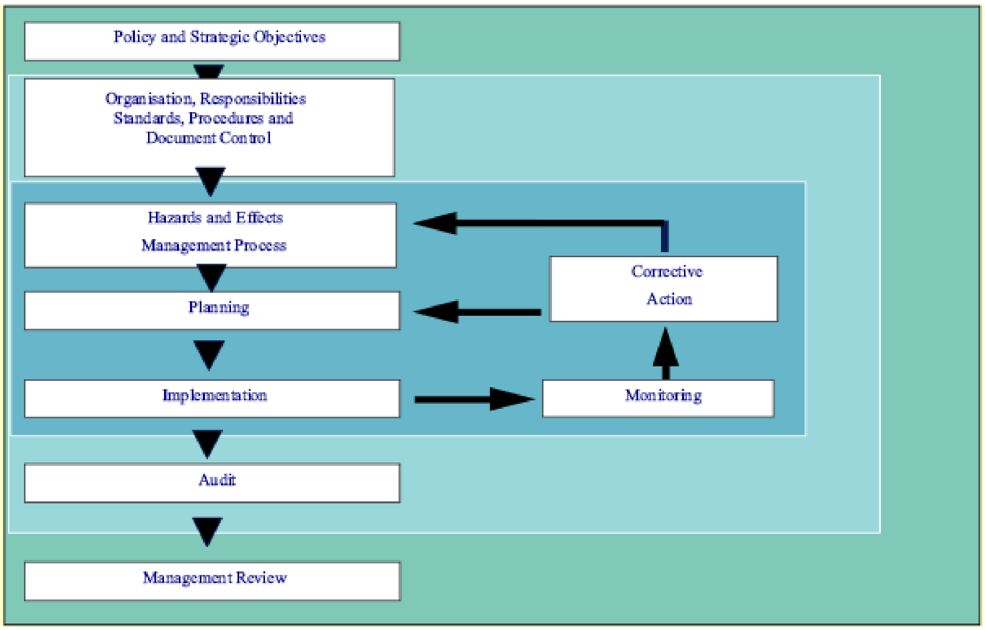
2. KEY ELEMENTS OF A HEALTH AND SAFETY MANAGEMENT SYSTEM

FIGURE 9.1: HEALTH AND SAFETY MANAGEMENT SYSTEM

Source: PDL Group, 2016.

- Policy: Effective H&S policies set a clear direction for the organization to follow.
- Organizing: An effective management structure and arrangements are in place for delivering the policy.
- Planning: A planned and systematic approach to implementing H&S policy is established within an effective H&S MS.
- Measuring Performance: Performance is measured against agreed standards to reveal when and where improvement is necessary.
- Auditing and Reviewing of Performance: The organization learns from all relevant experience and applies the lessons.

FIGURE 9.2: ELEMENTS OF LEADERSHIP AND COMMITMENT



Source: Oguntoyinbo, 2016.

3. LEADERSHIP AND COMMITMENT

Visible traits of commitment by top management are:

- Acceptance of HSE policies and procedures.
- Setting of objectives and targets.
- Provision of resources.
- Attending HSE meetings.
- Carrying out facility and site inspection.
- Detecting and stopping unsafe activities.
- Motivation and award scheme.

Commitment is required to enhance:

- Safe and healthy practices in all operations.
- Incident-free workplace.
- Properly engineered facilities, plants, and equipment.
- Maintained, safe, and secure equipment.
- Openness and participation in HSE matters.
- Awareness and education campaign.
- Reduction of waste and consumption energy materials.
- Reduction and avoidance of emission and discharges where practicable.
- Reduction of environmental risks at all levels.

4. POLICY AND STRATEGIC OBJECTIVES

Policy

This is the overall intention of an organization regarding HSE, as formally expressed by top management.

Strategic Objectives

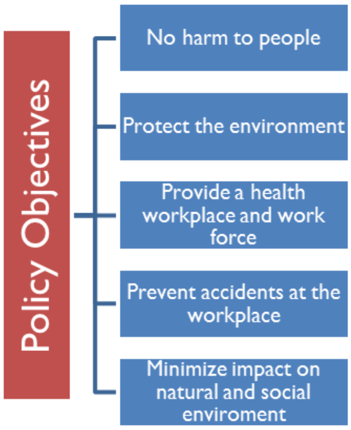
This is the overall HSE goal arising from HSE policy.

Target

Milestone to achieving objectives and quantifiable where practicable.

Policy and Strategic Objective

FIGURE 9.3: POLICY AND STRATEGIC OBJECTIVES



Source: HSE, 2013.

5. ORGANIZATION, RESOURCES, AND DOCUMENTATION

HSE matters are line responsibilities involving all levels and functions, and reflected in organizational structure and allocation of resources. HSE MS is a process approach.

Organizational Structure and Responsibilities

Organizational structure is a framework that describes:

- Roles.
- Responsibilities.
- Authorities.
- Accountabilities.
- Interactions necessary to implement HSE MS.

Allocation of HSE responsibilities depends on:

- Core processes.
- Supporting processes.

Resources

Resources should be allocated to accomplish the following:

- Facilities, plants, and equipment meet legislative and regulatory requirements.
- Adequate personnel, equipment, and infrastructure are in place to respond to and mitigate emergency situations.
- Management is available for HSE audits and reviews.
- Facilities and personnel can accommodate to new development, changes, and emergencies.

6. COMMUNICATION IN HSE MS

- Maintain a procedure to communicate to staff, contractors, partners, and stakeholders.
- Set up a two-way communication system.

- Assess and evaluate message to be transmitted, information sought, and most appropriate medium for doing so.
- Emphasize importance of achieving HSE policy and objective roles and responsibilities.
- Explain HSE risk and hazards of work, as well as preventative and mitigation measures.

HSE Documentation

- HSE policy and strategic objectives.
- Key roles and responsibilities.
- Manual conveying HSE management system elements and their interactions.
- Cross-referenced and linked documents, with other management systems.
- Results of HSE evaluation and risk management.
- Relevant legislations and regulations.
- Procedures and work instructions where required.
- Emergency plan and responsibilities.

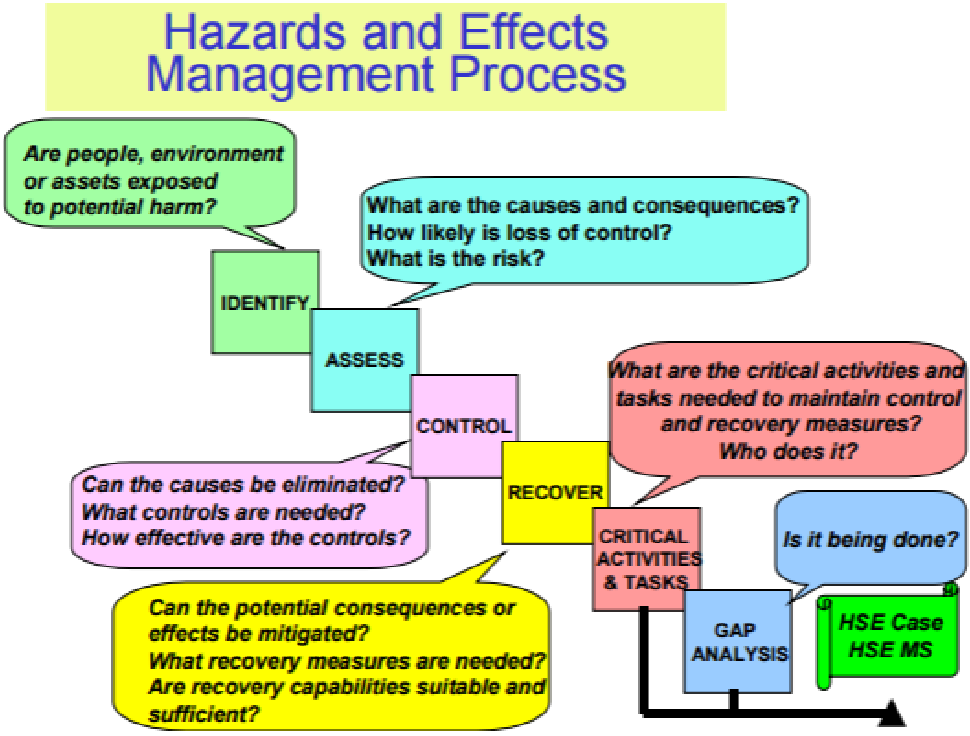
7. HAZARD AND EFFECT MANAGEMENT (HEMP)

The Hazards and Effects Management Process (HEMP) is defined as "The structured hazard analysis methodology involving hazard identification, assessment, control and recovery and comparison with screening and performance criteria." (Shell International Exploration and Production, 1995).

The HEMP process originally consisted of four steps, Identify, Assess, Control, Recover. These have now been expanded to five steps, which better focus the process on management of risk, rather than management of a hazard in isolation. The five steps of the HEMP process are:

1. Identification of hazards and effects – A systematic search for hazards and their effects, to include hazardous events, hazards, threats, and escalation factors.
2. Evaluation of risk – Assessment of hazard and effects to establish probability of occurrence and severity of exposure.
3. Recording of hazards and effects – Formal record of assessment using pre-defined forms.
4. Comparison with objectives and performance criteria – Gap analysis between assessed risk and acceptable risk.
5. Risk reduction criteria – Decision on best approach to reduce risk based on cost benefit analysis.

FIGURE 9.4: HEMP PROCESS



Source: Salter, 2005.

Objectives of HEMP

1. To provide a structured approach toward analysis of hazards throughout the life cycle of an asset.

2. To achieve step 1, use structured tools and techniques that allow identification and assessment of hazards, and when these are fully understood in both situation and context, control and if necessary recover from these hazards.

When to Apply HEMP

- At the start of each life cycle phase for an asset.
- Prior to any major change (structural, operational, or maintenance) to an asset.
- Prior to initiation of an activity.
- Prior to introduction of a new hazard to the operation.
- Prior to the start of any contracted operation.

Further triggers for application of HEMP should be:

- Appearance of hazards that could pose a significant threat.
- Recognition that established controls are inadequate to meet standards, or continuous improvement in HSE performance is required.

Hazards Identification and Assessment Process

Basis

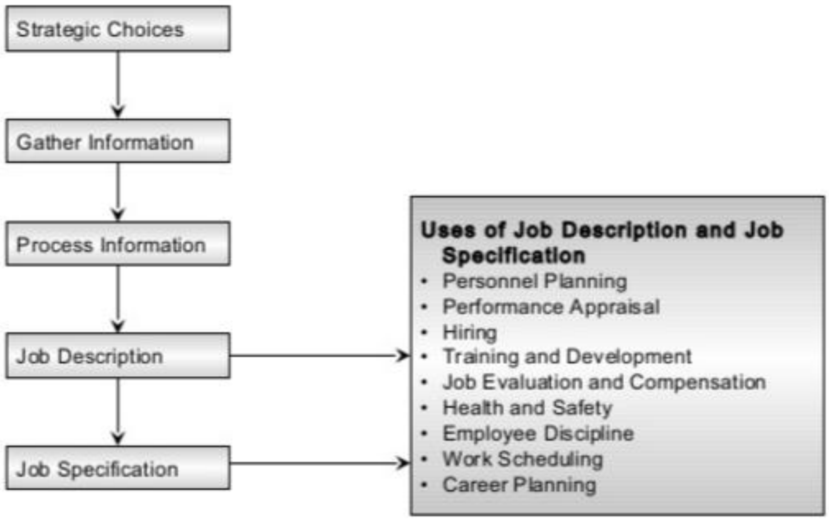
- Experience/judgement.

- Checklist.
- Codes, standards, regulations, laws, ISO Standards.
- Structural review techniques Hazard identification study (HAZID), Hazard and operability study (HAZOP).

8. JOB HAZARD ANALYSIS (JHA)

- JHA is an accident prevention technique that involves application of hazard and effect management at task level.
- The four HEMP tools are involved: a systematic **identification** of hazards, a qualitative **assessment** of risk posed by the hazards, and specification of appropriate **controls** and **recovery measures** to address these identified hazards.

FIGURE 9.5: JOB ANALYSIS PROCEDURE



Source: Aswathappa, 2015.

Planning

- Clearly define objectives.
- Designate roles and responsibility.
- Define acceptable performance criteria.
- Evaluate and choose method or means to achieve objectives.
- Understand resource requirement.
- Define time scale for implementation.
- Establish programs for monitoring and encouraging personnel toward a suitable HSE MS.
- Set up a feedback mechanism.
- Establish a mechanism for evaluation of HSE performance, and follow up.

Contingency and Emergency Response Planning

Foreseeable emergencies for which planning may be undertaken include:

- Fire and explosion.

- Drowning.
- Power failure.
- Collapse/structural failure.
- Worksite incidents.
- Security breaches.
- Outbreak of diseases.
- Water pollution.
- Flooding.
- Falls.

9. EMERGENCY RESPONSE MEASURES

- Shut down system.
- Access and implement firefighting devices.
- Implement previously established evacuation procedures.
- Access first aid equipment and trained personnel.
- Set up clinics.

10. IMPLEMENTATION AND MONITORING

Do what you said you would do and determine whether those actions are effective

Monitoring provides means of measuring performance

- Against set requirements.
- Objectives.
- Targets.
- Performance criteria.

Incident Investigation and Reporting

Why investigate accidents?

- To establish their root causes.
- Identify actions to minimize the chance of reoccurrence.
- Satisfy any statutory requirement for reporting and investigation.
- Provide factual record of the circumstance of the incident.

Non-compliance and Corrective Action

- Incidents of non-compliance may be sudden or temporary or may persist for a long time.
- They may result from failure or deficiencies or human errors.
- Causative mechanism should be investigated to enable planning for corrective action.

Audit

An audit could be internal, independent, or third-party. An audit could require broad knowledge of HSE, as well as practice and discipline. The audit team should include personnel with operational experience. An audit may suggest need for remedial action. A report of each audit must be developed and distributed.

Management Review

- Routine procedures.
- Organizational changes.
- Development of understanding of HSE issues.
- Changes in environmental sensitivity.
- Potential regulatory changes.
- Concerns of employee, contractors, customers, government agencies, the public.
- Market pressures.
- Changing company activities.
- Continuing suitability of policy or objectives.
- Objective evidence for continual improvement.

11. ACCIDENT INVESTIGATION AND REPORTING: PRACTICAL LESSONS

Introduction

This lesson applies resource materials to help trainees gain understanding of some basic skills in investigations of accidents or incidents, and in compiling reports of the incidents. The lesson includes short case studies that provide examples of real-life accidents during specific operations along the petroleum value chain. The case study narratives also provide links to or references of detailed reports of investigations, as well as video footage or animation of the accidents/incidents summarized in the case study narratives.

Instructors can utilize information and tools associated with this lesson to conduct practical lessons on specific aspects of the investigation process. Ideally, instructors should:

- Review ahead of the practical lesson all case study narratives and their respective resource materials (videos, investigation reports, etc.).
- Choose a case study that is particularly appropriate for demonstrating concepts covered in the theoretical sessions of the lesson.
- Hand out to trainees a written narrative of the identified case study and ask the trainees to read and review it exhaustively.
- Use the "Practical Lessons Tool" to undertake a "mock investigation" exercise of the accident/incident summarized in the case study.
- In view of time limitations, split trainees into three or four groups, tasking each group to focus on specific aspects of the investigation process (e.g., gathering information, evaluating information, identifying courses of action/recommendations, reporting findings, offering recommendations, and conducting follow up.
- For practical purposes, the instructor should encourage trainees to identify and frame objectives of the investigations in plenary before the trainees go into small groups. This will ensure that all

the trainees have a common understanding of the objectives of the exercise, and therefore a common basis for their respective group activities. Trainees should be instructed to ensure that their group work must contribute to achievement of the identified objectives of the "investigation" exercise.

- Ask the groups to report back in plenary, and ensure coherence in reporting and thus in meeting objectives of the exercise.
- Conduct a plenary discussion to review the individual group reports to identify commonalities that must be strengthened and points of departure that should be harmonized before synthesizing the group reports into a draft consolidated report of the exercise.
- Screen a video of the case study to provide the trainees with a strong visual appreciation of the nature, extent, and complexity of the accident/incident. The video can be screened after trainees read the case study and after the plenary discussion of group reports.
- Give the trainees a summary of the official report of the accident/incident investigation to convey to them an understanding of the scope of coverage of the official investigation and the level of reporting detail. This will give the trainees a good idea of obvious gaps in the exercise that they conducted in small groups and plenary, and thus an appreciation of areas that require improvement/strengthening.

Time permitting, this process could be repeated with use of a different case study package.

The following Practical Lesson Tool[21] is intended to help trainees acquire some basic skills in conducting a comprehensive accident investigation and compiling a report of the investigation.

	Element	Performance
1	Determine investigation objectives	• Determine the scope of the investigation to ensure pre- and post-incident time frame is considered, consistent with legislative requirements and site standard. • Determine the proposed investigation objectives from an analysis of available information. • Test the proposed objectives and clarify the scope of the investigation • Ensure that final objectives and scope of the investigation will be achievable by use of available resources and within authority constraints.
2.	Gather information	• Maintain site security and integrity of evidence in accordance with legislative requirements. • Plan and prepare for systematic collection of information. • Schedule information collection and completion to ensure minimum backtracking or repeat actions. • Ensure methods applied to collect and examine information, including interviewing and recording, meet appropriate standards and legislative requirements.
3.	Evaluate information	• Assess and evaluate information for its validity and reliability, and organize as evidence to aid decision making. • Undertake further research where information is unclear or inadequate, and correct the discrepancy/deficiency. • Analyze the evidence to determine the causes of the incident.

[21] Adopted from Course in Conduct Safety & Health Investigations: *RIIOHS301A* Student Study Guide. Retrieved from: http://www.ohsa.com.au/Mining-Supervisor_Workbooks/RIIOHS301A-Conduct_Safety_&_Health_Investigations-Study_Guide/RIIOHS301A%20Conduct%20Safety%20&%20Health%20Investigations%20v1.5-2011.pdf

	Element	Performance
		• Draw conclusions from the relevant evidence based on reasoned argument and balance of probability or other agreed standard. • Ensure that findings address the factual objectives established for the investigation.
4.	Identify courses of action	• Frame options for the courses of action to address or respond to the findings of the investigation. • Provide options in a form that meets the audience requirements, can be easily understood, and enable selection of the most appropriate course of action. • Ensure the course of action selected will resolve the issues or problems recognized by the investigation and reduce probability of recurrence. • Ensure that the selected course of action can be implemented in accordance with relevant national, state, and industry standards.
5.	Prepare and present investigation reports	• Prepare investigation reports in accordance with specified standards. • Present reports in a format that ensures findings, causes, options, and courses of action can be readily understood by the audience. • Present reports, including findings and recommendations, to the required audience. • Review the investigation process and offer recommendations for process changes and improvements to the appropriate authority.

Range Statement

The following range of variables is also intended to serve as a generic guide that can be modified and customized to suit the unique circumstances of the accident/incident to be investigated:

1. Investigations may involve a range of issues but will generally be related to:
   - Accidents, incidents, or near misses;
   - Safety and health systems and issues;
   - Safety aspects of technical processes and procedures; and
   - Safety aspects of equipment specifications and performance definition.
2. Information collection may include:
   - Reconstruction of events;
   - Interviews;
   - Statements;
   - Audio recording;
   - Photographs;
   - Scale diagrams; and
   - Access of other formal information sources.

3. Information sources may include:
   - Applicable legislation and codes of practice relating to the industry, dangerous and hazardous goods, environmental protection, etc.;
   - Emergency procedures;
   - Quality assurance procedures;
   - Manufacturer documentation and handbooks; and
   - Material safety data sheets.
4. Analysis of information may be divided into five main areas, including:
   - People;
   - Environment;
   - Equipment;
   - Procedures; and
   - Organization.
5. Investigation recommendations may include:
   - Safety management systems;
   - Processes and procedures;
   - Behaviors/actions;
   - Equipment and materials; and
   - Working environment.
6. Investigation report formats may be established on a site-by-site basis, but are likely to include:
   - Objective(s);
   - General overview;
   - Research and information collection methodology;
   - Analytical criteria;
   - Findings, including essential and contributing factors;
   - Recommendations;
   - Follow-up actions; and
   - Records of all relevant evidence.

Key Questions to Help Identify Potential Causal Factors

People

- Who was involved in the incident?
- What task was being conducted?
- What injury, loss, or damage occurred?
- How did the incident occur?

- Who was involved in the incident?
- Who saw the incident (witnesses)?
- Who instructed or supervised the injured/persons involved?
- Were the people trained, qualified, experienced, and authorized to perform the task?
- Were there any behavioral issues (risk taking acts, shortcuts, omitted actions, inappropriate work method, etc.)?
- What was the emotional state of the people involved (social/domestic pressure, conflict, bullying, and/or job demands)?
- When did supervision last see the injured person before the incident?
- Was everyone involved in the task fit for work (including alertness, physical ability, fatigue, and overexertion)?
- Why was the person applying the particular work method (doing the task this way)?
- How long has this person been doing this job?
- How much experience does this person have with this task?
- Had the person conducted a pre-start inspection prior to commencing this task?
- Was the person wearing the correct protective clothing?
- Was the person required to use any permits or tagging to do this task?
- When did this person start this shift?
- How many shifts had this person worked prior to this event?
- Was the person an employee, contractor, or visitor?

Equipment

- What equipment, tools, and plant were used?
- What were the part/model numbers?
- What was the equipment being used for at the time of the incident?
- Was the equipment appropriate for the job?
- What personal protective equipment was being used?
- What materials were being used?
- What and how much damage or loss occurred?
- How old was the equipment?
- When was the equipment last inspected/serviced (records)?
- Was it inspected/serviced by a qualified person?
- Who manages the inspection and services?
- Were the machine guards and other protection systems in place and operational?

- How effective was the protection system?
- Was the equipment properly designed?
- Was the equipment being used according to its specifications?
- Where was the equipment located at the time of the incident?
- Was the equipment/tools fit for purpose and in safe condition (including personal protective equipment)?
- Were there any unauthorized modifications or design deficiencies?
- Why did the equipment/tools/materials fail?
- Had there been any previous reports about problems, defects, issues with this equipment?

Environment

- When did the incident occur (date/time)?
- Where did the incident occur (location)
- What were the conditions of the worksite and natural environment (i.e., lighting, visibility, glare, hot, cold, wet, dry, ventilated, confined space, noise, vibration, working at heights, working in trenches, driving, vehicle/people interaction and control, working surface, ground state, access and egress, congestion, housekeeping, climate)?
- Was repetitive movement, abnormal or strained posture, or manual handling tasks involved?
- What environmental (worksite or natural) damage occurred?
- Had there been any recent changes to the location of the incident?
- Did the pre-start or risk assessment allow for environmental issues to be addressed?
- Was there adequate space at the incident scene for the task to occur?
- Was there any other task or equipment that contributed to the incident?
- Did the pre-start or risk assessment allow for environmental issues to be addressed?
- Did the risk assessment recognize any environmental issues?
- Was housekeeping adequate?

Management

- What procedures were in place for conducting the task (e.g., job hazards analysis (JHA), safe work practice (SWP) permits, material safety data sheets?
- How did the procedures fail?
- What instructions were given to the persons involved in the task?
- Was the work method appropriate to the task?
- Were the procedures available at the worksite?
- Were the procedures followed?
- Were required authorizations implemented (such as permits and JHAs)?

- Who developed and authorized the procedures?
- Were the permits followed?
- How effective was task planning and preparation?
- How effective was written/verbal communication?
- Were the hazard/risk controls effectively implemented?
- Were all hazards identified?
- Were all hazards controlled to an acceptable level?
- Was supervision adequate?
- Was the training provided effective?
- Was there a register of training?
- Were those involved in the incident trained and competent?
- What job demands existed (time constraints, extended hours of work, conflicting priorities)
- Were there any resourcing issues (materials, tool/equipment, or people)?
- Were at-risk conditions, practices, or behaviors tolerated?
- Was the emergency response effective?
- Was there compliance with the safe system of work?

Developing an Emergency Response Plan (Specialized Hazards)

Overview

Information below derives from guidelines developed by the Ministry of Environment in the Province of British Columbia, Canada (British Columbia Government, 2002). This information includes generic guidance for operators of industrial facilities or operations to develop emergency response plans for timely and effective response to major accidents and emergencies involving release of hazardous chemicals or dangerous goods to the environment. Generic guidance conveyed in the text below can be applied to the petroleum industry as well, especially regarding responses to hazard incidents large and small.

Purpose and Scope – Who Needs an Emergency Response Plan?

Industrial facilities that store, manufacture, transport, recycle, or handle dangerous goods, hazardous wastes, or hazardous chemicals should prepare a response (contingency) plan to respond to emergencies involving accidental release of these substances into the environment. Such facilities include, but are not limited to waste landfills, recycling (plastics, tires, paint, pesticide, batteries) facilities, and chemical and petroleum bulk storage or transportation facilities. The guidelines are intended for application by industries such as chemical, mining, metallurgical, oil and gas, petroleum, food, and forest products. Government officials also should refer to the guidelines when reviewing industry emergency response plans.

Definitions

- **Accident.** An unexpected event that results in loss or injury to a person and/or damage to property or the environment.

- **Dangerous Goods**. Dangerous goods include explosives, compressed and liquefied gases, flammable and combustible materials, oxidizing materials and organic peroxides, poisonous and infectious substances, radioactive materials, corrosives, and miscellaneous dangerous goods.
- **Emergency.** In the context of these guidelines, an accidental situation involving release or imminent release of dangerous goods or other substances that could result in serious adverse effects on the health and/or safety of persons or the environment. An emergency may be the result of man-made or natural occurrences such as, but not limited to, process upsets, uncontrolled reactions, fires, explosions, threats, structural failures, tornados, earthquakes, floods, and storms.
- **Emergency Response (Contingency) Plan.** A detailed program of action to control and/or minimize effects of an emergency requiring prompt corrective measures beyond normal procedures to protect human life, minimize injury, optimize loss control, and reduce exposure of physical assets and the environment to an accident.
- **Hazard.** An event with potential for human injury, damage to property, damage to the environment, or some combination thereof.
- **Incident Command System (ICS).** A method by which response to an extraordinary event, including a spill, is categorized into functional components, and responsibility for each component is assigned to the appropriate individual or agency.
- **Risk.** The chance of a specific undesired event occurring within a specified period or under specified circumstances. Risk may be either a frequency or a probability of a specific undesired event.
- **Risk Analysis**. Identification of undesired events that lead to materialization of a hazard, analysis of mechanisms by which these undesired events could occur, and, usually, estimation of extent, magnitude, and likelihood of any harmful effects.
- **Risk Assessment**. Quantitative evaluation of likelihood of undesired events and likelihood of harm or damage caused by them, together with value judgments concerning significance of the results.
- **Risk Frequency.** Number of occurrences per unit of time.
- **Risk Management**. Program that embraces all administrative and operational programs designed to reduce risk of emergencies involving acutely hazardous materials. Such programs include, but are not limited to, ensuring design safety of new and existing equipment, standard operating procedures, preventive maintenance, operator training, accident investigation procedures, risk assessment of unit operations, emergency planning, and internal and external procedures to ensure execution of these programs as planned.
- **Spill.** An unauthorized release or discharge of a dangerous good into the environment.

Contents of a Typical Emergency Response Plan

The guidelines identify principal components of an emergency response plan. Emergency response plans should identify potential hazards; develop systems for preventing accidents; provide appropriate mechanisms for minimizing risk, loss, and damage resulting from such incidents (i.e., reduce exposures to communities); and provide an incident management structure to guide response activities.

Policy Statement

A company or industry operator should have a policy statement reflecting its commitment to emergency prevention and preparedness. The statement is usually signed by a senior official such as the Chief Executive Officer or the company president. A policy statement should include:

- Management's commitment to safeguard H&S of the employees and the public, and to protect the environment.
- A statement of the company's priorities in the event of a spill. Generally, priority is in the order of immediate safety of employees at the site and the members of the surrounding community, followed by protection of the environment.
- A clear indication of the first-line supervisor's authority for emergency action and expenditure.
- A statement of authority regarding who will deal with public and media inquiries.
- A statement concerning the company's plan to monitor compliance with this policy.
- Effective date of the plan.
- A schedule for review and for testing/exercising of the plan.

Purpose and Scope of an Emergency Response Plan

The purpose of formulating an emergency response plan is to develop a state of readiness allowing for a prompt and orderly response to an emergency. This section of an emergency response plan should state the intent and scope of the plan. Emergency response plans should be structured around four major objectives:

- Understanding the type and extent of a potential emergency (risk/exposures)
- Establishing a high order of preparedness (equipment, personnel) commensurate with the risk
- Ensuring an orderly and timely decision-making and response process (notification, standard operating procedures
- Providing an incident management organization with clear missions and lines of authority (ICS, field supervision, Unified Command).

Prevention is by far the most effective way of reducing or eliminating potential for a spill, as well as impact mitigation to reduce effects on the community and environment should a spill occur. Developments of spill prevention measures (e.g., product loss control) and mitigation measures (buffer-zones, dangerous goods transportation corridors, land-use plans) are endeavors separate from an emergency response plan. These approaches are beyond the scope of these guidelines and are not addressed.

The terms of reference for the plan should include such items as:

- Whether the plan is for an individual operation or a part of an industry cooperative in a given area
- Geographic and physical location(s) covered by the plan
- Types of emissions or spills that the plan is designed to address, including spills to land, water, and air. This should include all dangerous goods and hazardous chemicals handled, along with transportation routes and the particular plant for which the plan is developed.
- A list of any other organizations or groups with responsibility under the plan.

Finally, the emergency response plan must be consistent with disaster, fire, and/or emergency response plans of local, provincial, and national agencies. The latter is largely achieved by implementation of the international and proven ICS System during and following an emergency.

Pre-emergency Planning

Hazard Identification

The first step is to identify potential hazards. This section of an emergency response plan should identify all potential on-site and off-site hazards of the operation, and the type of damage that may result. This requires information on toxicological, physical, and chemical properties of the substances handled. Potential impact on downwind air quality or downstream water quality from an accidental release, and danger to human and animal health should be clearly identified. A "mitigation plan" can be developed to passively reduce exposures to the community or the environment should a spill occur (e.g., buffer zones, fencing, dykes/barriers, transportation corridors). Man-made perils such as fire, explosion, transportation accidents, pipeline breaks, or equipment failure should be considered in addition to the natural perils such as floods, earthquakes or landslides.

A mitigation plan is a separate aspect of an emergency response plan, but can be used to determine the scope of response preparedness and tactical (operational) decisions.

Risk Analysis

The second step of the process is to determine the risk of an incident associated with each hazard. The basic procedure in a risk analysis is as follows:

1. Identify potential failures or accidents (including frequency).
2. Calculate the quantity of material that may be released in each failure, and estimate the probability of such occurrences.
3. Evaluate consequences of such occurrences based on scenarios such as most probable and worst-case events.

This combination of consequences and probability will allow ranking of hazards in a logical fashion to indicate zones of important risk. Criteria should then be established by which the quantified level of risk may be considered acceptable to all parties concerned.

To reduce or eliminate risk, consideration of spill prevention and spill mitigation in conjunction with preparation of an emergency response plan is advisable. For this purpose, workers involved in operating the plant, equipment, or systems should be encouraged to provide information concerning weaknesses in systems or operating procedures, "near misses," and potential problems they have observed, along with recommended measures for prevention/mitigation of such occurrences.

Legislation and Industry Standards

The emergency response plan should identify national regulations that apply to the facility and its operation. Where appropriate, regulatory agencies should be contacted for identification of requirements regarding the environment, pipelines, mining, fire, petroleum, boiler and pressure vessels, dangerous goods, transportation, H&S, and other operational considerations.

Certain industries may be bound to follow procedures recommended in codes of practice, which reflect an ethic, an attitude, and method of thinking about the way in which member companies do business and their role in society. To identify appropriate codes, industry associations should be contacted.

Emergency Organization and Responsibilities

The emergency response plan should identify the transition from normal operations to emergency operations, and delegation of authority from operations personnel to emergency response personnel. For this purpose, the plan should identify an emergency response organization with appropriate lines of authority, and how response management will escalate. Responsibilities for decision making should be clearly shown in an emergency organization chart. The plan should identify each responder's position, mission, duties, and reporting relationship (refer to ICS below). Sufficient details should be provided to ensure that all critical activities are covered.

Though not legally required, industries that pose a significant risk necessitating an incident management team must specify implementation of the ICS for emergency management (both organization and protocols) to receive emergency response plan approval by the appropriate government/national jurisdiction.

The ICS is an organized approach to effectively control and manage emergency operations under circumstances requiring:

- Direct supervision of field personnel (task forces, single resources, strike teams) from an Incident Command Post
- Development of an Incident Action Plan and delivery of tactical (operational) decisions
- Unified (shared) command with other jurisdictions (governments) or response functions (fire, police, ambulance), and with the responsible party (spiller/polluter).

In the ICS, the emergency response is categorized into functional components such as Command, Operations, Planning, Logistics, and Finance/Administration, and response is undertaken according to a standard set of protocols (e.g., rules of engagement). As well, a set of response personnel positions is established, each with defined missions and duties under the five ICS functions.

Under ICS, individual(s) in charge of the incident—Incident Commander(s)–have final authorities to jointly make strategic and tactical decisions, and have complete responsibility for management of the incident. Government (local, provincial, national), via its Incident Commanders and team members, has authority to monitor the responsible party's (spiller/polluter) response efforts, and to determine public safety and environmental protection priorities. Government may also augment the company's response efforts by providing government personnel and equipment. The latter could generally be based on a cost-recovery for such services. These monitoring and augmenting functions proceed jointly under the ICS application of Unified Command.

Response levels additional to those at the field and site are recommended to support the company's incident management team. These are the off-site Emergency Operations Center (EOC) at a company's regional office and headquarters office, and the company's crisis management team. The provincial government equivalent to a crisis management team is the "Agency Executive" or "Policy Group." The latter is composed of the company's Chief Executive Officer and senior executives.

Resources

This section of the emergency response plan identifies sources of local assistance, including telephone numbers and names of contacts in:

- Fire departments;
- Police department;
- Municipal and provincial agencies;
- Hospitals;
- Doctors;
- Other company facilities;
- Mutual aid organizations; and
- Cooperatives.

Other resources that should be considered to assist in the incident include:

- Helicopter and air transport services;
- Surface transport services;
- Safety and monitoring equipment suppliers; and
- Spill response and/or cleanup services.

Companies should also determine what resources (equipment, personnel, technology, expertise) can be provided by the federal and provincial governments, and under what conditions.

Internal Alerting/Communicating

In an emergency, information must be communicated quickly and accurately throughout the affected organization. The purpose of this portion of a plan is to establish an effective emergency communication network and a procedure for prompt notification of individuals and agencies involved in an emergency response.

The section must identify means for 24-hour notification of first responders and officials who can provide direction and control to the response effort, and who can authorize evacuation. A notification guide should also include a list of backup personnel for emergency response and their telephone numbers (cellular, pager, home numbers). To prevent system breakdown, an "alternate" person should be designated for each key position of designated responsibility.

The notification procedure may include flow charts and checklists indicating who should be involved, who has responsibility to notify these individuals, how the notification is accomplished (e.g., paging systems, cellular or mobile phones), and use of "fan out" (a call to one person/agency who in turn calls one or more key individuals during major emergencies). These numbers and checklists may be posted in critical areas for ready use or distributed as pocket cards.

External Alerting/Communicating

The plan should describe how and when the fire and police departments, emergency measures organizations, national and provincial authorities, news media, and volunteer or off-duty workers will be contacted during working and non-working hours. This responsibility may be designated to senior company personnel. Contacts for reporting purposes should also be included in the contact telephone listing. Roles and responsibilities of all external organizations and agencies involved in the emergency response and/or support function should be clearly defined. Duplication can be eliminated by ensuring coordination among the various agencies that provide similar services.

Electronic Communications

During an emergency, effective and reliable electronic communications equipment and procedures are vital. This section of the plan should detail the types of communication equipment to be used by personnel during an emergency response. Because normal means of communication can break down in an emergency, alternative means must be considered. Cellular telephones, public address systems, two-way radios, and messengers can be used.

Training and arrangements may be necessary to ensure that telephone services are available for official calls during an emergency, and that unauthorized calls will not be placed. Within an Incident Command Post, telephone circuits may quickly become jammed with calls. Direct hot lines not available to outside lines may be considered for critical communications, or dedicated phone lines may be set up for these purposes.

Public Affairs

A good public relations program is extremely important in an emergency situation. Inquiries will normally be received from the media, government agencies, local organizations, and the general public. This section of the emergency response plan should include a public relations or media plan. It should identify an Information Officer well equipped and trained in media relations.

Initial releases should be restricted to statements of fact such as the name of the installation involved, type and quantity of spill, time of spill, and countermeasure actions being taken. All facts must be stated clearly and consistently to everyone. Discrepancies will raise unnecessary concerns and speculation. To avoid mixed messages, the government's preferred way of issuing medial releases is through an appropriate information center (Joint Information Center [JIC]) separate from the Incident Command Post and staffed with Information Officers by both industry and government. Joint media releases are approved under Unified Command.

Plans should also be developed to utilize local media and television stations for periodic announcements during an emergency. This will also assist in reducing rumors and speculation.

Emergency Response

Response Action Decision

An emergency response plan should have emergency coding that defines severity and potential impact of an emergency. The three levels of emergencies may be identified as follows:

- LEVEL 1: Minor spills requiring an on-site worker to respond and take necessary collective actions.
- LEVEL II: Intermediate-level spills requiring response by on-site or off-site trained staff but posing no danger to the public.
- LEVEL III: A major incident beyond the resources of a single facility, involving subsidiary problems to complicate the situation such as fire, explosion, toxic compounds, and threat to life, property, and the environment. Assistance will be required from local, regional, and/or provincial organizations. The media will be present, and politicians at all levels will request action.

Incident detection, information gathering, and action decisions are the first steps in responding to an emergency incident. All these steps may occur over a short or protracted time period depending on circumstances and magnitude of the incident. The plan should identify responsibility of personnel having on-scene authority to evaluate the situation, assess the magnitude of the problem, and activate the emergency response plan.

A flowchart or decision tree posted in the facility or distributed as a pocket guide will assist in ensuring these first critical decisions are made.

Plan Activation and Response Mobilization

Normally, upon receiving initial notification of an incident involving release of a hazardous chemical into the environment, the individual having on-scene authority will assess the magnitude of the problem and potential threat to personnel, equipment, and the environment. If the situation warrants, the person having authority to invoke the emergency response plan will activate the plan, notify members of the Incident Management (Response) team and, as soon as possible, report to the Incident Commander. Situations must be assessed continually to develop an appropriate response strategy.

For each type of emergency, the plan should include a specific Emergency Action Checklist that may include the following:

- Nature of the emergency and ascertainment of any casualties.
- Location of the source, area of immediate risk, and potential for escalation.
- Procedures for raising the alarm; alerting local, provincial, and federal emergency services; and activating the appropriate warning system.
- Procedures for mobilizing appropriate resources to isolate the hazard as far as possible and to implement "first aid" remedial actions.

- Initiation of procedures for protection of personnel, plant, property, and the environment. Consideration of need to evacuate non-essential personnel and need for an emergency shut-down of operations. A detailed procedure for each foreseeable emergency.
- Implementation of procedures for protection of vital resources, continuity of critical services, and security of the property and records.
- Arrangement to account for personnel and to log events.
- Activation of emergency communications links. Notification to senior personnel, appropriate agencies, and neighbors as appropriate.
- Liaison with officers of the emergency services and with other senior personnel as they arrive on site, and cooperation as required.
- Call for further emergency assistance as may be necessary.
- Provisions to keep abreast of developments and ensure that the means of giving and receiving information, advice, and assistance function effectively, including these means related to public relations.
- Implementation of approved procedures for rehabilitation, as appropriate.

Response Action/Containment/Cleanup

This section should identify operational methods to manage an accidental spill or emission, as well as locations, capabilities, and limitations of equipment to be used. The emergency response plan should not provide detailed descriptions, but refer to separate operational guidelines (standard operation procedures) or detailed technical documents that apply to spill response operations.

The plan should list available on-site and off-site equipment, how it is to be accessed, and who has responsibility for it. The plan should also describe how people and equipment will get to the site, how they will be supported during the crisis, and how crews will be supplied for the duration of the incident.

EOC – Incident Command Post

During emergencies, response operations should be directed from an EOC, in concert with the Incident Command Post. The Incident Command Post is where the Incident Management (Response) Team resides, and generally has three characteristics:

- First line of direct supervision to field personnel (e.g., cleanup crews);
- Where response strategy, tactical decisions, and Incident Action Plans are formulated; and
- If a "jurisdictional unified command," command is shared among other jurisdictions such as local, provincial, and national; if a "functional unified command," command is shared among responding functions such fire, police, and ambulance.

A location for an Incident Command Post should be identified in the plan, as well as alternate locations for backup. Incident Command Post(s) must be located a safe distance away from the incident so as not to be subject to threat(s) of a spill.

A supporting EOC should be established where members of the Incident Management Team can seek additional information and support from the company, such as additional personnel, specialized analysis, technology, etc. A supporting EOC can be established in the company's regional office, headquarters, or both.

At the top of the hierarchy is a Crisis Management Team (also referred to in government as an Agency Executive). The Crisis Management Team is composed of the company's senior executive (e.g., Chief Executive Officer), senior Public Relations Officer, and senior Safety/Emergency Manager.

The purpose of the Crisis Management Team is to address and resolve issues on site that can be addressed only at the political/management level.

Evacuation

The purpose of this section is to ensure a safe and orderly emergency evacuation of each area or the entire plant. If required, the plan should also include procedures for notification and evacuation of the surrounding community. Planning for communities proceeds as a joint effort with local government and industry. The following elements must be considered when developing evacuation plans:

- Need for an alarm system capable of defining different areas and/or degrees of evacuation.
- Maps showing both primary and alternate evacuation routes.
- Designations of primary and alternate off-site assembly areas.
- Designations of employees responsible for checking the evacuation area and for taking personnel counts at the assembly area to ensure that the area has been safely evacuated.
- Designations of emergency escape equipment.
- Estimates of dispersions of worst and most likely gas/vapor releases to better define affected areas.
- Procedures to increase degree/extent of areas to be evacuated if the emergency situation escalates.

Evacuation decisions require knowledge by local authorities of the projected path of an air-borne chemical cloud, atmospheric dispersion rate, and ground-level concentrations. Ability to warn residents rapidly and reliably is also required. Use of appropriate and agreed-on warning systems such as sirens, emergency broadcast systems, mobile public address systems, and/or house-by-house contacts should be specified in the plan.

In some instances, it may be safer for citizens to remain inside with doors and windows closed rather than evacuate. A plume may move past homes very quickly. To address these situations, the plan should include appropriate procedures to warn downwind residents to shut off all circulation systems including heating, air conditioning, vent fans, and fireplaces. For example, in the Province of British Columbia, Canada, authority to issue mandatory evacuation orders is limited to the Fire Commissioner under Section 2 of the Fire Services Act. Evacuation plans should reflect this legislative authority.

Disposal of Spilled Contaminants and Debris

This section should include procedures for removal of recovered spilled material and contaminated soil or absorbents, and locations of temporary and/or permanent facilities for storage of contaminated materials. The various possible treatment and disposal options such as incineration, reprocessing, burying, etc., should be covered in the plan, along with procedures for obtaining required approvals or permits from government agencies. Details regarding disposal should be provided in a separate operation guideline or technical document.

Site Restoration/Remediation

This is the action taken to restore the affected environment to pre-spill conditions. The required degree of restoration will usually be determined via consultation between the party responsible for the spill and the government regulatory agency with primary responsibility in that situation.

Restoration can include physical removal of contaminated surface materials, high-pressure washing, chemical cleaning, replacement of contaminated beach materials, restocking of lakes, and bioremediation.

Post-Incident Evaluation

The plan should specify post-incident evaluations of emergency incidents, and describe the manner in which these evaluations are to proceed. The primary purpose of the post-incident evaluation is to identify from the spill response operation weaknesses or strengths in the emergency response plan, and to make appropriate corrections to the plan. Other uses of post-incident evaluation involve accounting, legal, and public relations matters.

The post-incident evaluation should include the following:

- Suitability of the organization structure, equipment, communication system, etc.
- Adequacy of training, alarm systems, contingency manual, control center, communication plans, security, spill containment and recovery procedures, monitoring, etc.
- Appropriateness of the emergency response plan, media communications plan, mutual aid plans, etc.

An emergency response plan should specify development of a written report regarding each incident, which should include:

- General description of the incident;
- Source and cause of the incident;
- Description of the response effort;
- Quantity of the spill and percent recovered;
- Itemized cleanup costs;
- Recommendations for prevention and mitigation measures; and
- Plans for upgrading emergency preparedness and response plans.

Training and Practice Drills

Training

Competency in responding to emergency incidents requires a complete understanding of the roles and duties of each person responsible on the team. Comprehensive training in use of emergency response equipment and personnel protection devices and tactics is necessary to ensure best response capability. Provision for training is an integral part of a complete contingency planning and implementation program. Initial training must be followed by periodic updates to maintain familiarity with all aspects of the plan.

This section of the plan should provide details of training programs for company personnel and mutual aid agencies involved in responding to an emergency. Amount, type, and frequency of training for each member of the team should be clearly specified.

Training should be provided at least annually and in the following situations:

- For new employees during their orientation period;
- For existing employees whose duties change;
- When new equipment or materials are introduced;
- When emergency procedures are revised; and
- When a drill indicates need for improvement.

It is wise to extend training as far as possible, even beyond plant gates. The plan should provide for familiarizing local agencies such as fire, police, and ambulance staff with potential hazards of the operation.

Practice Drills

This section should provide for periodic simulation exercises or practice drills. It is important to develop employee skills and evaluate adequacy of the contingency plan through use of mock exercises or drills. Objectives of a drill include evaluation of the following:

- Practicality of the plan (structure and organization);
- Adequacy of communications and interactions among parties;
- Emergency equipment effectiveness;
- Adequacy of first aid and rescue procedures;
- Adequacy of emergency personnel response and training;
- Public relations skills; and
- Evacuation and personnel count procedures.

Drills may be conducted in various forms such as desktop, on-site, or computer-synthesized. Complexity of drills may be increased as the response team gains proficiency. Drills must be frequent enough to ensure that the response team maintains proficiency in all aspects of the contingency plan. Drills should cover a variety of situations. It is also desirable to include mutual aid organizations and public emergency response organizations in these drills.

Plan Evaluation

This section of the plan should describe a step-by-step procedure by which the plan may be evaluated internally. The purpose of evaluation of an emergency response plan is to determine adequacy and thoroughness of the plan. Ease of understanding and use of the plan are also important considerations.

Plan Updates

A procedure should be in place to update the emergency response plan regularly so its call-out numbers and procedures are current. When an amendment to a plan occurs, the amendment date should be noted on the updated page of the plan. A senior employee of the company should be designated to ensure that all involved in the plan are notified of changes as soon as possible; those involved in the plan should be requested to verify that they have received the changes.

The most common amendments include telephone listings, response personnel, equipment, chemicals handled, emergency services available and resource lists.

Those involved in the plan should be notified immediately of any key changes, regardless of review period.

Appendices and Operational Guidelines

In an emergency situation, response personnel must have immediate access to vital information. Therefore, some information may be organized in easy-to-follow tables in the appendices. Types of information that may be included in appendices include:

- Response team and key company personnel callout list.
- Provincial, federal, and local government agencies; news media; and medical services telephone list.

- Community residents contact list.
- Facility maps, drawings, and product hazard list.
- Organization, roles and responsibilities.
- Emergency incident report forms.
- Emergency shutdown procedures.
- On-site mobile and emergency equipment list by location.
- Off-site mobile and emergency equipment list by location.
- Equipment inspection and maintenance schedules.
- Air- and water-quality monitoring procedures.
- Weather information contacts.
- Statutes/laws/regulations (e.g., spill reporting regulation).
- Emergency evacuation plan and escape routes.
- Cleanup contractors.
- Mutual aid contacts.
- Decontamination procedure.
- Material safety data sheets.
- Emergency response manual distribution list.

Integrating Biodiversity in Emergency Response Plans

Source: The Energy and Biodiversity Initiative, n.d.

The facility/industry must ensure that biodiversity issues are fully integrated with any planned response to emergency situations, and that where project-level plans are required, these are regularly reviewed.

If significant potential impacts on biodiversity could occur during or following significant accidents or emergencies (e.g., oil spills, uncontrolled fires), the facility/industry may undertake a more detailed risk analysis—identifying vulnerable resources and sites, and drawing up plans for emergency preparedness and contingency measures for each potential impact. This is particularly relevant if the petroleum operation is within or near a sensitive biodiversity area. Notably, H&S concerns may outweigh environmental and biodiversity protection during and after some emergency situations, and the correct balance should be determined case-by case.

The following information would be particularly useful in ensuring that biodiversity is adequately addressed in emergency response plan development processes:

- Protected areas and their legal status.
- National red-lists on vulnerable species.
- Biodiversity action plans for areas in question.
- Biodiversity resources at risk.
- Conservation organizations with which the organization cooperates.

- Environmental management guidelines and procedures published by professional and industrial bodies to which the organization subscribes.

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