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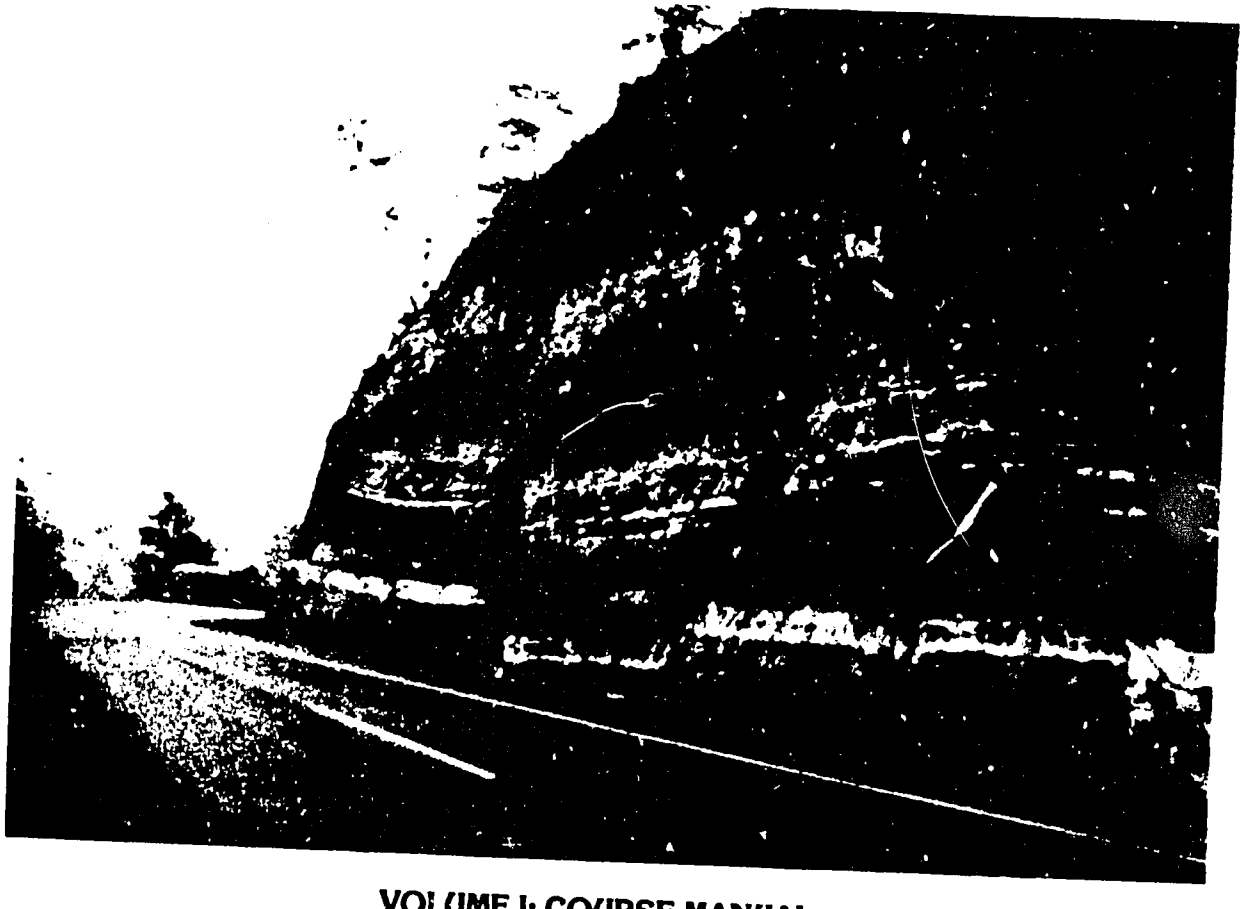
DEPARTMENT OF REGIONAL DEVELOPMENT
ORGANIZATION OF AMERICAN STATES

Natural Hazards Risk Assessment and Disaster Mitigation
Pilot Project in Latin America and the Caribbean Basin

COURSE ON THE USE OF NATURAL HAZARDS INFORMATION IN THE PREPARATION OF INVESTMENT PROJECTS



VOLUME I: COURSE MANUAL
VOLUME II: COURSE MANUAL ANNEXES

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ORGANIZATION OF AMERICAN STATES

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VOLUME II: COURSE MANUAL ANNEXES

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ORGANIZATION OF AMERICAN STATES

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V O L U M E I

C O U R S E M A N U A L

The Natural Hazards Pilot Project of the Department of Regional Development receives support from the United States Agency for International Development/Office of Foreign Disaster Assistance (USAID/OFDA). This manual is based on two pilot courses presented by the project in Merida, Venezuela, during 1986 with the collaboration of the InterAmerican Center for the Integral Development of Water and Land (CIDIAT).

PRESENTATION AND ACKNOWLEDGEMENTS

The Department of Regional Development (DRD) of the Economic and Social Area, General Secretariat, Organization of American States strives to disseminate the results of its technical cooperation not only to the immediate beneficiaries, but also to other potentially interested agencies and individuals. Based on experiences in direct technical assistance, training and field investigations, the DRD periodically draws together insights and lessons learned to produce technical publications. The present manual addresses the issue of natural hazards, which is of increasing concern to member states. It focuses on training, which is an essential element for dealing with the issue.

Two pilot courses on the use of natural hazards information in the preparation of investment projects and the preparation of this manual were carried out by DRD's Natural Hazards Risk Assessment and Disaster Mitigation Pilot Project in Latin America and the Caribbean Basin. The courses were designed for mid-level project planners to acquaint them with the source and content of natural hazards assessment information and its application in the economic analysis of sectorial investment projects. The manual is a summary guide for future course presentations and describes the organizational, administrative, academic and curriculum aspects of the course.

The DRD wishes to thank the institutions and individuals whose efforts made the pilot courses and this manual possible. Special recognition is due to the InterAmerican Center for Integral Development of Water and Land (CIDIAT) for co-sponsoring the course and for the participation of its staff; to the United States Agency for International Development/Office of Foreign Disaster Assistance for their financial support and sustaining interest; to Los Andes University, the Special Commission for the Prevention of Seismic Risks of the State of Merida, Venezuela, the United States Geological Survey and the World Meteorological Organization for their donation of staff time and documents; and to the Government of Venezuela for its scholarship support.

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manual were completed under the direction of Stephen Bender. Roger Amisial served as coordinator of activities between the DRD and CIDIAT. The coordination of the pilot courses and the drafting of the manual were carried out by Boris Utria. The coordination of the pilot courses for CIDIAT was carried out by Ricardo Smith and Jose Perez Roa. DRD senior specialists Salvador Archondo and Richard Saunier participated in the design and presentation of the courses. Enrique Bello prepared the translation and production of the manual.

Kirk P. Rodgers
Director
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COURSE ON THE USE OF NATURAL HAZARDS INFORMATION
IN THE PREPARATION OF INVESTMENT PROJECTS

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INTRODUCTION

During 1983, in response to the increasing requests by its member states, the Area for Economic and Social Affairs, General Secretariat of the Organization of American States through its Department of Regional Development (DRD) and with support from the United States Agency for International Development/Office of Foreign Disaster Assistance (USAID/OFDA) initiated the "Natural Hazards Risk Assessment and Disaster Mitigation Pilot Project in Latin America and the Caribbean Basin" (NHP).

The principal objective of the NHP is to promote the use of natural hazards information in the integrated development planning process and the mitigation of disasters in the OAS member states. Although the dissemination of such information through formal training courses was not included among the initially programmed activities of the NHP, the project's rapidly accumulated field experience made evident the need to train professionals in the subject matter. Upon verifying the absence of relevant training programs in terms of orientation, content and instructional language, the NHP obtained in 1985 additional support from USAID/OFDA to develop a course on the use of natural hazards information in the preparation of investment projects. The process of designing, testing and revising the course curriculum was carried out through two pilot courses presented in Merida, Venezuela in 1986 in collaboration with the InterAmerican Center for the Integral Development of Water and Land (CIDIAT). Both pilot courses were successfully completed and provided training to a total of 42 professionals from 18 Latin American and Caribbean countries.

This manual is a result of that effort and is intended as a guideline document. It has been designed to provide prospective sponsoring institutions with necessary information to program and present national or regional courses on the use of natural hazards information in the preparation of investment projects. While the course curriculum presented in this manual draws from the two pilot courses that where presented in Merida and thus has a particular scope and orientation, it is expected that the manual will be of value in subsequent natural hazards and development planning courses. The manual not only provides comprehensive information about the organizational and administrative aspects involved in presenting such courses, but also provides a working structure upon which to design a course suited to the sponsoring organization's needs.

The present format, content, and orientation of the course, as presented in this manual, have the following general and specific training objectives:

General objectives:

i.- To create an awareness among Latin American and Caribbean professionals of the importance of considering natural hazards in the integrated development planning process.

ii.- To provide training on the use of natural hazards information in the preparation of sectorial investment projects to mid-to-high level professionals on a national and/or interAmerican basis.

Specific training objectives:

i.- Provide information to the participants concerning the sources and types of existing natural hazards information.

ii.- Train the participants in the identification, collection, generation, and technical analisis of specific natural hazards information.

iii.- Train the participants in economic and social analysis of the possible impact of specific natural and corresponding disaster mitigation measures.

iv.- Train the participants in the use of specific natural hazards information in the integrated development planning process and governmental decision making.

v.- Train the participants in the use of specific natural hazards information in the formulation and evaluation of investment projects.

vi.- Train the participants for work in the subject of natural hazards management in multi-disciplinary groups.

The course covers a program of four weeks duration which includes approximately 85 hours of formal instruction, 25 hours of classroom exercises and 30 hours of technical field trips. The formal instructional component includes thematic units of a technical-scientific nature covering relevant natural hazards in the countries of the two regions, thematic units covering methods and techniques for the analysis of natural hazards information, and thematic units covering the formulation and evaluation of investment projects. The classroom exercises component includes the execution of activities covering specific analytical methods and techniques, and the development of a final course case study. The technical field trip component includes visits to observe the presence of specific natural hazards and to the subject area of the final course case study.

This manual is organized in two volumes and in a modular fashion to facilitate its use in the different aspects involved in staging a course. **VOLUME I: COURSE MANUAL** presents the complete course and is divided into three parts. The first part, Organizational and Administrative Aspects, presents a summary of key aspects and recommendations for the organization of the course. The second part, Principal Academic Aspects, presents a summary of relevant academic norms and procedures. Finally, the third part, Course Curriculum, presents a detailed description of all the academic units of the course, and provides information on each unit's content, suggested classroom/homework exercises, recommended instructor's readings, additional instructional materials, additional suggested bibliography, and sample exam questions. **VOLUME II: COURSE MANUAL ANNEXES** contains selected supporting material for the different sections of Volume I.

PART I.- ORGANIZATIONAL AND ADMINISTRATIVE ASPECTS

PART I.- ORGANIZATIONAL AND ADMINISTRATIVE ASPECTS

This part of the manual is divided into nine sections which contain the principal organizational and administrative aspects of the course, and presents guidelines and recommendations to assist in the planning and staging of the course.

1.- SELECTION OF COURSE SITE:

In selecting a site for the course it is recommended that the principal criteria be the existence of an academic institution or a government planning agency that can assume a sponsorship role and assume all planning and operational responsibilities in the presentation of the course. In addition to that criteria it is suggested that the following guidelines be taken into consideration:

a.- Overall logistic considerations

1.- availability of classroom installations
2.- availability of housing accommodations
3.- availability of local transportation and communications systems
4.- linkages to regional and national transportation and communications systems
5.- availability of office services (secretarial support, supplies, reproduction, etc.)
6.- availability of medical facilities

b.- Academic support considerations

1.- proximity to a university with strong natural and physical sciences program
2.- availability of research/library facilities
3.- availability of qualified local professionals that can participate as course instructors and/or case study resource personnel

c.- Natural hazards, local climate, and course case study considerations

1.- existence of observable local natural hazards phenomena
2.- existence of moderate climatic conditions (at least during the duration of the course)
3.- proximity to the site of the course case study

It is also recommended that any course site, field trip location, facilities and personnel considered for the course be visited by the principal sponsor and/or organizing institution prior to making any final decision.

2.- SELECTION OF COURSE DATES:

The selection of dates for presenting the course should be done observing the local activities calendar (holidays, elections, carnivals, etc..) to ensure that non-conflicting dates are chosen. If the course is to be offered to government officials on a region-wide basis it is recommended not to present the course in the first quarter of the (fiscal and/or calendar) year as government officials from most Latin American and Caribbean countries will not be able to obtain travel clearances until national budgets and operations programs have been approved. The course should be offered at least once every two years in order to form a cadre of course alumni and cover training needs presented by turnovers in staffing.

3.- SELECTION, CONTRACTING AND TRAVEL ARRANGEMENTS OF COURSE INSTRUCTORS AND RESOURCE PERSONNEL:

While it is expected that the selection and contracting of instructors for the course will be subject to the policies and procedures of the sponsoring institution, it is recommended that their selection and contracting be done observing the following guidelines:

a.- Staffing needs

The number of instructors and resource personnel for the course should be limited to a maximum of 10 professionals. The reasons for this are the necessity to minimize problems in the coordination and orientation of the course, maximize the interaction between instructors and participants, and, minimize costs.

b.- Professional qualification requirements

1.- academic credentials on the subject to be presented
2.- practical experience on the subject to be presented
3.- general and specific teaching experience

c.- Selection and contractual options for course instructors

Based on the experience of the first two pilot courses, it is recommended that the maximum use possible of local and regional instructors be suplemented by national and international professionals. The reasons for this are to encourage the establishment of a local cadre of instructors for continued course offerings, take advantage of local experiences, and simplify course management. Sponsor institutions, however, are urged to pay special attention to each country's particular regulations on the hiring of government and universities employees, and on the different programs for inter-institutional cost-free loan of professionals between government officials and university faculty and special non-profit training programs and/or international technical assistance programs. In general, the basic contractual options that are most likely to be found are:

1.- consultancy contracts with individual professionals
2.- inter-institutional agreements with professionals; and,
3.- participation of professionals from local co-sponsoring institutions

It is further suggested that the selection and confirmation of instructors be finalized at least three months in advance of the starting date of the course in order to allow instructors ample time to prepare their presentations. All participating instructors should be provided with a complete course curriculum (Part III of this manual) so that they can have detailed information as to the course objectives, contents and orientation.

d.- Travel arrangements for course instructors

It is recommended that all necessary travel arrangements (visas, tickets, terminal expenses, hotel reservations, etc.) be completed either by the sponsoring institution or by a collaborating organization. The direct remittance of money to instructors to arrange their own travel is an alternative.

4.- IDENTIFICATION, SELECTION AND TRAVEL ARRANGEMENTS OF COURSE PARTICIPANTS:

While it is expected that the selection of participants and processing of all the necessary arrangements for their participation in the course will be subject to the policies and procedures of the sponsoring institution, it is recommended that the following guidelines be observed:

a.- Enrollment

The number of participants in any course should be limited to a maximum of 24 professionals. The reasons for this are the necessity to maximize the interaction between instructors and participants, maximize the individual participation and assimilation of the participants in the lectures and workshop sessions, and minimize problems in the organization and execution of the course.

b.- Course announcement

A key factor in attracting qualified candidates to the course will be the timely announcement of the course and the distribution of application materials. Course announcements should include the necessary information about the content and orientation of the course, general conditions and requirements, scholarship terms (if applicable), and other relevant issues. If the course is to be offered on a region-wide basis, it is recommended that the announcement be published at least six months prior to its initiation date. It is suggested that the announcement of the course be done through the following channels and media:

1.- national offices or official contacts of the sponsoring institutions
2.- national, regional, and local government development planning and sectorial agencies
3.- national, regional, and local natural hazards research agencies and institutes
4.- national, regional, and local universities
5.- natural hazards, natural resource and development planning, and specialized natural sciences magazines and publications
6.- international development assistance agencies

c.- Selection criteria

The selection criteria that were used in the first two pilot courses, and that are recommended for future course offerings are:

1.- candidates must have a university degree;
2.- candidates must have five to seven years of practical experience at a mid-to-high level position with a governmental sectorial, regional or national development planning agency;
3.- candidates must have basic project formulation and evaluation experience or a solid technical background in project identification and preparation.
4.- participants must be in good physical and mental health; and,

as an <u>optional requirement</u>,

5.- selected candidates must prepare and submit a brief case study paper on a natural hazards issue of relevance in their respective countries covering one of the following three topics:

1.- assessment of natural hazards as part of the investment project formulation process;
2.- formulation of a specific project which includes the selection and evaluation of natural hazards mitigation measures; and,
3.- analysis of a natural hazard event, the analysis of the adopted post-disaster mitigation measures, and the formulation of a reconstruction program.

In addition to the above individual selection criteria, it is recommended that the following general criteria be observed:

1.- the group of selected participants should form a balanced multi-disciplinary group, including natural, economic and social sciences, in as far as the participants meet the above individual criteria. To the extent possible, participants should include those responsible for setting hazard mitigation policies.
2.- unless the course is intended as an international course, the group of selected participants should represent a balanced cross-section of local sub-national and national agencies.

d.- Travel arrangements

It is recommended that all travel arrangements (visas, tickets, terminal expenses, hotel reservations, etc.) be done either by the sponsor or co-sponsoring institution. The direct remittance of money to participants to arrange their own travel is not recommended.

e.- Medical insurance

It is recommended that medical insurance be provided either by the sponsor or co-sponsoring institution. The direct remittance of money to participants to arrange their own insurance coverage is not recommended.

f.- Disbursement of scholarships

If applicable, it is recommended that the disbursement of scholarship funds for subsistence be done at the time of registration at the course.

5.- COURSE CASE STUDY MATERIAL:

Based on the experience of the two first pilot courses, it is considered essential that the case study to be used in the course be developed around a real development project in the geographical area where the course is to take place. The reasons for this are the necessity to combine theoretical information with practical field observations, and the necessity to have sufficient information and resource persons with first-hand experience on the project.

In the two first pilot courses, the case study used was the proposed "Merida Massive Transport System -M.M.T.S.," which, if built, would be subject to the natural hazards of the area. While much discussion exists at the local level on whether sufficient research has been done to assess the hydrologic and geologic hazards present, the necessary investment and the multisectorial economic development benefits that are attributed to it presented an interesting scenario to test the assimilation of natural hazards information and project formulation skills of the participants.

In that context it is recommended that the selection of a case study for the course observe the following guidelines:

a.- Recommended case study topics

1.- agroindustrial projects and support infrastructure with critical rural, agricultural and economic (regional/national) development implications:

1.1.- large scale food production systems
1.2.- large scale water management and irrigation systems
1.3.- regional food storage systems
1.4.- regional highway infrastructure

2.- industrial projects with critical social and economic (regional/national) development implications:

2.1.- labor-intensive basic industry complexes
2.2.- high cost capital-intensive industrial complexes
2.3.- industrial complexes for the production of critical export products
2.4.- industrial complexes for the production of capital goods

3.- energy sector projects with critical social and economic development and national self sufficiency implications:

3.1.- hydro-electric power plants
3.2.- thermal and nuclear power plants
3.3.- petroleum refineries
3.4.- fuel storage facilities

4.- service sector projects with critical social and economic development implications:

4.1.- large and medium scale medical facilities
4.2.- large and medium scale educational facilities
4.3.- high cost essential communications facilities

5.- high cost transport systems and infrastructure with critical urban and economic development implications:

5.1.- national and international airports
5.2.- fixed rail mass transit systems
5.3.- sea and river ports
5.4.- regional and national highways

b.- Basic information to be gathered about the case study project and supplied to participants

1.- financial project data:

1.1.- capital investment
1.2.- detailed project cash-flow
1.3.- financing sources and conditions
1.4.- operating expenses

2.- technical project data:

2.1.- physical lay-out of structures and buildings
2.2.- engineering specifications
2.3.- equipment and machinery
2.4.- operating systems and procedures
2.5.- power and fuels supplies

3.- economic project data:

3.1.- benefits (local,regional and national)
3.2.- costs (local,regional and national)
3.3.- externalities

4.- social project data:

4.1.- benefits (local,regional and national)
4.2.- costs (local,regional and national)
4.3.- externalities

c.- Natural hazards information to be gathered about the case study area and supplied to participants

1.- general data (applicable to all case studies):

1.1.- natural resources
1.2.- geographic characteristics
1.3.- climatic characteristics
1.4.- special local features

2.- general atmospheric and hydrologic hazards information (when applicable):

2.1.- event information
2.2.- hazards information
2.3.- risk information
2.4.- vulnerability information

3.- flood hazard information (when applicable):

3.1.- event information
3.2.- hazards information
3.3.- risk information
3.4.- vulnerability information

4.- geologic hazards information (when applicable):

4.1.- event information
4.2.- hazards information
4.3.- risk information
4.4.- vulnerability information

5.- other hazards information (when applicable):

5.1.- event information
5.2.- hazards information
5.3.- risk information
5.4.- vulnerability information

d.- Case study structure and schedule

The case study should be structured in two different phases: (1) initial case study presentation to course participants; and, (2) case study development by course participants.

The first phase should total no more than six hours of formal presentation time, and another six hours of field visits. The second phase of the case study should cover a minimum of ten hours of consecutive supervised workshop sessions. It is suggested that the following schedule totalling a minimum of 24 hours be adhered to:

1st. week:	1 hour presentation lecture 6 hours field trip (Saturday)
2nd. week:	1 hour presentation lecture
3rd. week:	1 hour presentation lecture
4th. week:	1 hour presentation lecture 14 hours case study development

While field visits to the case study site are considered essential during the first phase of the case study, further field trips during the second phase are optional.

e.- Case study coordination and resource people

The case study should be coordinated by one of the instructors of the course. Preference should be given to instructors that will participate in the entire course.

The presentation and development of the case study should be supported by local professionals who have first-hand knowledge of the project, and who can act as resource persons. It is recommended that these professionals be directly involved in the project and, as needed, be supplemented by professionals from local universities (faculty members) and from government planning and sectorial agencies.

f.- Case study working groups

The case study should be developed through the establishment of multidisciplinary working groups drawn from the participants in the course. These groups should be formed by the beginning of the second week so that they have at least three weeks to carry out the necessary research, preliminary discussions, and progressive preparation of the required case study group report.

g.- Case study evaluation

It is recommended that the participants' performance in the case study be evaluated through the preparation of written group reports and oral presentations. The actual contents of the written reports should be defined according to the particular case study and the resource material made available, but a fairly detailed document should be required from the different groups. The oral presentations should be brief in nature and limited to the presentation of each group's conclusions and recommendations, followed by a discussion with all participants.

6.- TECHNICAL FIELD TRIPS:

It is recommended that technical field trips in which participants can observe natural phenomena and their development implications be used to supplement theoretical material and classroom work of the course. While additional field activities are optional, a one day technical field trip directly related to the course case study and a more extensive weekend field trip focusing on several natural hazards are recommended.

In addition to a one day technical field trip to the site(s) associated to the Merida Massive Transport System case study, the two first pilot courses included a major two and a half days technical field trip in which participants travelled to the central flatlands of the country to observe a regional flood control system that covers some 25 000 hectares of extension. During the trip to and from the flatlands, the course participants had the opportunity to observe various natural hazard prone areas (seismic faults, landslides and mass-movements) in the Andean range.

It is suggested that the technical field trips, and particularly the major trip, be carried out within the course structure observing the following guidelines:

a.- Organizational aspects

1.- The sponsoring institution should be completely responsible for the organization of the field trips.
2.- The course instructors of the relevant thematic units should participate in the field trips.
3.- The field trip leaders should be local professionals with first-hand knowledge of the area and the natural hazard problems.
4.- The participants should receive a briefing prior to the field trips which emphasizes on the observable natural hazards and the development planning issues of the trips.
5.- The participants should receive a briefing on the form and content of the required field trip reports.

b.- Natural hazards considerations (major field trip)

1.- existence of major observable natural hazards conditions
2.- existence of economic and human activities in the areas to be visited
3.- existence of some type of mitigation programs or measures (projected or already in place)

c.- Logistic considerations

1.- easy accessibility of the area to be visited
2.- safe and healthy environment
3.- existence of adequate accommodations and food supplies (major field trip)

7.- COURSE BUDGET:

Due to the differences that exist in terms of costs in the different countries, it is not possible to predetermine an overall budget for proposed course offerings. Likewise, the number of participants and instructors, and the characteristics of the field trips will affect the total course cost. In spite of such differences in costs the following items can be pointed out as being the main budget components:

a.- Participants

1.- travel and terminal expenses
2.- subsistence allowance

b.- Instructors (contracted)

1.- honorarium
2.- travel and terminal expenses
3.- per-diem allowance

c.- Training activities and instructional material

1.- administrative and organizational expenses
2.- photocoping
3.- field trips
4.- telephone and telex

Annex I.6.1 presents a detailed sample budget sheet for use in planning the course.

8.- HANDLING OF INSTRUCTIONAL MATERIALS AND DOCUMENTS FOR DISTRIBUTION

The adequate handling and distribution of instructional materials and handouts is an important component of the course. Materials and documents for distribution should be submitted by instructors and participants (individual case studies) which should be reviewed and reproduced. The following guidelines for the handling of such materials and documents are recommended:

a.- Instructional materials

1.- Instructors and resource persons should submit materials for distribution at least one week before their respective presentations or workshops take place.

2.- Instructors and resource persons should be required to submit material following a predetermined format to facilitate handling and reproduction.

b.- Participants' individual case studies

1.- Participants should be requested to submit their respective individual case studies during registration at the beginning of the course.
2.- Participants should be requested to submit their respective individual case studies following a predetermined format to facilitate revision and reproduction.

9.- GENERAL ORGANIZATIONAL SCHEDULE:

The presentation of the course will require the execution of a number of programming activities which will have to be coordinated and completed in a timely fashion. While the specific components of that organizational process will tend to vary with the course structure, site and dates, **Table 1** presents a general schedule to be used as a guideline.

TABLE 1.- GENERAL ORGANIZATIONAL COURSE SCHEDULE

	ACTIVITIES	****** PLANNING HORIZON BEFORE THE COURSE STARTS (months) *****												
		12	11	10	9	8	7	6	5	4	3	2	1	0
CURSE	Identification of course objectives and content				XXXXXX									
	Identification of potential course sites				XXX	XXX								
	Visits and selection of course site					XXXXXXX	XXX							
	Identification, visits and selection of course field trip sites					XXXXXXX	XXX							
	Final definition of course objectives and content						XXXXXXX							
INSTIT.	Identification of instructors					XXXXXXX	XXXXXXX	XXXXXXX	XXXXXXX					
	Selection of instructors								XXXXXXX	XXXXXXX				
	Travel and hotel arrangements (a)										XXXXXXX			
PARTICIP.	Course announcement						XXXXXXX	XXXXXXX	XXXXXXX	XXX				
	Candidate application (b)							XXX	XXXXXXX	XXX				
	Selection of participants (b)									XXXXXXX				
	Notification to participants (b)										XXX			
	Travel and hotel arrangements (a)										XXXXXXX	XXX		
MATERIALS	Instructors' lecture materials											XXXXXXX	XXXXXXX	
	Other materials (videos, films, etc.)											XXXXXXX	XXXXXXX	
	Handouts revision and editing											XXXXXXX	XXXXXXX	
	Participant case studies											XXX	XXXXXXX	
	Reproduction of materials												XXXXXXX	

Notes: (a) Subject to the tourist/holiday schedule of the course site city.
(b) Subject to the course being national or regional, and to whether participants will be required to present a case study.

SUMMARY OF THE ANNEXES TO PART I (*)

I.6.1.- Course Budget Format Sample

Note:(*) Refer to **VOLUME II: COURSE MANUAL ANNEXES**

Numeration of annexes corresponds to the specific section to which they are related and, thus, the numeration used will not necessarily be consecutive.

PART II.- PRINCIPAL ACADEMIC ASPECTS

PART II.- PRINCIPAL ACADEMIC ASPECTS

This part of the manual is divided into two sections which contain the principal academic aspects of the course, and is intended as a guide to assist in the organization and determination of academic standards for the course.

1.- ACADEMIC NORMS:

While it is expected that the implementation of a set of academic norms will be subject to existing policies of the sponsoring institution, it is recommended that the following guidelines be observed:

a.- Individual participation

Participants are expected to actively participate on a full-time basis in all the activities of the course, including the preparation of homework assignments, classroom presentations and exercises, field trips, examinations and the course case study.

b.- Course completion (evaluation of participants)

The approval of the course, and thereby the granting of an "APPROVAL CERTIFICATE" to an individual participant should be subject to the following conditions:

1.- attendance at no less than 90 percent of all course activities; and,

2.- obtaining at least a 75 percent grade point average for the four examinations, graded homework, trip reports, and case study workshop.

Participants who do not meet the class attendance criteria but who have a 75 percent or above grade point average should be entitled to receive a "PARTICIPATION CERTIFICATE."

Participants who meet the 90 percent class attendance criteria but who have a grade point average between 50 and 75 percent should also be entitled to receive a "PARTICIPATION CERTIFICATE."

Participants with less than a 50 percent grade point average should not be entitled to a course certificate.

2.- COURSE EVALUATION BY PARTICIPANTS:

While the sponsoring institutions might already have a course evaluation systems, the following evaluation system and questionnaires are recommended for use in the course:

a.- Evaluation system

The proposed evaluation system is composed of two questionnaires. The first one is to be completed by participants at the end of the second week of the course, and the second one at the end of the course. Dividing the evaluation process in two separate units is recommended as a means to achieve a greater clarity in the evaluation process.

b.- Evaluation questionnaires **(See Annex II.2.1).**

3.- CLASS SCHEDULE:

While it is expected that future proposed courses will undergo changes in structure and sequence to accommodate special country and/or regional interests, **Table 2** presents a class schedule as a basis for course planning.

Note should be made with respect to the lecture hours devoted to the "presentation of participant's case studies" (See **Table 2**). These units are included in the proposed course schedule but are not presented in the COURSE CURRICULUM section of this manual (**Part III**). The reasons for that is that they do not constitute formal lectures, and that requiring case studies from participants is an optional feature within the recommended course "core requirements."

TABLE 2.- RECOMMENDED CLASS SCHEDULE

"sponsoring institution" "co-sponsoring institution"

COURSE ON EVALUATION OF NATURAL HAZARDS INFORMATION IN THE PREPARATION OF INVESTMENT PROJECTS

City, Country (date)

* * * * C L A S S S C H E D U L E * * * *

F i r s t W e e k

time	MONDAY (mm/dd)	TUESDAY (mm/dd)	WEDNESDAY (mm/dd)	THURSDAY (mm/dd)	FRIDAY (mm/dd)	SATURDAY (mm/dd)
8:00	Registration					
9:00				Introduction to geologic hazards		F I E L D
9:05		Environmental management and natural hazards	Flood hazards		Seismic and volcanic hazards	
10:00	COURSE INTRODUCTION			(Unit #6)		
10:15				Seismic and volcanic hazards		
	(Unit #1)	(Unit #3)	(Unit #5)		(Unit #7)	T R I P
11:15						
14:00						
15:00						I
15:05	Natural hazards and the process of integrated development planning	Atmospheric and hydrologic hazards: drought and desertification	Flood hazards	Seismic and volcanic hazards	WEEKLY EXAM	
16:00			(Unit #5)			(Unit #9)
16:15			Presentation of participant case studies	(Unit #7)	Course case study - Part I	
17:15	(Unit #2)	(Unit #4)			(Unit #8)	

rev. x - mm.dd.yy

TABLE 2.- RECOMMENDED CLASS SCHEDULE (Cont.)

"sponsoring institution" "co-sponsoring institution"

COURSE ON EVALUATION OF NATURAL HAZARDS INFORMATION IN THE PREPARATION OF INVESTMENT PROJECTS

City, Country (date)

* * * * C L A S S S C H E D U L E * * * *

S e c o n d W e e k

time	MONDAY (mm/dd)	TUESDAY (mm/dd)	WEDNESDAY (mm/dd)	THURSDAY (mm/dd)	FRIDAY (mm/dd)
8:00 9:00 9:05 10:00 10:15 11:15	Mass-movement hazards (Unit #10)	Land use and soil degradation hazards (Unit #11)	Multiple geologic hazards and lifeline network mapping (Unit #12)	Multiple geologic hazards and lifeline network mapping (Unit #12)	Natural hazards information systems and sources (Unit #13) First course evaluation by participants
14:00 15:00 15:05 16:00	Land use and soil degradation hazards (Unit #11)	Land use and soil degradation hazards (Unit #11)	Multiple geologic hazards and lifeline network mapping (Unit #12)	Natural hazards information systems and sources (Unit #13)	WEEKLY EXAM
16:15 17:15	Presentation of participant case studies	Presentation of participant case studies	Presentation of participant case studies		Course case study - Part II (Unit #14)

rev. x - mm.dd.yy

TABLE 2.- RECOMMENDED CLASS SCHEDULE (Cont.)

"sponsoring institution" "co-sponsoring institution"

COURSE ON EVALUATION OF NATURAL HAZARDS INFORMATION IN THE PREPARATION OF INVESTMENT PROJECTS

City, Country (date)

* * * * C L A S S S C H E D U L E * * * *

T h i r d W e e k

time	MONDAY (mm/dd)	TUESDAY (mm/dd)	WEDNESDAY (mm/dd)	THURSDAY (mm/dd)	FRIDAY (mm/dd)	SAT./dd SUN./dd
8:00 – 10:00	Economic planning and natural hazards (Unit #15)	General economic analysis theory (Unit #17)	Project formulation and natural hazards (Unit #19)	Project formulation and natural hazards (Unit #19)	Technical field trip II briefing (Unit #21)	FIELD TRIP II
10:15 – 11:15	Multicriteria Analysis (Unit #16)				(10:15 - 12:15) WEEKLY EXAM	
14:00 – 16:00	Multicriteria analysis and integrated development planning (Unit #16)	General economic analysis theory (Unit #17)	Project formulation and natural hazards (Unit #19)	Review of probability theory (Unit #20)	TECHNICAL FIELD TRIP II (Unit #22)	(Unit #22)
16:15 – 17:15		Course case study-Part III (Unit #18)	Presentation of participant case studies			

rev. x - mm.dd.yy

TABLE 2.- RECOMMENDED CLASS SCHEDULE (Cont.)

"sponsoring institution" "co-sponsoring institution"

COURSE ON EVALUATION OF NATURAL HAZARDS INFORMATION IN THE PREPARATION OF INVESTMENT PROJECTS

City, Country (date)

* * * * C L A S S S C H E D U L E * * * *

F o u r t h W e e k

time	MONDAY (mm/dd)	TUESDAY (mm/dd)	WEDNESDAY (mm/dd)	THURSDAY (mm/dd)	FRIDAY (mm/dd)
8:00 9:00					Final course evaluation by participants
9:05 10:00 10:15 11:15	Natural hazards and project evaluation (Unit #23)	Natural hazards and project evaluation (Unit #23)	COURSE CASE STUDY WORKSHOP (Unit #24)	COURSE CASE STUDY WORKSHOP (Unit #24)	
14:00 15:00					CLOSING SESSION
15:05 16:00 16:15 17:15	Natural hazards and project evaluation (Unit #23)	COURSE CASE STUDY WORKSHOP (Unit #24)	COURSE CASE STUDY WORKSHOP (Unit #24)	WEEKLY EXAM	

rev. x - mm.dd.yy

SUMMARY OF THE ANNEXES TO PART II (*)

II.2.1.- Course Evaluation Questionnaires

Note: (*) Refer to **VOLUME II: COURSE MANUAL ANNEXES**

Numeration of annexes corresponds to the specific section to which they are related and, thus, the numeration used will not necessarily be consecutive.

PART III.- COURSE CURRICULUM

PART III.- COURSE CURRICULUM

This part of the manual is divided into 24 sections, each of which corresponds to a thematic unit of the course curriculum. While the course curriculum presented herein has been tested in the first two pilot courses presented in Merida, Venezuela, during 1986, its components, structure and sequence should be revised and adjusted for future course offerings to ensure that it fulfills the specific course interests and intended orientation.

The 24 unit summaries are presented following a common format to facilitate their understanding and include, when applicable, the following information:

1.- Unit sequence number and title

2.- Objective

3.- Time allotment

4.- Contents

5.- Classroom and/or homework exercises

6.- Recommended instructor's reading

7.- Additional instructional material

8.- Additional suggested bibliography

9.- Sample exam questions

Selected support materials for the Course Curriculum section of this manual are presented in **Vol II.-COURSE MANUAL: ANNEXES.**

UNIT #1: COURSE INTRODUCTION

OBJECTIVE: Introduction of the course, the sponsoring organizations and the collaborating institutions. Explanation of the course objectives, structure, schedule, and requirements.

TIME ALLOTMENT: 2 hours

CONTENTS:

1.- Description of the institutions that are participating in the organization and presentation of the course

2.- Description of the evolution of the course

3.- Presentation of the course objectives

Within an integrated development planning context and through an interdisciplinary approach, the basic objectives of the course are:

a.- to familiarize the participants with available information on natural hazards, including an understanding of its generation, content, orientation, and potential uses in development planning activities;

b.- to generate an awareness among the participants concerning the importance of natural hazard management in development planning;

c.- to familiarize the participants in the use of natural hazards information in the formulation and evaluation phases of the preparation of investment projects; and,

d.- to expose the participants to a multidisciplinary working group and to provide them the opportunity to develop the necessary technical attitude and language to address natural hazards and development planning issues in such groups.

4.- Explanation of the course structure

a.- principal weekly topics

b.- brief description of the course units

c.- classroom and homework exercises

d.- participants case studies

e.- course case study

f.- technical field trips

g.- evaluations systems (examinations, classroom and homework exercises, individual case studies, course case study, and field trip reports)

h.- academic requirements (attendance, approval, etc.)

i.- course evaluation by participants

5.- Question and answer period

END OF UNIT #1

UNIT #2: NATURAL HAZARDS AND THE PROCESS OF INTEGRATED DEVELOPMENT PLANNING

OBJECTIVE: Introduction of terms and concepts relevant to natural hazards issues within an integrated development planning perspective

TIME ALLOTMENT: 3 hours

CONTENTS:

1.- Natural Hazards

a.- types of natural hazards

1.- geologic
2.- atmospheric
3.- hydrologic

b.- relationship between disciplines and natural hazards information

1.- producers
2.- users

c.- basic types of information about natural hazards and the components which characterize those hazards

1.- event: presents natural phenomena in terms of geographic location and historic records

2.- hazard: presents estimated recurrence and/or geographic locations of possible and/or probable events

3.- risk: presents concepts of geographic location, magnitude, return period (frequency), and identification of event impacts

4.- vulnerability: presents risk information plus a determination of expected losses due to an event

d.- concepts related to the terms, "hazard mitigation," "hazard prevention," and "hazard reduction"

1.- the modification of the magnitude or frequency of an event
2.- the reduction of the hazard posed by an event
3.- the lessening of vulnerability of population and property at risk from an event
4.- the use of preparedness and emergency response measures to reduce losses should an event occur

2.- The "vicious cycle" of disasters

Reflecting on the natural disaster occurrences and hazard management activities that come to pass in most countries, a vicious cycle is discernable that does not permit the design and implementation of adequate hazard mitigation. The principal factor is the lack of integration between the different hazard management activities and the development planning process. The principal elements of that cycle are **(See Annex III.2.1)**:

a.- occurrence of a disaster;

b.- emergency response;

c.- rehabilitation (recovery);

d.- reconstruction;

e.- mitigation and prevention;

f.- emergency preparedness; and,

g.- pre-event anticipation with or without monitoring and alert.

3.- Principal protagonisc in natural hazards management

There are three general protagonist groups which are different in nature but through whose efforts effective hazard management can take place:

a.- scientific research (universities, research centers, government agencies, etc.)

b.- disaster preparedness and emergency response entities

c.- integrated development planning and sectorial agencies

4.- Principal elements of an integrated development planning process

a.- evaluation of natural resources, including natural hazards, and of social, economic and institutional aspects

b.- definition of development strategies and identification of regional and sectorial investment projects

c.- formulation of investment projects and their implementation

5.- Important aspects of natural hazards information

a.- relationship between the type of information and the uses to which it will be put in terms of priorities, presentation, terminology, etc.

b.- geographic, administrative, and political focus

c.- temporal context

d.- geographic scale

e.- content

f.- use of the information in the different stages of an integrated development planning process

6.- Priority areas in natural hazards research and disaster management

a.- prevention and mitigation within an integrated development planning context

b.- increased attention to atmospheric and hydrologic events concurrent with geological event research

c.- development of natural hazard assessment methodologies for use within the planning process

d.- restructuring of the project formulation process to amplify use of hazards information

e.- training of development planners, particularly project formulation specialists, in the use of natural hazards information

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RECOMMENDED INSTRUCTOR'S READINGS:

1.- **Bender, Stephen O.**, (1985). "Disaster Mitigation as Part of Integrated Regional Development Planning," in Proceedings of the International Conference on Disaster Mitigation Program Implementation, College of Architecture and Urban Studies, Virginia Polytechnic Institute and State University. **(See Annex III.2.2)**

2.- **Bender, Stephen O.**, (1985). "Natural Hazards Assessment in Integrated Regional Development." OAS/Dept. Regional Development. **(See Annex III.2.3)**

ADDITIONAL SUGGESTED BIBLIOGRAPHY:

Cuny, Frederick, (1983). Disasters and Development. Oxford University Press.

David, Ian, (1983). Disasters as Agents of Change ? or: Form Follows Failure. HABITAT INTL., No. 5/6, Great Britain.

Hagman, Gunnar, (1984). Prevention Better Than Cure. Swedish Red Cross, Stockholm.

Hewitt, K., Ed., (1983). Interpretations of Calamity. Allen & Unwin, Boston.

Independent Commission on International Humanitarian Issues, (1985). Famine: A Man Made Disaster? Vintage Books, New York.

Sen, Amartya, (1981). Poverty and Famines: An Essay on Entitlement and Deprivation. Clarendon Press, Oxford.

Wijkman, A. and L. Timberlake, (1984). Natural Disasters Acts of God or Acts of Man? Earthscan, London.

UNIT #2 HOMEWORK EXERCISE

COURSE ON THE USE OF NATURAL HAZARDS INFORMATION IN THE PREPARATION OF INVESTMENT PROJECTS

Instructions: Complete the table by identifying the relevant agencies that work in these areas in your country.

HAZARDS	SCIENTIFIC INVESTIGATION (1)	TRANSLATION (2)	IMPLEMENTATION (3)
1.- Geologic Hazards			
Earthquakes			
Volcanic Eruptions			
Tsunami			
Landslides			
2.- Atmospheric and Hydrologic Hazards			
Hurricanes			
Floods			
Drought			
Desertification			
Frost and Freezes			
Fires (Forests, etc.)			

Notes:
(1) Agencies responsible for basic and applied research.
(2) Agencies responsible for assessment and information translation and dissemination.
(3) Agencies responsible for the introduction and use of the information in the formulation of programs and projects.

EXAM QUESTIONS:

1.- Define the following terms as they relate to natural hazards:

a.- event

b.- hazard

c.- risk

d.- vulnerability

e.- hazard management

2.- Describe the differences between the following types of natural hazard information:

a.- event information

b.- hazard information

c.- risk information

d.- vulnerability information

3.- For the case of earthquakes, describe the thematic content of one type of map which corresponds to each of the following types of natural hazards information:

a.- event information

b.- hazards or risk information

c.- vulnerability information

4.- Identify the three principal protagonist groups which should participate in natural hazard management.

5.- Which are the three most important information components necessary to characterize a natural hazard ?

END OF UNIT #2

UNIT #3: ENVIRONMENTAL MANAGEMENT AND NATURAL HAZARDS

OBJECTIVE: Introduction of terms and concepts relevant to methods of environmental management planning which specifically generates and includes natural hazards information.

TIME ALLOTMENT: 3 hours

CONTENTS:

1.- A brief discussion of the currently used definitions of "human environment" and of the on-going debate on "environment and development"

a.- environment as defined by the dictionary:

"Set of natural, social, and cultural values which exist in a given place and point in time that influences the material and psychological life of man."

"The aggregate of all external conditions and influences affecting life and development."

b.- environment as defined by the Cocoyoc, Founex and Stockholm Conferences

c.- environment as defined by The World Bank, SCOPE and the OAS

d.- conclusion: There are an infinite number of environments (equal to the number of all human beings and their past, present and future groupings) and that it is much more than nature and/or natural resources.

2.- The concept of ecosystem and its use in environmental management planning, **(See Annex III.3.1)**

a.- Any ecosystem has biotic and abiotic portions.

b.- All ecosystems have structure and function.

1.- flow and storage of energy
2.- recycling of materials
3.- accumulation of information through generic adaptation

c.- Succession and change are significant characteristics of ecosystems.

1.- They occur when photosynthesis or the input of energy is greater than respiration.
2.- By holding an ecosystem at the earlier stages of succession, it is possible to harvest the excess energy.

d.- Goods, services and hazards are the economic, cultural, social and political manifestations of ecosystem's structure and function, **(See Annex III.3.2 and Annex III.3.3)**. They have value or are a problem for the following reasons:

1.- Certain characteristics of ecosystem structure and function have economic, cultural, or social utility and therefore are of value for current development.
2.- Certain characteristics of ecosystem structure and function have scientific utility and therefore are of value for future development.
3.- Certain characteristics of ecosystem structure and function are important for the control of that system and there for are of value for long-term development.
4.- Certain characteristics of ecosystem structure and function are important because they are dangerous to the activities of development within the same or allied systems, and their control or mitigation is important for actual, future and long-term development.

3.- Quality of life and environmental quality

a.- The quality of an environment is measured in terms of its capacity to offer goods and services that satisfy the needs of the individuals and groups which belong to that environment.

b.- needs

While necessities (and desires) change according to culture, race, age, sex, seasons, climate, education, income levels, etc., their satisfaction normally generates conflicts in terms of resource allocation. Something can be considered a necessity if:

1.- its absence causes illness;
2.- its presence prevents illness;
3.- its reintroduction heals illness; and,
4.- if the deprived person prefers it to other satisfactions.

4.- Environmental management concepts:

a.- Development: is the use, improvement and/or conservation of system goods and services and the mitigation of hazardous events.

b.- Environmental management: is the planning and implementation of actions geared to improve the quality of human life.

c.- Negative environmental impacts: are the result of any activity of development (or the result of any hazardous event) which prohibits the use of, deteriorates, or destroys goods and services which could be used or are being used to improve the quality of human life. **(See Annex III.3.4).**

5.- Erroneous concepts and terms in the "environmental" literature

It is very common to find certain terms in the current literature which, in the absence of a previous and well defined concept, lack meaning and lead to unappropriate understanding and treatment of environmental management issues. Some of these are the following:

a.- "the environment": Whose environment?

b.- "fragile ecosystems": A term used in the popular press but which has not been studied and to date has no scientific basis.

c.- "environmental problem": All problems except for those which arise from within are environmental problems.

d.- "environmental project": All development projects are designed to improve someone's environment.

e.- "environmental expert": Given the nature of environments, there can never be an environmental expert.

f.- "sustained development": Has not been defined and probably cannot be defined satisfactorily. A better phrase would be sustained flow of a system good or service.

HOMEWORK EXERCISE: (See Annex III.3.5).

RECOMMENDED INSTRUCTOR'S READINGS:

1.- **United Nations Environmental Program**, (1981). In Defense of the Earth; The Basic Text on Environment: Founex, Stockholm, Cocoyoc. Executive Series 1.

2.- **Munn, R.E.**, (1975). Environmental Impact Assessment. Scope 5. International Council of Scientific Unions. Scientific Committee on Problems of the Environment.

3.- **Ehrenfeld, D.W.**, (1976). "The Conservation of Non-resources," in American Scientist. Vol. 6:648-656.

ADDITIONAL SUGGESTED BIBLIOGRAPHY:

Gosselink, J.G., E.P. Odum, and R.M. Pope, (1973). "The Value of the Tidal Marsh". Center for Wetland Resources, Louisiana State University. Baton Rouge. LSU-SG-74-03.

Lugo, A.E., (1978). "Stress and Ecosystems," in J.H. Thorp and J.W. Gibbons, Eds., Energy and Environmental Stress in Aquatic Systems. Department of Energy of the United States, DOE Symposium Series.

Maslow, A.H., (1962). Towards a Psychology of Being. D. Van Nostrand Co., New York.

Organization of American States, (1984). Integrated Regional Development Planning: Guidelines and Case Studies from OAS Experience. Department of Regional Development. Secretariat for Economic and Social Affairs. Washington, D.C.

Odum, E.P., (1962). "Relationship Between Structure and Function in Ecosystems", in Japanese Journal of Ecology 12:108-118.

Streetton, P. and S. Burki, (1978). "Basic Needs: Some Issues", in World Development. Vol. 6:411-21.

Saunier, R.E., (1983). "Environment and Development ... a Future Together?" in Development Forum, XI No. 8. Nov-Dec.

Saunier, R.E., (1984). "Regional Approaches Utilized in Development Planning." Natural Resource Technical Bulletin. AID-NPS Natural Resources Project No. 5.

EXAM QUESTIONS:

1.- Define and comment on the term and concept of "human environment."

2.- Define and comment on the term and concept of "ecosystem" in terms of its significance for "environmentally sound development."

3.- Explain what is a human need, and what determines the quality of an environment.

4.- What can be considered an "environmentally sound development strategy?"

5.- Explain how are natural and anthropic hazards related to environmental management and to development planning.

END OF UNIT # 3

UNIT #4: ATMOSPHERIC AND HYDROLOGIC HAZARDS

OBJECTIVE: A general introduction to atmospheric and hydrologic hazards including principal phenomena and concepts. Familiarize participants with basic terminology. Generate an awareness as to the importance of atmospheric and hydrologic hazards in integrated development planning.

TIME ALLOTMENT: 3 hours

CONTENTS:

1.- Atmospheric and hydrologic hazards

a.- origin of the hazards

b.- characteristics of the hazards, (general considerations, causes, and effects)

1.- floods
2.- droughts
3.- frost
4.- winds

c.- available information and the integrated development planning process

1.- sources
2.- mitigation measures
3.- use of information in planning

2.- The "El Nino" Phenomenon

a.- general considerations

b.- nature of the phenomenon

c.- effects of the phenomenon

d.- information necessary for integrated development planning

3.- Desertification

a.- definition of the problem

b.- method for the identification and evaluation of desertification hazards

1.- necessary information
2.- desertification indicators
3.- desertification evaluation
4.- desertification monitoring

c.- preparation and use of desertification maps in development planning

1.- criteria for the preparation of the maps
2.- use of computer mapping techniques

d.- desertification prevention and control

RECOMMENDED INSTRUCTOR'S READINGS:

1.- Lopez O., Carlos, "Meteorological Hazards and Desertification," (lecture notes), Merida, Venezuela, 1986.

ADDITIONAL INTRUCTIONAL MATERIAL:

1.- Video tape (Spanish), "El Nino." Available through the Centro de Investigaciones de Zonas Aridas (CIZA) Universidad Nacional Agraria - La Molina, Casilla Postal 330, Lima 1, Peru.

2.- Video tape (English), "Planet Earth Series: The Climate Puzzle." Available through Films Incorporated, 5547 North Ravenswood, Chicago, Illinois 60640-1199.

ADDITIONAL SUGGESTED BIBLIOGRAPHY:

Dregne, H.E., (1983). Desertification of Arid Lands. Hardwood Academy Publishers, New York.

Garcia, R.V., (1981). Drought and Man: The 1972 Case History. Pergamon Press, New York.

Hall, A.L., (1978). Drought and Irrigation in North-East Brazil. Cambridge University Press, New York.

National Geographic Society (U.S.), (1978). Powers of Nature. Special Publications Division, N.G.S., Washington, D.C.

Reining, P., Ed., (1982). Handbook on Desertification Indicators. AAAS, Washington, D.C.

Sears, P.B., (1981). Deserts on the March. University of Oklahoma Press, Norman, Oklahoma.

Spooner, B. and H.S. Mann, Edts., (1982). Desertification and Development: Dryland Ecology in Social Perspective. Academy Press, New York.

Stiles, D., (1984). "Desertification: A Question of Linkage." in Desertification Control No. 10, UNEP.

Tolba, M.K., (1984). "A Harvest of Dust." in Desertification Control No. 10, UNEP.

Walls, J., (1980). Land, Man and Sand: Desertification and its Solutions. Macmillan Pub. Co., New York.

UNIT #4 HOMEWORK EXERCISE

ATMOSPHERIC AND HYDROLOGIC HAZARDS

Based on the material presented in class prepare a brief essay (approximately 150 words) on each of the following topics:

a.- The most predominant atmospheric and hydrologic hazards by geographic region in your country (you can follow either a topographic zoning or a transversal section of the country).

b.- The incipient and/or evidence of desertification processes that can be found in your country, and their respective social and economic impacts (examples of desertification processes: soil losses due to salinization, hydrologic and eolic erosion, poor drainage and floods, losses in the quantity and quality of surface and underground waters, reduction of the vegetal cover due to anthropic intervention, etc.)

EXAM QUESTIONS:

1.- Explain what are atmospheric and hydrologic hazards and what are their basic causes.

2.- Briefly explain which are the impacts of:

a.- floods

b.- winds

3.- What is the "El Nino" phenomenon?

4.- Briefly explain:

a.- What is desertification?

b.- Which are the principal anthropic causes of the desertification hazard?

c.- Which are the principal atmospheric and hydrologic hazards that assist in the intensification of the desertification hazard?

d.- What constitutes desertification prevention and monitoring?

5.- Explain how would you go about gathering and utilizing meteorological hazards information in the integrated development planning process.

END OF UNIT #4

UNIT #5: FLOOD HAZARDS

OBJECTIVE: Provide participants with an overview of flood hazards. Familiarize participants with the principal concepts and basic terminology, and with an understanding of the methodologies used in the evaluation of flood hazards for formulating investment projects. Generate an awareness about the importance of floods in integrated development planning.

TIME ALLOTMENT: 5 hours

CONTENTS:

1.- Basic concepts

a.- flood

b.- floodplain

c.- controlled floodway

d.- design flood

e.- flood severity

f.- vulnerability

g.- elements under risk

h.- specific risk

i.- risk

j.- frequency and magnitude

2.- Causes of floods

a.- tropical cyclones

b.- strong local storms

c.- combined atmospheric, hydrologic, and geologic factors

d.- artificial obstructions

3.- Analysis of flood events

a.- water depth

b.- water volume

c.- sediment content

d.- flood duration

e.- seasonal factors

f.- rate of water elevation

g.- return period (frequency)

h.- information sources

i.- time of occurrence

4.- Vulnerability analysis

a.- critical factors

1.- water depth

2.- flood frequency
3.- water volume
4.- topography

b.- basic criteria

1.- loss of life and injuries
2.- capital investment losses (infrastructure and production facilities)
3.- disruption of infrastructure and production facilities functions

c.- flood vulnerability classification

1.- frequent and infrequent floods
2.- low, medium, and high vulnerability

5.- Limitations in the use of lands and infrastructure

a.- application of standards and codes

b.- vulnerability index matrix

c.- vulnerability matrix for frequent floods

d.- vulnerability matrix for infrequent floods

6.- Flood damages

a.- damage evaluation method

b.- economic classification

1.- direct damages
2.- indirect damages
3.- secondary damages

7.- Annual damage and risks cost

a.- expected annual damages estimation

b.- flood frequency analysis

c.- risks cost

8.- Flood mitigation measures

a.- types of measures

1.- measures that reduce severity
2.- measures that reduce vulnerability
3.- emergency measures
4.- flood-proof construction
5.- flood insurance
6.- floodplain zoning
7.- flood warning system
8.- public education

b.- information requirements

1.- river geometry
2.- flow and elevation
3.- economic data
4.- value of expected damage

RECOMMENDED INSTRUCTOR'S READINGS:

1.- Amisial Roger A., "Flood Hazards, (lecture notes), Merida, Venezuela, 1986.

2.- Smith, K. and G. Tobin, (1979). Human Adjustment to Flood Hazards. Longman, New York.

3.- Southeastern Wisconsin Regional Planning Commission, (1968). Floodland and Shoreland Development Guide, Wankesha, Wisconsin.

4.- USGS, (1984). Proceedings of the Geologic and Hydrologic Hazards Training Program. Open File Report 84-760. USGS, Reston, Virginia.

ADDITIONAL INTRUCTIONAL MATERIAL:

1.- Video tape (English), "Planet Earth Series: The Blue Planet." Available through Films Incorporated, 5547 North Ravenswood, Chicago, Illinois 60640-1199.

ADDITIONAL SUGGESTED BIBLIOGRAPHY:

James, D.L. and R.R. Lee, (1971). Economics of Water Planning. McGraw-Hill, New York.

Ministry of the Environment, (1975). Canada Water Year Book 1975. Information Canada, Ottawa.

UNDRO, (1977). Analysis of Combined Vulnerability: Methodology and Study of Manila's Metropolitan Zone. United Nations, Geneva, Switzerland.

UNDRO, (1978). Disaster Prevention and Mitigation, Vol. 2 Hydrological Aspects. United Nations, Geneva, Switzerland.

UNDRO, (1979). Natural Disaster and Vulnerability Analysis. United Nations, Geneva, Switzerland.

U.S. Water Resource Council, (1978). "Floodplain Management Guidelines for Implementing E.O. 11988." Washington, D.C.

Whipple, W., et al., (1983). Stormwater Management in Urbanizing Areas. Prentice Hall, New Jersey.

White, G.F., (1974). "Natural Hazards Research: Concepts, Methods and Policy Implications," in Natural Hazards, Local, National, Global, Ed. G.F. White, Oxford University Press, New York.

Wood, D.W., T.C. Gooch, P.M. Pronovost, and D.C. Noonan, (1985). Development of a Flood Management Plan, in Journal of Water Resource Planning and Management, ASCE, 111:4(417-433).

UNIT #5 HOMEWORK EXERCISE

FLOOD HAZARDS

Based on the material presented in class prepare a brief discussion essay (approximately 250 words) on <u>one</u> of the following topics:

a.- The principal measures that could be implemented to reduce flood severity and flood vulnerability in a flood prone urban settlement in your country.

b.- The principal "artificial" and anthropic causes for the occurrence of floods and the corresponding mitigation measures that could be implemented to avoid or reduce such events.

c.- The use of flood and flood mitigation information in the integrated development planning process.

EXAM QUESTIONS:

1.- Explain which are the causes of floods.

2.- List the three most important factors that determine the severity of a flood, explaining how each of those factors causes damage.

3.- Define the following terms:

a.- floodplain

b.- controlled floodway

c.- flood

d.- design flood

4.- List the basic criteria that are used in the evaluation of flood vulnerability and the different flood classifications that are commonly used in vulnerability evaluations.

5.- Enumerate the different types of flood mitigation measures that are commonly used and explain how flood hazards and flood mitigation information can be used in the integrated development planning process.

END OF UNIT #5

UNIT #6: INTRODUCTION TO GEOLOGIC HAZARDS

OBJECTIVE: Introduce the science of geology including principal concepts and theories. Familiarize participants with basic terminology.

TIME ALLOTMENT: 2 hours

CONTENTS:

1.- Introduction to geology

a.- the science of geology

b.- basic principles

1.- geologic eras
2.- principal theories of geologic evolution

c.- the earth's crust

1.- the four spheres
2.- elements, minerals, and rocks

2.- Plate tectonics and geologic phenomena

a.- introduction to plate tectonics

1.- oceanic trenches, central-oceanic ridges, and faults
2.- plate formation and displacement

b.- types of faults

1.- slip (lateral)
2.- normal
3.- reverse

c.- hazard implications of plate tectonics

1.- earthquakes and areas of seismic activity
2.- volcanoes and areas of volcanic activity

RECOMMENDED INSTRUCTOR'S READINGS:

1.- Zumberge, J., and C.A. Nelson, (1972). Elements of Geology. (Chapters 3 and 4). 2nd. edition. John Wiley and Sons, New York.

2.- Flint, R.F., and B.J. Skinner, (1974). Physical Geology. John Wiley and Sons, New York.

ADDITIONAL SUGGESTED BIBLIOGRAPHY:

Cattermole, P.J. and P. Moore, (1985). The Story of the Earth. Cambridge University Press, New York.

McKenzie, G.D. et al., Eds., (1975). Man and His Physical Environment: Readings in Environmental Geology. Burgess Publishing Company, Minneapolis, Minnesota.

Mears, B., (1977). The Changing Earth: Introduction to Geology. 2nd edition. D. Van Nostrand Co., New York.

Parker, R., (1984). Inscrutable Earth: Explorations Into the Science of Earth. Scribner, New York.

Van Andel, T.H., (1985). New Views on an Old Planet: Continental Drift and the History of the Earth. Cambridge University Press, New York.

EXAM QUESTIONS:

1.- List the different geologic eras of the earth's evolutionary process.

2.- Explain the continental drift theory.

3.- What are the layers of the earth's crust and of what elements is the crust composed?

4.- Define the following terms:

a.- tectonic plate

b.- oceanic trench

c.- central-oceanic ridge

d.- seismic fault

5.- Explain the formation and movement of tectonic plates.

END OF UNIT # 6

UNIT #7: SEISMIC AND VOLCANIC HAZARDS

OBJECTIVE: Introduce seismic and volcanic hazards including principal phenomena and concepts. Familiarize participants with the basic terminology. Provide a general understanding of the scientific and technical aspects of seismic and volcanic hazards. Present the principal long term mitigation techniques and systems. Generate an awareness about their importance in integrated development planning.

TIME ALLOTMENT: 7 hours

CONTENTS:

1.- Evaluation and monitoring of seismic activity

a.- earthquake hazards

1.- ground shaking
2.- surface fault rupture
3.- landslides
4.- liquefaction
5.- tsunamis
6.- other

b.- summary of major seismic event impacts

1.- loss of life or injuries
2.- capital losses (infrastructure and production facilities)
3.- disruption of infrastructure and production facilities functions

c.- seismic evaluation

1.- earthquake parameters
2.- dynamic parameters of seismic waves
3.- macroseismic observation
4.- geotectonic and geophysical features

d.- monitoring and information systems

1.- institutional structures
2.- components and equipment of a seismologic monitoring network
3.- monitoring and prediction capability

e.- process of information generation

1.- event
2.- hazard
3.- risk
4.- vulnerability

2.- Evaluation and monitoring of volcanic activity

a.- types of volcanoes and eruptions

1.- Hawaiian
2.- cinder cones
3.- Vesuvian
4.- other phenomena (calderas and fissure eruptions)

b.- volcanic hazards

1.- volcanic ash
2.- pyroclastic phenomena
3.- mudflows
4.- secondary effects of mudflows
5.- volcanic gases
6.- lava flows
7.- debris flows and
8.- other

c.- monitoring and information systems

1.- institutional structures
2.- components and equipment of a volcanologic monitoring network
3.- monitoring and prediction capabilities

d.- process of information generation

1.- event
2.- hazard
3.- risk
4.- vulnerability

e.- summary of major volcanic event impacts

1.- loss of life and injuries
2.- capital losses (infrastructure and production facilities)
3.- disruption of infrastructure and production facilities functions

3.- Seismic and volcanic hazards reduction programs and mitigation techniques

a.- general planning techniques

1.- integrated urban and rural development planning
2.- criticals facilities including life-line network identification
3.- development of alert and emergency response plans

b.- education techniques

1.- formal hazards education in academic institutions (schools and universities)
2.- mass-media education and awareness programs
3.- creation of civilian response coordination groups
4.- design and implementation of emergency situation simulation exercises
5.- other

c.- engineering techniques

1.- safety evaluation and strengthening of existing buildings, and cost and levels of seismic upgrading: Aseismic strengthening of "existing buildings" is an effective and efficient measure to mitigate possible seismic calamities and forms the indispensable part of the urgent task for the control of urban earthquake disaster.
2.- codes, practice and judgement: For structures not yet built it is important to point out that the design and construction process needs improvement in: (1) codes and state-of-the-art practice, (2) independent peer review (special structures, critical facilities and dams), (3) plan-checking and inspection, and (4) construction performance and quality control.
3.- lifeline systems and their risk analyses: Water and sewage, telecommunications, transportation, and energy systems are recognized as essential

lifelines whose continued service following a major earthquake is indispensable for implementing emergency operations to mitigate the immediate consequences of the earthquake. Effort should be made to include in this particular section of the program the study of lifeline systems as an investment project and their corresponding risk analyses.

d.- regulatory techniques

1.- urban and rural land-use macro-zoning
2.- urban and rural land-use micro-zoning
3.- real estate development and construction codes, regulations, ordinances and laws
4.- other

e.- financial and economic techniques

1.- taxation incentives and penalties
2.- non-subsidized insurance
3.- lending and insuring policies
4.- other

f.- direct government techniques

1.- public acquisition of hazard prone areas
2.- expropriation of hazard prone areas
3.- relocation of endangered population
4.- other

4.- The use of information in integrated development planning

a.- problems in the use of seismic and volcanic hazards information

1.- social and cultural
2.- economic
3.- technical
4.- political
5.- other

b.- opportunities for the use of seismic and volcanic hazards information

1.- avoidance of losses (human, financial, etc.)
2.- contribution to economic stability
3.- formulation and implementation of safer investment projects and programs

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RECOMMENDED INSTRUCTOR'S READINGS:

1.- **Blong, R.J.**, (1984). Volcanic Hazards. Academic Press, New York.

2.- **Brown, R.D. Jr., and W.J. Kockelman**, (1983). Geologic Principles for Prudent Land Use. U.S. Geological Survey Proffesional Paper 946.

3.- **Decourt, J., and J. Paquet**, (1985). Geology: Principles and Methods. (Chapter 7). Graham & Trotman, London.

4.- **Kockelman, W.J.**, (1979). "Examples of Use of Geologic and Seismologic Information for Earthquake Hazards Reduction in Southern California." U.S. Geological Survey, Open-file Report 83-82.

5.- **USGS**, (1984). Proceedings of the Geologic and Hydrologic Hazards Training Program. Open File Report 84-76C. USGS, Reston, Virginia.

ADDITIONAL INSTRUCTIONAL MATERIAL

1.- **Video tape** (English), "Mexico Earthquake, September 19, 1985," available through the U.S. National Bureau of Standards, Washington D.C.

2.- **Movie** (16mm) (English), "When The Earth Moves," available through the U.S.G.S., Reston, Virginia.

ADDITIONAL SUGGESTED BIBLIOGRAPHY:

Crandall, D.R., et al., (1984). "Sourcebook for Volcanic Hazards Zonation." Natural Hazards 4, UNESCO, Paris.

Decker, R. and B. Decker, (1981). Volcanoes. W.H. Freeman and Company, San Francisco, California.

Lambert, M.B., (1980). Volcanoes. University of Washington Press, Seattle, Washington.

Nichols, D.R., and J.M. Buchanan-Banks, (1974). "Seismic Hazards and Land Use Planning." U.S. Geological Survey, Circular 690, USGS Washington, D.C.

Simkin, T., et al., (1981). Volcanoes of the World. Smithsonian Institution. Hutchinson Ross Publishing Company, Stroudsburg, Pennsylvania.

UNDRO, (1985). Volcanic Hazards Management. UNESCO, New York.

UNDRO, (1978). Disaster Prevention and Mitigation, Vol. 1. Volcanological Aspects. United Nations, Geneva, Switzerland.

UNDRO, (1982). Disaster Prevention and Mitigation, Vol. 3. Seismological Aspects. United Nations, Geneva, Switzerland.

Urban Regional Research, (1982). Land Management in Tsunami Hazard Areas. NSF, Washington, D.C.

UNIT #7 HOMEWORK EXERCISE

SEISMIC AND VOLCANIC HAZARDS

Based on the material presented in class prepare a brief discussion essay (approximately 250 words) on one of the following topics:

a.- The principal elements of a seismic and/or volcanic hazards public education and awareness program.

b.- The principal problems that normally take place in planning and responding to a seismic and/ or volcanic event in lesser developed countries, considering in particular overall development planning issues and governmental responsibilities.

c.- The process of seismic and/or volcanic hazards information generation and dissemination, and the lack of communication between the scientific and planning communities with respect to such information.

EXAM QUESTIONS:

1.- Describe the principal seismic and volcanic hazards.

2.- List the principal international and national (your country) institutions that are involved in seismic research and information generation, and list the main types of seismologic and volcanologic information that is available at the event, hazard, risk, and vulnerability levels.

3.- Compare the characteristics of a seismologic monitoring network and a volcanologic monitoring network.

4.- Define the following terms:

a.- earthquake magnitude

b.- earthquake damage intensity

c.- return period

d.- liquefaction

e.- mudflow

f.- cinder cone

5.- List the principal seismic and volcanic hazard reduction programs and mitigation techniques.

END OF UNIT #7

UNIT #8: COURSE CASE STUDY PRESENTATION (PART I)

OBJECTIVE: Introduce the case study of the course, presenting the general characteristics of the natural hazards problem, and the overall geographic, social and economic context of the problem-area. Prepare participants for the first technical field trip.

TIME ALLOTMENT: 1 hour

CONTENTS:

1.- Presentation of the basic characteristics of the case study

   a.- basic geographic context

   b.- natural hazards problem

   c.- basic social and economic characteristics

   d.- basic characteristics of the investment project(s) which are to be included in the case study

2.- Introduction to Technical Field Trip I

   a.- general explanation of field trip objectives

   b.- explanation of field trip schedule and points of interest

   c.- distribution of necessary handouts and reference material to participants

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END OF UNIT #8

UNIT #9: TECHNICAL FIELD TRIP I

OBJECTIVE: Provide participants with the opportunity to visi the site(s) of the case study.

TIME ALLOTMENT: 6 hours

CONTENTS:

To be determined in accordance with the specific case study that is chosen for the course.

END OF UNIT #9

UNIT #10: MASS-MOVEMENT HAZARDS

OBJECTIVE: Introduce mass-movement hazards including principal phenomena and concepts. Familiarize participants with the basic terminology. Provide a general understanding of the scientific and technical aspects of mass movements and generate an awareness about their importance in integrated development planning.

TIME ALLOTMENT: 3 hours

CONTENTS:

1.- Mass-movement hazards

a.- principal types of mass movements

1.- falls
2.- topples
3.- slides
4.- lateral spreads
5.- flows
6.- complex slope movements

b.- causes of mass movements

1.- topographic
2.- geologic
3.- climatic
4.- seismic

2.- Mass-movements reduction programs and mitigation techniques

a.- slope protection and stabilization techniques

1.- biological stabilization (vegetation)
2.- biotechnical stabilization
3.- structural-mechanical stabilization

b.- education techniques

1.- formal hazards education in academic institutions (schools and universities)

2.- mass-media education and awareness programs
3.- other

c.- engineering techniques

1.- development and enforcement of construction code
2.- seismic evaluation of buildings and infrastructure
3.- buildings and infrastructure including lifeline strengthening
4.- water and mudflow containment devices
5.- other

d.- regulatory techniques

1.- urban and rural land-use macro-zoning
2.- urban and rural land-use micro-zoning
3.- real estate development and construction codes, regulations, ordinances and laws
4.- other

e.- financial and economic techniques

1.- taxation incentives and penalties
2.- non-subsidized insurance
3.- lending and insuring policies
4.- other

f.- direct government techniques

1.- public acquisition of hazard prone areas
2.- expropriation of hazard prone areas
3.- relocation of endangered population
4.- other

3.- Use of information in development planning

a.- problems in the use of mass-movement hazards information

1.- social and cultural
2.- economic
3.- political
4.- other

b.- opportunities in the use of mass-movement hazards information

1.- avoidance of losses (human, financial, etc.)
2.- formulation and implementation of adequate investment projects

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CLASSROOM EXERCISE: (See Annex III.10.1)

RECOMMENDED INSTRUCTOR'S READINGS:

1.- **Gray, D.H. and A.T. Leiser,** (1982). Biotechnical Slope Protection and Erosion Control. Van Nostrand Reinhold Company, New York. (Chapters 2, 3, 5, and 7).

2.- **Kockelman, W.J.,** (1986). "Some Techniques for Reducing Landslide Hazard." Bulletin of the Association of Engineering Geologists, College Station, Texas, Vol.23, No.1.

3.- **UNDRO,** (1978). Disaster Prevention and Mitigation, Vol. 5 - Land Use Aspects. United Nations, Geneva, Switzerland.

ADDITIONAL SUGGESTED BIBLIOGRAPHY:

Brown, R.D. Jr. and W.J. Kockelman, (1983). "Geologic Principles for Prudent Land Use, A Decision-Maker's Guide for the San Francisco Bay Region." Professional Paper 946, U.S. Geological Survey. Government Printing Office, Washington, D.C.

Morgenstern, N.R. and D.A. Sangrey, (1978). "Methods of Stability Analysis" in Landslides: Analysis and Control, ed. by Shuster, R.L. and R.J. Krizek, Trans. Res. Board Spec. Rept. 176, NAS-NRC, Washington, D.C.

U.S. Geological Survey, (1983). "Goals and Tasks of the Landslide Part of a Ground-failure Hazards Reduction Program." Circular 880.

Varnes, D.J., (1978). "Slope Movement: Types and Processes" in Landslides: Analysis and Control, ed. by Shuster, R.L. and R.J. Krizek, Trans. Res. Board Spec. Rept. 176, NAS-NRC, Washington, D.C.

EXAM QUESTIONS:

1.- Describe the principal types of mass-movements.

2.- Describe the three basic causes of mass-movements.

3.- Describe two instances in which man's intervention can generate mass-movement in otherwise stable slopes.

4.- Define the following terms:

a.- soil creep

b.- foliation

c.- rock topple

d.- retaining structure

5.- Describe using specific examples the three basic measures for slope stabilization.

END OF UNIT # 10

UNIT #11: LAND USE AND SOIL DEGRADATION HAZARDS

OBJECTIVE: Introduce the principal concepts and terminology used in soil science. Provide participants with an understanding of the problems and opportunities associated with soil deterioration and conservation. Generate an awareness about the importance of adopting adequate soil management practices and soil degradation mitigation techniques.

TIME ALLOTMENT: 7 hours

CONTENTS:

1.- Introduction to soil use hazards

a.- saturated soils

b.- salinity and alkalinity

c.- lateritic soils

2.- Characteristics and properties of the soil

a.- morphology

1.- color
2.- texture
3.- consistency
4.- acidity

b.- horizon limits in the soil profile

1.- organic horizons
2.- mineral horizons
3.- lithologic discontinuity

3.- Physical and chemical characteristics

a.- physical characteristics

1.- apparent density
2.- porosity
3.- humidity

b.- chemical characteristics

1.- PH factor
2.- organic matter
3.- cation and base exchange capacity

c.- soil profile

1.- typical pedon
2.- range of characteristics
3.- analysis techniques

4.- Soil classification

a.- scientific classification

1.- classification system
2.- categories of soil classification

b.- land use classification

1.- classification system
2.- categories of soil classification

c.- classification of irrigable soils

1.- classification system
2.- categories of soil classification

5.- Soil studies and development planning

a.- elements of a soils study

1.- preparatory phase
2.- preliminary photo-interpretation

3.- systematic photo-interpretation
4.- field work
5.- laboratory analysis
6.- map compilation and report

b.- types of soil studies

1.- exploratory
2.- reconnaissance
3.- semi-detailed
4.- detailed

c.- development planning applications

1.- general land/soils classification
2.- agriculture planning
3.- non-agricultural planning
4.- engineering studies
5.- soil degradation mitigation techniques

RECOMMENDED INSTRUCTOR'S READINGS:

1.- **Davison, D.A.**, (1980). Soils and Land Use Planning. Longman, New York.

ADDITIONAL SUGGESTED BIBLIOGRAPHY:

Batten, J.W. and J. Sullivan, (1977). Soils, Their Nature, Classes, Distribution, Uses and Care. University of Alabama Press, Alabama.

Birkeland, P.W., (1984). Soils and Geomorphology. Oxford University Press, New York.

Blaikie, P.M., (1985). The Political Economy of Soil Erosion in Developing Countries. Longman, New York.

Buol, H. and M.C. Craken, (1973). Soils Genesis and Morphology. Iowa State University Press, Iowa.

Olson, G.W., (1972). "Engineering Interpretations for Uses of Soils in Developing Countries." Agronomy Mimeo 72-14, Department of Agronomy. Cornell University, Ithaca, New York.

Olson, G.W., (1984). Field Guide to Soils and the Environment: Applications of Soil Surveys. Chapman and Hall, New York.

UNIT #11 HOMEWORK EXERCISE

LAND USE AND SOIL DEGRADATION HAZARDS

Based on the material presented in class prepare a brief essay (approximately 250 words) discussing one of the following topics:

a.- Soil degradation can only occur in poor soils or in areas of accentuated slopes and little forest cover.

b.- In planning agricultural development projects it is essential to first identify the capability measure of the soils. Given that such a measure is so specific, not doing so may result in inappropriate land use schemes, and eventually in severe soil degradation.

EXAM QUESTIONS:

1.- Briefly explain which are the principal characteristics and properties of soils.

2.- Describe the principal types of soil degradation, explaining in detail the corresponding causes and mitigation techniques.

3.- Define the following terms:

a.- saturated soils

b.- salinity and alkalinity

c.- lateritic soils

d.- horizons

4.- Briefly describe the principal elements of a detailed soil study.

5.- Describe the application of soil studies in the integration of natural hazards assesment information in development planning work.

END OF UNIT #11

UNIT #12: MULTIPLE GEOLOGIC HAZARDS AND LIFELINE NETWORK MAPPING

OBJECTIVE: Introduce hazards mapping applied to geologic phenomena, and basic and service infrastructure lifeline network mapping. Familiarize participants with the basic procedures and terminology. Provide an understanding of the scientific and technical aspects of cartographic analysis and its application in integrated development planning

TIME ALLOTMENT: 8 hours

CONTENTS:

1.- Problems and opportunities of multiple hazards mapping techniques

a.- scientific versus planning information

1.- producers and users perspective
2.- scientific and planning language
3.- single theme and multiple theme maps

b.- applications of multiple hazards and lifeline network mapping

1.- general urban development planning
2.- general rural and agricultural development planning
3.- specific investment project formulation

2.- A methodology for multiple geologic hazards diagnostic map

a.- multiple hazards diagnostic map

1.- multiple hazards concept
2.- scope and approach

b.- geotechnical macrozonation map

1.- lithologic map
2.- geomorphologic map
3.- hydrologic map

c.- geotechnical microzonation map

1.- clinometric map
2.- structure map
3.- talus geometrical stability and orientation map

d.- supporting studies

1.- soils
2.- climate
3.- human activities
4.- current and proposed spatial development strategies
5.- other

3.- Lifeline network mapping

a.- lifeline network map

1.- lifeline network concept
2.- scope and approach

b.- identification of the lifeline network elements

1.- transportation, energy and communication systems (basic infrastructure)
2.- medical, educational and public safety facilities
3.- food supply chains
4.- emergency shelters
5.- other

c.- lifeline network vulnerability assessment

1.- assessment of previous events
2.- multiple hazards and lifeline network map overlays
3.- structural assessment of buildings and installations

CLASSROOM EXERCISE: (See Annex III, 12.1)

RECOMMENDED INSTRUCTOR'S READINGS:

1.- **California Department of Conservation, Division of Mines and Geology,** (1982). Earthquake Planning Scenario For a Magnitude 8.3 Earthquake on the San Andreas Fault in Southern California. Special Publication 60, State of California, Sacramento, California.

ADDITIONAL SUGGESTED BIBLIOGRAPHY:

Puerto Rico Department of Natural Resources, (1974). Sensitivity of Coastal Environments and Wildlife to Spilled Oil: Puerto Rico, A Coastal Atlas. San Juan, Puerto Rico.

St. Helen, L., (1986). "Natural Hazards Risk Assessment of Coastal Settlements in Saint Lucia, West Indies." OAS/DRD - Government of Saint Lucia.

Matteuci, S.D., A. Colma and L. Pla, (1982). "Desertification Maps of Falcon State, Venezuela" in Environmental Conservation, Vol. 9, No. 3, Autumm, the Netherlands.

EXAM QUESTIONS:

1.- Discuss the gap that exists between the scientific information that is generally available about natural hazards phenomena and the information required by development planners.

2.- Providing examples, list the principal applications of multiple hazards mapping in integrated development planning.

3.- Describe what you would consider as a comprehensive methodology for preparing a multiple geologic hazards diagnostic map for a given geographical area.

4.- Explain the concept of lifeline network, pointing out its relevance to development and natural hazards mitigation planning.

5.- Describe what you would consider as a comprehensive methodology for preparing a lifeline network map of a given geographical area.

END OF UNIT #12

UNIT #13: NATURAL HAZARDS INFORMATION SYSTEMS AND SOURCES

OBJECTIVE: Summarize natural hazards information sources presented in the technical units of the course. Review different systems and techniques for obtaining and processing natural hazards information for use in integrated development planning.

TIME ALLOTMENT: 5 hours

CONTENTS:

1.- Natural hazards and the development planning process

a.- Review of basic elements of the preliminary mission, development diagnosis and strategy formulation, project identification and formulation, and action plan

1.- objectives
2.- effect on development patterns
3.- information use

2.- Information organization according to hazard type and its proposed use

a.- event monitoring and alerts: information for prediction and emergency alerts

b.- phenomena investigation: information for scientific and engineering investigations

c.- translated information: transforming scientific and engineering information into a format and with the content needed for risk and vulnerability assessment

d.- synthesized information: translated mapped information for macro and micro hazards and risk zonification maps, and vulnerability maps for disaster prevention and emergency preparedness

3.- Application of different information sets to produce useful products for the integrated development planning process

a.- assigning priorities (geographic focus, use of maps, graphs, tables, etc., mapping scale, content, format and level of detail)

b.- summary of remote sensing information and techniques (aerial photography, radar imagery, satellite imagery)

c.- overview of computerized mapping systems and techniques

d.- defining the type of translated information needed and the appropriate techniques for its preparation

e.- use of the prepared information in the corresponding stage of the integrated development planning process

4.- Relationship between the different information sets and mitigation techniques

a.- techniques to modify or reduce an event

b.- techniques to control or guide the physical course of an event

c.- techniques to control or guide development activities to avoid the impact of an event

d.- techniques to withstand the impact of an event

e.- techniques to evacuate the population and reduce to the extent possible material damage

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RECOMMENDED INSTRUCTOR'S READINGS:

1.- **Brown, R.D. Jr. and W.J. Kockelman,** (1983). "Geologic Principles for Prudent Land Use, A Decision-Maker's Guide for the San Francisco Bay Region." Professional Paper 946, U.S. Geological Survey. Government Printing Office, Washington, D.C.

2.- **Kockelman, W.,** (1983). "Examples of the Use of Geological and Seismological Information for Earthquake Hazard Reduction in Southern California." USGS Open File Report 83-82, USGS, Menlo Park, California.

3.- **UNDRO,** (1977). Disaster Prevention and Mitigation, Vol. 1. Volcanological Aspects. United Nations, Geneva, Switzerland.

4.- **UNDRO,** (1976). Disaster Prevention and Mitigation, Vol. 2. Hydrological Aspects. United Nations, Geneva, Switzerland.

5.- **UNDRO,** (1978). Disaster Prevention and Mitigation, Vol. 3. Seismological Aspects. United Nations, Geneva, Switzerland.

6.- **UNDRO,** (1978). Disaster Prevention and Mitigation, Vol. 4. Meteorological Aspects. United Nations, Geneva, Switzerland.

7.- **UNDRO,** (1978). Disaster Prevention and Mitigation, Vol. 5. Land Use Aspects. United Nations, Geneva, Switzerland.

ADDITIONAL SUGGESTED BIBLIOGRAPHY:

Additional bibliography can be found in the listings for Units 4, 5, 6, 7, 10, 11, and 12.

UNIT #13 HOMEWORK EXERCISE

COURSE ON THE USE OF NATURAL HAZARDS INFORMATION IN THE PREPARATION OF INVESTMENT PROJECTS

"DESCRIPTION AND USE OF NATURAL HAZARDS INFORMATION BY TYPE IN DEVELOPMENT PLANNING STUDIES"

INSTRUCTIONS: Complete the table with the title of a specific information piece (map, table, etc).

	PROJECT FORMULATION STAGE		
HAZARDS	PRELIMINARY MISSION (EVENTS)	PROJECT IDENTIFICATION (RISK)	PROJECT FORMULATION (VULNERABILITY)
1.- Geologic Hazards			
Earthquakes			
Volcanic Eruptions			
Tsunami			
Landslides			
2.- Ateospheric and Hydrologic Hazards			
Hurricanes			
Floods			
Drought			
Desertification			
Frost and freezes			
Fires (Forest, etc.)			

EXAM QUESTIONS:

1.- Describe the four basic types of information organization according to hazard type and proposed use.

2.- Describe the three primary considerations in applying different information sets to produce useful products for the integrated development planning process.

3.- List the five principal types of mitigation techniques with one example of each.

4.- Describe the principal characteristics and natural hazards information applications of:

a.- aerial photography

b.- radar imagery

c.- satellite imagery

5.- Describe the principal characteristics and natural hazards information applications of:

a.- computerized mapping systems

b.- geo-based information systems (GIS)

END OF UNIT #13

UNIT #14: COURSE CASE STUDY PRESENTATION (PART II)

OBJECTIVE: Present to the participants a detailed review of the specific natural hazards issues of the case study area and their actual and/or potential impact in the natural resource, social, and economic context.

TIME ALLOTMENT: 1 hour

CONTENTS:

To be determined in accordance to the specific case study selected for the course.

END OF UNIT #14

UNIT #15: ECONOMIC PLANNING AND NATURAL HAZARDS

OBJECTIVE: Introduce the economic analysis section of the course, including an explanation of its basic orientation and contents. Discuss the relationship between economic development planning and natural hazards, and introduce economic analysis of natural disasters and their consequences.

TIME ALLOTMENT: 2 hours

CONTENTS:

1.- Difference between scientific and economic understanding of natural hazards and their impacts

a.- scientific approach

1.- natural phenomena
2.- objective evaluation

b.- economic approach

1.- identification of economic tra
2.- socio-political evaluation

2.- Impact of natural hazards in economic development planning

a.- economic development planning vis-a-vis overall development planning

b.- description of the economic development planning process **(See Annex III.15.1)**

1.- macro-planning
2.- micro-planning

c.- policy determination and economic "reality"

1.- general policy tools
2.- natural hazards mitigation policy

d.- "Planning-implementation-results" chain

1.- without natural hazards mitigation
2.- with natural hazards mitigation

3.- Economic trade-off analysis **(See Annex III.15.2)**

a.- event magnitude versus survival capacity

1.- absence of human and/or economic interest
2.- presence of human and/or economic interest

b.- problems and opportunities of implementing natural hazards mitigation measures

1.- economic interests
2.- social and cultural interests
3.- political interests
4.- scientific/technical knowledge
5.- financial constraints
6.- other

RECOMMENDED INSTRUCTOR'S READINGS:

1.- **Todaro, M.P.,** (1981). Economic Development in the Third World. 2nd edition. Longman, New York.

ADDITIONAL SUGGESTED BIBLIOGRAPHY:

Blitzer, C.D., et al., (1977). Economy-Wide Models and Development Planning. Oxford University Press, Oxford, England.

Bendavid-Val, A., (1980). Local Economic Development Planning: From Goals to Projects. American Planning Association, Chicago, Illinois.

)ixon, J., et al., (1986). Economic Analysis of the Environmental Impacts of Development Projects. Asian Development Bank, Manila, Philippines.

ant, G., (1979). Development Administration: Concepts, Goals, and Methods. University of Wisconsin Press, Madison.

ilbert, A., Ed., (1983). Development Planning and Spatial Structure. John Wiley and Sons, New York.

EXAM QUESTIONS:

1.- Describe the economic development planning process.

2.- Describe the principal policy tools available at the macro-planning level.

3.- What is the relationship between specific investment projects and economic development planning?
What are the linkages between investment projects and natural hazards?

4.- What is the relationship between the magnitude of a natural hazard event and the actual level of destruction that it can cause?

5.- Describe the principal problems and opportunities of incorporating natural hazards mitigation techniques into economic development planning.

END OF UNIT #15

UNIT #16: MULTICRITERIA ANALYSIS AND INTEGRATED DEVELOPMENT PLANNING

OBJECTIVE: Introduce multicriteria analysis and its potential applications in integrated development planning. Provide participants with an understanding of the mechanisms of multicriteria analysis and show how it can be used to incorporate natural hazards considerations into planning at the macro and micro analysis levels.

TIME ALLOTMENT: 4 hours

CONTENTS:

1.- Development planning

a.- economic development planning philosophies

1.- market economies
2.- non-market economies

b.- levels of economic development planning

1.- national
2.- sub-national (regional or sectorial)
3.- local (micro-regional or sub-sectorial)

c.- necessity to define investment criteria

1.- definition of objectives
2.- definition of parameters

d.- standard techniques for investment evaluation

1.- financial
2.- economic
3.- socio-economic
4.- integrated development

2.- Multicriteria analysis

a.- components of the technique

1.- objectives
2.- attributes
3.- coefficients
4.- matrixes and sub-matrixes

b.- operation of the technique

1.- common denominator units
2.- utilization of the technique
3.- application of the results in the decision-making and development planning processes

c.- problems and opportunities of the technique

1.- subjectivity in the selection of attributes
2.- subjectivity in the determination of coefficients
3.- qualitative aspects of the analysis technique
4.- other

RECOMMENDED INSTRUCTOR'S READINGS

1.- **Vira, C. and Y.Y. Haimes,** (1983). Multiobjective Decision Making: Theory and Methodology. North Holland, New York.

ADDITIONAL SUGGESTED BIBLIOGRAPHY:

Haimes, Y.Y., et al., (1978). Multiobjective Optimization in Water Resource Systems. E.S.P. Corp., New York.

Keeney, R.C. and H. Raiffa, (1976). Decision Analysis with Multiple Conflicting Objectives: Preferences and Value Trade-Offs. John Wiley and Sons, New York.

Edwards, W. and J.R. Newman, (1982). Multiattribute Evaluation. Sage Publications, Beverly Hills, California.

UNIT #16 HOMEWORK EXERCISE

MULTICRITERIA ANALYSIS AND INTEGRATED DEVELOPMENT PLANNING

Based on the material presented in class prepare a simplified multicriteria analysis matrix, i.e., define a set of objectives and attributes for the incorporation of flood hazard considerations into the process of selecting agricultural development projects. Your analysis matrix should be useful for both orienting the formulation of projects and the selection of already formulated projects or project alternatives. Provided that you present the corresponding assumptions in terms of economic, social, technical, political, and "environmental" goals and criteria , you may choose to base your exercise on a particular country or region with which you are familiar.

EXAM QUESTIONS:

1.- Briefly describe the difference between a market economy and a non-market economy.

2.- Describe the traditional techniques used in the evaluation of investment projects, indicating which are used in the private and public sectors, respectively.

3.- Describe the multicriteria analysis technique specifying its different components.

4.- Describe the principal problems and opportunities of applying the multicriteria analysis technique.

5.- Explain, giving a specific example, how would you go about utilizing multicriteria analysis for incorporating natural hazard considerations into the analysis of an investment project.

END OF UNIT #16

UNIT #17: GENERAL ECONOMIC ANALYSIS THEORY

OBJECTIVE: Introduce the principal project appraisal methods used in the private and public sectors, and provide participants with an understanding of their concepts, terminology and basic mechanisms.

TIME ALLOTMENT: 5 hours

CONTENTS:

1.- Foundations of project appraisal

a.- historical background

b.- principal currents in project appraisal

1.- financial analysis
2.- economic analysis
3.- socio-economic analysis

2.- Structure and components of the project cycle

a.- project phases

1.- project idea identification
2.- project profile
3.- prefeasibility
4.- feasibility
5.- implementation
6.- operation and control

b.- technical and economic elements

1.- market study
2.- determination of size and location
3.- project engineering
4.- investment calculation
5.- cash flow analysis
6.- financing assessment
7.- organization and implementation

c.- special types of projects

1.- integrated projects (multiple)
2.- service output projects (non-commodity)

3.- Principal issues in project appraisal

a.- determination of benefits

1.- direct and indirect
2.- quantifiable and non-quantifiable
3.- double accounting problems

b.- determination of costs

1.- direct and indirect
2.- quantifiable and non-quantifiable
3.- double accounting problems

c.- externalities

1.- positive
2.- negative

d.- accounting measurements and standards

1.- internal rate of return (IRR)
2.- net present value (NPV)
3.- cost-benefit ratio (CB)
4.- other

e.- shadow pricing applications

1.- project inputs (natural and capital resources)
2.- project outputs
3.- wages
4.- taxation and subsidies
5.- foreign exchange and border prices
6.- other

f.- income distribution effects

1.- welfare criteria
2.- regional/sectorial impacts
3.- socio-economic impacts
4.- savings versus consumption trade-offs

g.- evaluation of uncertainty

1.- general concepts
2.- elements of uncertainty in a project's structure
3.- decision making under conditions of uncertainty

RECOMMENDED INSTRUCTOR'S READINGS:

1.- **Squire, L. and H.G. Van der Tak,** (1981). Economic Analysis of Projects. 4th. printing. The Johns Hopkins University Press, Baltimore, Maryland.

ADDITIONAL SUGGESTED BIBLIOGRAPHY:

Gittinger, J.P., (1982). Economic Analysis of Agricultural Projects. 2nd. edition. The Johns Hopkins University Press, Baltimore, Maryland.

Little, I.M.D. and J.A. Mirrlees, (1974). Project Appraisal and Planning for the Developing Countries. Heinemann Educational Books, Maryland.

Ray, A., (1984). Cost-Benefit Analysis: Issues and Methodologies. The World Bank. The Johns Hopkins University Press, Baltimore, Maryland.

UNIDO, (1978). Guide to Practical Project Appraisal. United Nations, New York.

UNIT #17 HOMEWORK EXERCISE

GENERAL ECONOMIC ANALYSIS THEORY

Based on the material presented in class prepare a brief essay (approximately 250 words) discussing one of the following topics:

a.- The principal differences and similarities between financial, economic, and socio-economic analyses.

b.- The principal problems that exist in your country in terms of the identification, formulation and preparation of investment projects in the public sector, and the problems that you can identify in trying to incorporate natural hazards considerations into such projects.

EXAM QUESTIONS:

1.- Describe the principal methods that have been developed for project appraisal clearly stating their similarities and differences in terms of their objectives, criteria, and procedures.

2.- List and describe the structure and components of the project cycle.

3.- Discuss the principal issues in the appraisal of investment projects.

4.- Describe the principal accounting measures and standards used in the appraisal of investment projects.

5.- Describe the principal elements of uncertainty that can be found in investment projects, and explain how are they normally dealt with at the appraisal stage.

END OF UNIT #17

UNIT #18: COURSE CASE STUDY PRESENTATION (PART III)

OBJECTIVE: Present a review of the financial and economic data of the investment project(s) of the course case study. Provide participants with the necessary data and information for group discussion and analysis.

TIME ALLOTMENT: 1 hour

CONTENTS:

To be determined in accordance to the specific case study selected for the course.

END OF UNIT #18

UNIT #19: PROJECT FORMULATION AND NATURAL HAZARDS

OBJECTIVE: Provide participants with a detailed understanding of the project formulation process and the different ways to incorporate natural hazards considerations. Generate an awareness of the importance of adequate project formulation for economic development planning.

TIME ALLOTMENT: 9 hours

CONTENTS:

1.- Introduction

a.- scope of the project formulation phase

b.- relevance of the project formulation phase

1.- with respect to the specific project
2.- with respect to global development planning

2.- Market studies

a.- general description

b.- standard practices

c.- issues which should include natural hazards considerations

1.- determination of market areas
2.- product's supply and demand analysis
3.- price analysis
4.- commercialization strategies
5.- project's market range
6.- other

3.- **Determination of size and location**

a.- general description

b.- standard practices

c.- issues which should include natural hazards considerations

1.- current and expected demands
2.- technical-economical constraints to plant size
3.- geographical and temporal availability of inputs
4.- geographical and temporal cost of inputs
5.- regional development policies
6.- market proximity
7.- transportation and communications
8.- other

4.- Project engineering

a.- general description

b.- standard practices

c.- issues which should include natural hazards considerations

1.- selection of the production technology
2.- specification of equipment and floor location
3.- infrastructure and buildings design and location
4.- production process flexibility
5.- operating schedule
6.- other

5.- Investment calculations

a.- general description

b.- standard practices

c.- issues which should include natural hazards considerations

1.- capital investment
2.- equipment and buildings
3.- land and natural resources
4.- engineering and administration
5.- implementation
6.- other

6.- Cash flow analysis

a.- general description

b.- standard practices

c.- issues which should include natural hazards considerations

1.- inputs and other materials
2.- energy and fuels
3.- insurance and taxes
4.- depletion of natural resources
5.- other

7.- Financing assessment

a.- general description

b.- standard practices

c.- issues which should include natural hazards considerations

1.- financing sources
2.- financing conditions
3.- other

8.- Organization and implementation

a.- general description

b.- standard practices

c.- issues which should include natural hazards considerations

1.- legal dispositions
2.- installation and operation
3.- other

RECOMMENDED INSTRUCTOR'S READINGS:

1.- UNDRO, (1979). Disaster Prevention and Mitigation, Vol. 7. Economic Aspects. United Nations, Geneva, Switzerland.

ADDITIONAL SUGGESTED BIBLIOGRAPHY:

Cohan, H., (1975). "Introduccion al Tema Proyectos." Lecture Notes (Mimeo #48). IICA, Montevideo, Uruguay.

Dasgupta, P. et al., (1972). Guidelines for Project Evaluation. United Nations, New York.

FAO - World Bank Cooperative Programme, (1977). Guidelines for the Preparation of Agricultural Investment Projects. FAO, Rome.

UNDRO, (1980). Disaster Prevention and Mitigation, Vol. 9. Legal Aspects. United Nations, Geneva, Switzerland.

UNIT #19 HOMEWORK EXERCISE

PROJECT FORMULATION AND NATURAL HAZARDS

Based on the material presented in class prepare a brief essay (approximately 250 words) discussing one of the following topics:

a.- The principal elements of a market study related to an agricultural development project for the production of an essential national consumption or export product in which you would explicitly incorporate natural hazards considerations (Start by specifying the project that you will consider.)

b.- The principal elements of a size and location study related to an integrated hydro-power plant/irrigation system project in which you would explicitly incorporate natural hazards considerations (Start by specifying the project that you will consider.)

c.- The principal elements of a project engineering study related to a capital intensive industrial project in which you would explicitly incorporate natural hazards considerations (Start by specifying the project that you will consider.)

EXAM QUESTIONS:

1.- Describe the principal elements of the project formulation process, providing examples of their components.

2.- Describe the principal components of a market study which should incorporate natural hazards considerations. Briefly explain, for each case, how would you go about doing so.

3.- Describe the principal components of an investment project location study which should incorporate natural hazards considerations. Briefly explain, for each case, how would you go about doing so.

4.- Describe the principal components of an engineering study which should incorporate natural hazards considerations. Briefly explain, for each case, how would you go about doing so.

5.- Explain in which components of a project's investment calculations should natural hazards be considered. Be sure to justify your answer.

END OF UNIT #19

UNIT #20: REVIEW OF PROBABILITY THEORY

OBJECTIVE: Review the basic statistical concepts that are required to work with probabilistic data within project appraisal.

TIME ALLOTMENT: 3 hours

CONTENTS:

1.- Probabilistic nature of natural hazards

a.- moderate event models

b.- extreme event models

c.- rapid versus slow on-set hazards

2.- General probability theory

a.- probability

b.- random variables

c.- accumulated probability

d.- probability density functions

3.- Representation of probability distributions

a.- general representation

b.- general representation for extreme values

c.- theoretical distribution for extreme values

d.- derivation of probability distribution

e.- three point distribution

f.- use of probabilistic information in project appraisal

RECOMMENDED INSTRUCTOR'S READINGS:

1.- Irvin, G., (1978). Modern Cost-Benefit Methods: An Introduction to Financial, Economic and Social Appraisal of Development Projects, (Chapter III). Harper and Row Publishers, Inc., London, England.

ADDITIONAL SUGGESTED BIBLIOGRAPHY:

Billingsley, P., (1986). Probability and Measure. 2nd Edition. John Wiley and Sons, New York.

Hamett, D. and J.L. Murphy, (1980). Introductory Statistical Analysis. 2nd Edition. Addison Wesley Publishing Co., Reading, Massachusetts.

Larson, H.J., (1974). Introduction to Probability Theory and Statistical Inference. 2nd Edition. John Wiley and Sons, New York.

EXAM QUESTIONS:

1.- Explain why most natural hazards are probabilistic in nature.

2.- Using seismic and flood hazards as examples, discuss the incorporation and evaluation of natural hazards in project appraisal strictly from a probabilistic point of view.

3.- Define the following terms:

a.- normal distribution

b.- random variable

c.- three point distribution

d.- accumulated probability function

4.- Describe the principal probability distribution representation forms providing a brief explanation of their main characteristics.

5.- Explain when would you want or need to derive a "subjective" probability distribution and describe the process that you would use to do so.

END OF UNIT #20

UNIT #21: TECHNICAL FIELD TRIP II BRIEFING

OBJECTIVE: Brief participants on the field trip technical content and schedule, including a detailed analysis of the geographic context and location of the sites to be visited, the natural hazards phenomena that are expected to be observed, and corresponding technical information.

TIME ALLOTMENT: 2 hours

CONTENTS:

To be determined in accordance to the specific case study that is chosen for the course.

END OF UNIT #21

UNIT #22: TECHNICAL FIELD TRIP II

OBJECTIVE: Provide participants with the opportunity to visit an area with multiple and large scale natural hazards problems, and to assess the level of assimilation of the material presented thus far in the course by the participants.

TIME ALLOTMENT: 36 hours

CONTENTS:

To be determined in accordance to the specific field trip that is selected for the course.

HOMEWORK EXERCISE: Preparation of individual field trip reports containing a chronological schedule of sites visited, principal hazards phenomena observed, and observations related to the planning of social and economic development projects, and observed and desirable hazard mitigation techniques.

END OF UNIT #22

UNIT #23: NATURAL HAZARDS AND PROJECT EVALUATION

OBJECTIVE: Provide participants with a detailed understanding of several techniques for incorporating natural hazards considerations into the process of economic evaluation of investment projects.

TIME ALLOTMENT: 9 hours

CONTENTS:

1.- Risk and uncertainty issues associated to natural hazards

a.- the question of risk aversion

1.- individual behavior
2.- government's behavior
3.- lending institution's behavior

b.- economic evaluation of natural hazards

1.- impact of an event
2.- probability of occurrence
3.- vulnerability

2.- Methods for incorporating natural hazards considerations into project appraisal under limited information conditions

a.- cut-off period

1.- description
2.- application
3.- information requirements
4.- problems and opportunities

b.- adjustments in the discount rates

1.- description
2.- application
3.- information requirements
4.- problems and opportunities

c.- maxi-min (game theory)

1.- description
2.- application
3.- information requirements
4.- problems and opportunities

d.- mini-max regret (game theory)

1.- description
2.- application
3.- information requirements
4.- problems and opportunities

e.- sensitivity analysis

1.- description
2.- application
3.- information requirements
4.- problems and opportunities

2.- Methods for incorporating natural hazards considerations into project appraisal with probabilistic information

a.- mean variance analysis

1.- description
2.- application
3.- information requirements
4.- problems and opportunities

b.- safety first analysis

1.- description
2.- application
3.- information requirements
4.- problems and opportunities

c.- "Monte Carlo" and other special models

1.- description
2.- application
3.- information requirements
4.- problems and opportunities

RECOMMENDED INSTRUCTOR'S READINGS:

1.- **Department of Regional Development,** (1986). "The Use of Natural Hazards Information in the Economic Analysis of Agricultural Projects." Organization of American States, Washington, D.C. **(See Annex III.23.1)**

2.- **Pouliquen, L.Y.,** (1979). Risk in Project Appraisal. The Johns Hopkins University Press, Baltimore, Maryland.

ADDITIONAL SUGGESTED BIBLIOGRAPHY:

Anderson, J.R. et al., (1979). Agricultural Decision Analysis. Iowa State Univesity Press, Ames, Iowa.

Anderson, L.G. and R.F. Settle, (1977). Benefit-Cost Analysis: A Practical Guide. Lexington, Mass. D.C., Heath.

Baum, W.C., (July 1980). "Risk and Sensitivity Analysis." The World Bank Central Projects, Washington, D.C.

Pandey, S., (March 1983). "Incorporating Risk in Project Appraisal: A Case Study of a Nepalese Irrigation Project." A/D/C - APROSC, Research Paper Series #18, Kathmandu, Nepal.

Reutlinger, S., (1979). Techniques for Project Appraisal Under Uncertainty. The Johns Hopkins University Press, Baltimore, Maryland.

UNIT #23 HOMEWORK EXERCISE

NATURAL HAZARDS AND PROJECT EVALUATION

Based on the material presented in class prepare two brief essays (each approximately 150 words) discussing <u>two</u> of the following topics:

a.- The traditional attitude of government agencies and banking institutions in respect to risk considerations in the process of selecting investment projects, and your views on how should they treat the risk and uncertainty associated with natural hazards.

b.- The principal problems and opportunities of the cut-off period, adjustment in the discount rates, maxi-min, mini-max regret and sensitivity analysis methods for considering natural hazards issues in the evaluation of investment projects in the public sector.

c.- The principal problems and opportunities of the mean-variance, safety first, and Monte Carlo methods for considering natural hazards issues in the evaluation of investment projects in the public sector.

EXAM QUESTIONS:

1.- Discuss what are the traditional attitudes of individuals, governments, and lending institutions about risk and uncertainty related to natural hazards.

2.- Which are the three basic types of information that are required to economically assess natural hazards?

3.- Describe, providing practical examples, the methods reviewed in class to incorporate natural hazards into project appraisal under limited information conditions.

4.- Describe, providing practical examples, the methods reviewed in class to incorporate natural hazards into project appraisal with probabilistic information.

5.- Explain why or why not the traditionally used "mean expected analysis" is useful in accounting for natural hazards in the appraisal of development projects.

END OF UNIT #23

UNIT #24: COURSE CASE STUDY WORKSHOP

OBJECTIVE: Provide participants with the opportunity to participate in a multidisciplinary working group on a practical natural hazards problem. Expose participants to the principal difficulties involved in incorporating natural hazards into development planning. Provide participants and instructors with an opportunity to use the knowledge assimilated during the course.

TIME ALLOTMENT: 15 hours

WORKSHOP TECHNICAL OBJECTIVES:

Working groups must analyse the case study area, its natural hazards issues, and the characteristics of the proposed investment project(s), and prepare a report containing:

a.- a detailed description of the general characteristics of the case study area;

b.- a description of natural hazards as they affect the case study area;

c.- a description of the expected impact of natural hazard events on the current and projected human and economic life;

d.- a detailed account of the impacts expected on the specific investment project(s) being considered; and,

e.- a comprehensive set of recommendations for the implementation of economic analysis methods that incorporate natural hazards mitigation techniques into investment project formulation.

END OF UNIT #24

SUMMARY OF THE ANNEXES TO PART III (*)

III.2.1.- Handout on the Vicious Cycle of Disasters

III.2.2.- Handout on Natural Hazards and Integrated Development Planning

III.2.3.- Handout on Natural Hazards and Integrated Development Planning

III.3.1.- Handout on Concept of Ecosystems

III.3.2.- Handout on Natural Goods and Services

III.3.3.- Handout on Natural Hazards

III.3.4.- Handout on Environmental Impacts

III.3.5.- Unit #3 Homework Exercise

III.10.1.- Unit #10 Classroom Exercise

III.12.1.- Unit #12 Classroom Exercise

III.15.1.- Handout on the Economic Planning Process

III.15.2.- Handout on Natural Hazards Trade-Off Analysis

III.23.1.- Handout on Natural Hazards and Project Evaluation

Note:(*) Refer to **VOLUME II: COURSE MANUAL ANNEXES**

Numeration of annexes corresponds to the specific section to which they are related and, thus, the numeration used will not necessarily be consecutive.

DEPARTMENT OF REGIONAL DEVELOPMENT
ORGANIZATION OF AMERICAN STATES

Natural Hazards Risk Assessment and Disaster Mitigation Pilot Project in Latin America and the Caribbean Basin

COURSE ON THE USE OF NATURAL HAZARDS INFORMATION IN THE PREPARATION OF INVESTMENT PROJECTS

V O L U M E I I

C O U R S E M A N U A L A N N E X E S

The Natural Hazards Pilot Project of the Department of Regional Development receives support from the United States Agency for International Development/Office for Foreign Disaster Assistance (USAID/OFDA). This manual is based on two pilot courses presented by the project in Merida, Venezuela, during 1986 with the collaboration of the InterAmerican Center for the Integral Development of Water and Land (CIDIAT).

COURSE ON THE USE OF NATURAL HAZARDS INFORMATION IN THE PREPARATION OF INVESTMENT PROJECTS

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III.2.2.- Handout on Natural Hazards and Integrated Development Planning

III.2.3.- Handout on Natural Hazards and Integrated Development Planning

II.3.1.- Handout on Concept of Ecosystems

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II.12.1.- Unit #12 Classroom Exercise

II.15.1.- Handout on the Economic Planning Process

II.15.2.- Handout on Natural Hazards Trade-Off Analysis

II.23.1.- Handout on Natural Hazards and Project Evaluation

INTRODUCTION

VOLUME II: COURSE MANUAL ANNEXES is intended as a support document and guide to facilitate the preparation and presentation of the course. The material presented was either used in the pilot courses that were presented in Merida, Venezuela, in 1986, or was subsequently added to complement the course manual. In both cases the material responds to the original course objectives and orientation and, therefore, it is expected that they will have to be revised in the context of future course offerings. Likewise, instructors are encouraged to change, delete and/or add material in accordance with their teaching methods.

When using this document attention should be paid to the fact that the numeration of the annexes corresponds to the specific section to which they are related in VOLUME I and, thus, the numeration used is not necessarily consecutive.

ANNEXES TO PART I

ANNEX I.6.1.- COURSE BUDGET FORMAT SAMPLE

ANNEX I.6.1.- COURSE BUDGET SAMPLE

Item	Sponsoring Organization	Co-Sponsoring Organization(s)	Total
1. Participants			
1.1. Travel and terminal expenses	-----	-----	-----
1.2. Subsistence allowance	-----	-----	-----
1.3. Medical insurance	-----	-----	-----
1.4. Photocopying allowance	-----	-----	-----
1.5. Postage allowance	-----	-----	-----
1.6. Sub-total	-----	-----	-----
2. Contracted Instructors			
2.1. Honorarium	-----	-----	-----
2.2. Travel and terminal expenses	-----	-----	-----
2.3. Per diem	-----	-----	-----
2.4. Other	-----	-----	-----
2.5. Sub-total	-----	-----	-----
3. Training Center			
3.1. Administrative Costs	-----	-----	-----
3.2. Instructors	-----	-----	-----
3.3. Secretarial support	-----	-----	-----
3.4. Facilities usage	-----	-----	-----
3.5. Basic course material acquisition	-----	-----	-----
3.6. Equipment rental	-----	-----	-----
3.7. Photocopying	-----	-----	-----
3.8. Telephone and telex	-----	-----	-----
3.9. Postage	-----	-----	-----
3.10. Local transportation	-----	-----	-----
3.11. Course announcements and promotion	-----	-----	-----
3.12. Course summary publication	-----	-----	-----
3.13. Entertainment	-----	-----	-----
3.14. Other	-----	-----	-----
3.15. Sub-total	-----	-----	-----

ANNEX I.6.1.- COURSE BUDGET SAMPLE (Cont.)

Item	Sponsoring Organization	Co-Sponsoring Organization(s)	Total
4. Field Trips			
4.1. Transportation	-----	-----	-----
4.2. Food	-----	-----	-----
4.3. Lodging	-----	-----	-----
4.4. Fees and permits	-----	-----	-----
4.5. Other	-----	-----	-----
4.6. Sub-total	-----	-----	-----
5. Total	-----	-----	-----

Notes:

ANNEXES TO PART II

ANNEX II.2.1.- COURSE EVALUATION QUESTIONNAIRES

***** FIRST COURSE EVALUATION *****

INSTRUCTIONS: FILL IN THE BLANKS ASSIGNING GRADES FROM 1 TO 5 USING THE FOLLOWING SCALE:

1 - POOR 2 - BELOW AVERAGE 3 - AVERAGE
4 - GOOD 5 - EXCELLENT

** FIRST AND SECOND WEEK UNITS **	INSTRUCTOR/ LEADER	SUBJECT RELEVANCE	LECTURER COMPETENCE
COURSE INTRODUCTION	(type-in name)		
NATURAL HAZARDS AND THE PROCESS OF INTEGRATED DEVELOPMENT PLANNING	" "		
ENVIRONMENTAL MANAGEMENT AND NATURAL HAZARDS	" "		
HYDROLOGIC AND ATMOSPHERIC HAZARDS	" "		
FLOOD HAZARDS	" "		
INTRODUCTION TO GEOLOGIC HAZARDS	" "		
SEISMIC AND VOLCANIC HAZARDS	" "		
PRESENTATION OF COURSE CASE STUDY (I)	" "		
TECHNICAL FIELD TRIP I	" "		
MASS-MOVEMENT HAZARDS	" "		
LAND USE AND SOIL DEGRADATION HAZARDS	" "		
MULTIPLE GEOLOGIC HAZARDS AND LIFELINE NETWORK MAPPING	" "		
NATURAL HAZARDS INFORMATION SYSTEMS AND SOURCES	" "		
PRESENTATION OF COURSE CASE STUDY (II)	" "		

GENERAL COMMENTS:

***** FINAL COURSE EVALUATION *****

INSTRUCTIONS: FILL IN THE BLANKS ASSIGNING GRADES FROM 1 TO 5 USING THE FOLLOWING SCALE:

1 - POOR 2 - BELOW AVERAGE 3 - AVERAGE
4 - GOOD 5 - EXCELLENT

** THIRD AND FOURTH WEEK UNITS **	INSTRUCTOR/ LEADER	SUBJECT RELEVANCE	LECTURER COMPETENCE
ECONOMIC PLANNING AND NATURAL HAZARDS	(type-in name)		
MULTICRITERIA ANALYSIS AND INTEGRATED DEVELOPMENT PLANNING	" "		
GENERAL ECONOMIC ANALYSIS THEORY	" "		
PRESENTATION OF COURSE CASE STUDY (III)	" "		
PROJECT FORMULATION AND NATURAL HAZARDS	" "		
REVIEW OF PROBABILITY THEORY	" "		
TECHNICAL FIELD TRIP II BRIEFING	" "		
TECHNICAL FIELD TRIP II	" "		
NATURAL HAZARDS AND PROJECT EVALUATION	" "		
COURSE CASE STUDY WORKSHOP	" "		

GENERAL COMMENTS:

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**** F I N A L C O U R S E E V A L U A T I O N ****

*** OVERALL EVALUATION CRITERIA ***	CODE	GRADE
1. Coordination of the course:		
a. Leadership effectiveness	1	
b. Assistance to participants	2	
2. Different teaching methods:		
a. Lectures	3	
b. General talks	4	
c. Technical field trips	5	
d. Film / videos	6	
e. Participants case studies	7	
f. Workshop case study	8	
g. Classroom exercises	9	
h. Homework exercises	10	
3. The quantity of information presented:	11	
4. The quality of information presented:	12	
5. The quantity of resource materials and bibliography:	13	
6. The quality of resource materials and bibliography:	14	
7. The course work schedule:	15	
8. Quantity and quality of audio-visual equipment and systems used:	16	

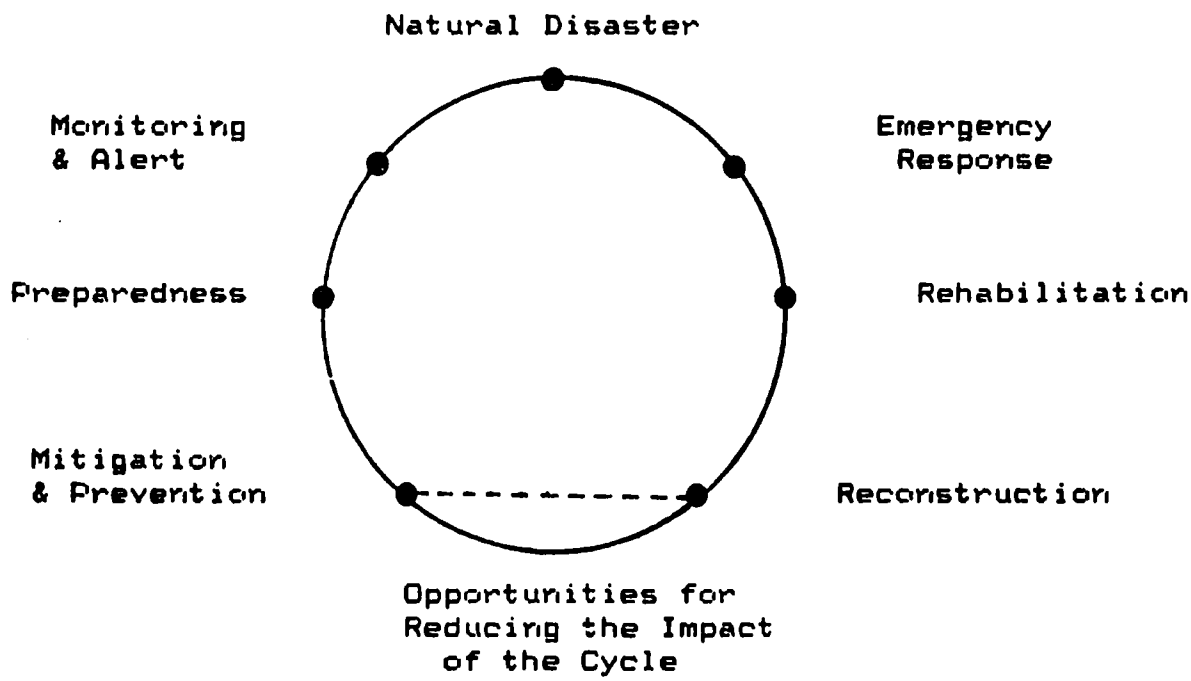
*** OVERALL EVALUATION CRITERIA ***	CODE	GRADE
9. The balance of course components between:		
a. Theoretical and practical sessions	17	
b. Individual and group work	18	
10. The working / living conditions:		
a. Work environment	19	
b. Accommodations	20	
c. Meals	21	
11. Number of course participants:	22	
12. Balance of course participants:		
a. Professional fields	23	
b. Levels of working experience	24	
c. Countries (or regions)	25	
13. Assessment of personal performance in the course:		
a. Assimilation of materials	26	
b. Contribution to the course	27	
c. Participation in class	28	
d. Participation in field trips	29	
e. Participation in group work	30	

ANNEXES TO PART III

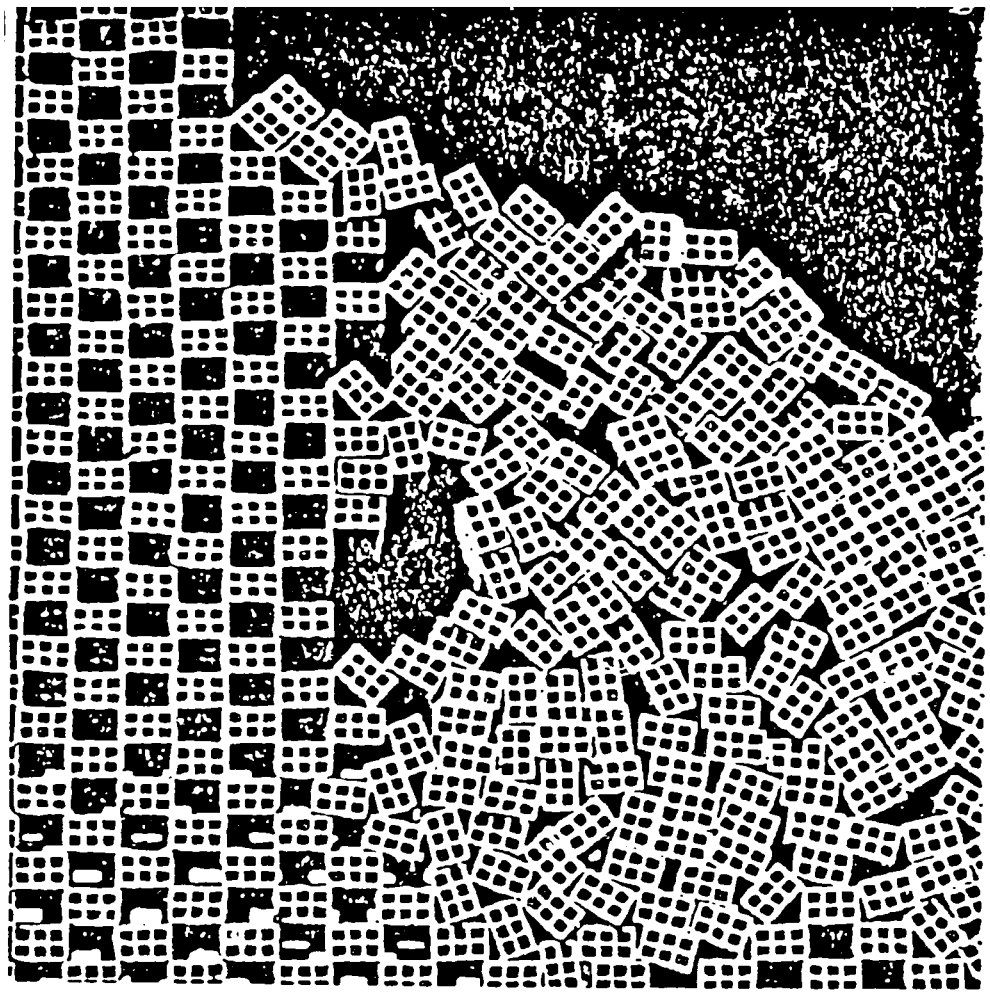
ANNEX III.2.1.- HANDOUT ON THE VICIOUS CYCLE OF DISASTERS

ANNEX III.2.1

THE VICIOUS CYCLE OF DISASTERS



ANNEX III.2.2.- HANDOUT ON NATURAL HAZARDS AND INTEGRATED DEVELOPMENT PLANNING



PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON DISASTER MITIGATION PROGRAM IMPLEMENTATION

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CENTER FOR INTERNATIONAL DEVELOPMENT PLANNING AND BUILDING, COLLEGE OF ARCHITECTURE AND URBAN STUDIES, VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

DISASTER MITIGATION AS PART OF INTEGRATED REGIONAL DEVELOPMENT PLANNING

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PART I

INTRODUCTION

In the past, disaster management in Lesser Developed Countries (LCDs) has concentrated on reacting to the damage caused by natural phenomena. The reduction of the vulnerability levels of production facilities, infrastructure, and human settlements to natural hazard risks was frequently not explored. As a consequence, the need for massive local and foreign assistance for post-disaster relief and reconstruction has increased dramatically as ever larger segments of LDCs' population—particularly the poor—and ever greater portions of their productive capacity are affected each year by disasters. While disaster prevention is widely recognized as the most efficient and effective means of reducing damage and loss of life, mitigation measures have proved extremely difficult to implement. Mitigation implementation ought to be part of development activities and the development planning process must include natural hazard risk assessment and mitigation measure identification if significant reductions in the damage caused by natural phenomena are to be achieved.

1.1 The OAS/Department of Regional Development Natural Hazards Pilot Project.

The Organization of American States through its Department of Regional Development (OAS/DRD), with the support of the United States Agency for International Development and its Office of Foreign Disaster Assistance (USAID/OFDA), has undertaken an initiative to incorporate natural hazard risk assessment and mitigation measure identification into the integrated regional development planning process through the "Natural Hazard Risk Assessment and Disaster Mitigation Pilot Project in Latin America and the Caribbean Basin" (NHP).

With the intention of modifying development activities so that potential disaster can be avoided, the NHP seeks to:

(1) assess natural hazard risk as part of natural resource evaluation and development strategy formulation;
(2) identify and formulate mitigation measures for development investment projects;
(3) improve information interchange; and
(4) train planning technicians and decision makers in risk assessment and disaster mitigation techniques.

The NHP is bringing to the disaster management area a decidedly focused approach, as will be quickly observed in this case study. It is an effort in researching, field testing and implementing disaster mitigation measures through integrating appropriate technical information into real technical assistance activities. The NHP, recognizing the special role that integrated regional development planning plays in LDCs, is attempting to expand that role in the short term using the resources at hand while collaborating in drawing up an agenda for intermediate and long term mitigation research and implementation activities.

*(The views expressed in this case study are those of the author, and do not necessarily represent those of the Organization of American States.)

1.2 The Three Pilot Country Integrated Regional Development Planning Studies

To reach these objectives, the NHP is acting as a technical component in three ongoing integrated regional development planning studies already underway where the national government has requested OAS/DRD technical assistance. The countries are Honduras, Paraguay and Saint Lucia. In Honduras, the planning study covers the Caribbean Departments of Las Islas de Bahia and Atlantida with an emphasis on restructuring the agricultural production sector and developing the fishing and tourism industries. In Paraguay, the study covers the Paraguayan Chaco and focuses on structuring agricultural, industrial and colonization activities. In St. Lucia, the study covers the entire island and focuses on natural resource management, land use planning and settlement development.

These three planning studies offer a rich diversity of geographical settings, natural resource endowment, and population density, as well as a mix and prevalence of different natural hazards— earthquakes, volcanoes, hurricanes, major flood events and incipient desertification. The experiences gained through these three planning studies as well as knowledge of planning activities and disaster mitigation implementation issues in other OAS Member States form the basis for this case study.

PART 2

MITIGATION AND THE INTEGRATED REGIONAL DEVELOPMENT PLANNING PROCESS

2.1 The Stages of the Planning Process

The OAS/DRD development planning process is comprised of four stages: The Preliminary Mission, Execution: Phases I and II, and the Implementation Phase (see Figure 1).

The purpose of the Preliminary Mission is to collect available information, diagnose problems and potentials, and define a preliminary set of objectives for the planning study. This preliminary diagnosis involves creating a profile of the natural resources base and the economic development potential, and identifying in a preliminary manner those areas most apt for sustaining development activity. In Phase I a detailed analysis of development potentials and problems with emphasis on natural resource management issues is prepared. From this detailed analysis, a multisectoral development strategy is proposed and a series of sectoral investment ideas are formulated for government review. Based on its decision, Phase II is undertaken to prepare detailed studies of packages of investment projects, usually at the prefeasibility stage, and an action plan. The role of the production sectors, support infrastructure, and human settlements is defined for each package of projects. The final stage deals with the implementation of investment projects. During this stage, support is given to final project design preparation and institutional, financial and technical activities to implement the projects.

2.2 Risk Assessment and Mitigation Measures Information Needs

To address mitigation needs, specific information must be incorporated into the various stages of the regional development planning process. This information can be divided into four groupings.

(1) *Natural phenomena:* As part of natural resource investigation, the presence and effect of natural phenomena on the goods and services that natural resources provide must be determined.

(2) *Natural risk assessment:* As part of natural resource evaluation, risk assessment information qualifies the impact natural phenomena have on natural resource potential and possible development activities.

(3) *Post disaster investigations:* Following the occurrence of natural events which result in disaster, be they major or not, post-disaster investigations further describe the qualitative and quantitative aspects of natural hazards, often supplanting the lack of historical observation and scientific research.

(4) *Lifeline network identification and vulnerability analysis:* Lifeline networks for production facilities, infrastructure networks and support systems to settlements define those critical segments or components which should have the lowest damage vulnerability or which should be recognized as priority elements for rehabilitation following a disaster.

In accordance with these groupings, the NHP has identified key information pieces that are required for effective mitigation to take place through the planning process (see Figure 2):

(a) In the Preliminary Mission, information concerning natural phenomena, the presence or absence of hazards, and post-disaster damage evaluation of the study area should be collected. The presence of hazards will indicate the need for further qualitative assessment as it affects natural resource management and economic development potential.

(b) In Phase I an assessment of the risks that natural hazards present to the study area should be prepared. Existing critical segments or portions of production facilities, infrastructure and settlements in high risk areas should be identified through examining risk and lifeline network maps. The vulnerability of those segments or portions should also be determined. The development strategy is affected by the presence of hazards, and hazard mitigation is a consideration in the identification of sectoral development projects.

(c) In Phase II specific mitigation measures for selected investment projects should be determined as well as vulnerable lifeline network elements for disaster preparedness activities. The presence of hazards should affect specific site selection, project engineering design and economic feasibility of development investment projects.

(d) In the Implementation Phase, the monitoring of mitigation implementation and disaster preparedness activities provides information for evaluation of development studies in execution and the formulation of new development studies and disaster management activities.

The information pertaining to these four stages is presently generated by three principal networks: international and national, natural phenomena research and monitoring centers and universities, disaster management entities, and multisectoral and sectoral planning agencies and operational secretariats and ministries. The source of financial support, staff training, subject areas of responsibility, and role in mitigation program implementation of these networks varies greatly from country to country, as does their interrelationship. The situation can be generally characterized, however, by an emerging disaster management program, resource constraints in the area of natural phenomena research and monitoring, and a planning process that is under tremendous pressure to design and implement economic development programs in the absence of natural hazard risk information.

2.3 Information Provided by and to Disaster Management Programs

Most national disaster management programs are beginning to establish linkages with research and monitoring activities, and development planning programs. These linkages attempt to cover the four above-mentioned information groupings. The role played by disaster management programs varies from country to country and in respect to each of the groupings.

The generation of natural phenomena and risk assessment information has been and is primarily an activity carried out by research and monitoring centers and universities as well as by operational entities such as the ministries of agriculture, transportation, public works, and defense. Disaster management programs are pointing out the need for inter-institutional coordination in the selection of subjects to be carried out, and the collection, dissemination and use of the information generated. When presented with a need for further natural

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resource information, development planning studies are fulfilling a role not unlike the one just described, and by doing so, they support the efforts of the incipient mitigation program.

Following a catastrophic event, disaster management programs usually take the lead in generating damage assessments and relief need analysis, supported by sectoral studies for funding and executing rehabilitation activities. These individual investigations can be quite detailed, and when considered as a group, they are quite comprehensive. Overall analysis of the disaster and its impact are sometimes undertaken by research groups and universities. But often their usefulness in formulating reconstruction programs in the context of development planning is overlooked. Moreover, development planning studies, lacking a comprehensive view of the results of the disaster, may not consider sectoral reports and the implications of rehabilitation efforts.

As far as identifying lifeline networks, little has been done in this area by any group although disaster management programs recognize its importance. Likewise, assessing the vulnerability of the networks to natural hazards is rarely done given the lack of risk assessment information availability.

2.6 General Impact to Date of Natural Disasters on Mitigation Program Implementation

It would have to be said that the principal driving force behind mitigation program implementation has been the increased incidence of damage caused by natural hazards and the occurrence of major natural events in Latin America and the Caribbean in the past twenty-five years. The impact of these occurrences has stimulated support, particularly from international funding sources, for basic natural phenomena study and risk assessment and some ill-fated event prediction efforts. Increased support, both national and international, has been given to disaster management activities. The primary focus of these activities has been the creation of a national disaster relief organization, and the assignment of specific responsibilities for disaster preparedness, relief and rehabilitation actions.

The greatest impact on national, regional and local development planning processes has been the formulation of reconstruction programs following major disasters. The degree to which these programs have been integrated into existing planning processes varies considerably from country to country and occurrence to occurrence. The most typical response has been the creation of a reconstruction planning process in parallel with existing planning processes. Reconstruction programs are often supported by major international technical assistance and funding programs, and the preference has been to implement reconstruction programs outside of the mainstream of development activities in the hopes of expediting execution and avoiding existing bureaucratic delays.

The result of this dual development planning approach has often led to sectoral reconstruction efforts taking place without an assessment of the post-disaster reality of the particular affected area. The natural event may have altered substantially the conformation of the natural resource potential, if by nothing other than making clearly evident the natural hazard risk and the vulnerability of pre-disaster development activities. The resultant damage from the event has almost always necessitated a reevaluation of existing development policies and sectoral projects. In many cases, such policies and projects are no longer appropriate to the needs of the area, nor do they coincide with the best use of its natural resources. Reconstructing damaged production facilities, infrastructure and settlements without formulating a comprehensive development strategy based on the post-disaster situation has often lead to missed opportunities for incorporating disaster mitigation measures and recognizing the influence natural hazard risks have on development planning decisions.

PART 8

EXPERIENCES TO DATE OF THE NATURAL HAZARDS PROJECT

To date, NHP has participated with the OAS/DRD planning studies serving as pilot projects in the three countries in the preliminary mission and natural resources evaluation stages. While the actual timing of the NHP activities has varied, several general observations can be made from the experiences gained thus far. These experiences have allowed the NHP to further refine the orientation and content of programmed technical activities for its future activities as well as influence those of the planning studies.

8.1 Initial Information Collection and Analysis

It should be noted again that the OAS/DRD technical assistance activities are taking place in the context of the individual country's development planning process. As such, natural hazard risk assessment and mitigation measure identification activities are taking place in parallel with the two other main activity areas related to natural hazards: disaster management and basic research concerning natural phenomena. The presence of NHP activities has promoted a recognition of these three areas of activities and has set in motion, to varying degrees, a dialogue between the participants of the three areas.

The majority of the activities carried out by the NHP to date are related to the preliminary mission stage, that is, the collection of existing information concerning natural hazards, associated risk assessment information, identification of existing mitigation measures, and the review of specific catastrophic natural hazard events. In addition to this information, which focuses on the study area (national or sub-national), the NHP has also inventoried international programs and projects related to natural hazard risk assessment which are, or may be of use to the individual country given the type of integrated regional development planning study that is being undertaken.

The types of information collected to date cover geological and meteorological events including earthquakes, volcanoes, hurricanes, floods and drought. The origin of this information is from diverse sources since in most cases there does not exist a designated entity with the responsibility to collect and analyze natural phenomena, risk, and post-disaster evaluation information. Thus, visits were made to sectoral development agencies, universities and research centers, national disaster relief offices, and international development, financing, and relief agencies to collect available information.

The information collected also varied in detail and scale. In the case of Paraguay and St. Lucia, base maps and natural resource information had been prepared as part of work previously undertaken by the OAS/DRD and the national counterpart. Thematic maps at a common scale covering precipitation, geology, soil classification, vegetation, land capability and land use were prepared by the OAS/DRD project team drawing on previously completed natural resource studies studies and project field work. In the case of Honduras, the preparation of these maps is programmed as part of the activities to be carried out during the initial stages of the planning study. In all three cases, this natural resource information will form the basic reference for subsequent natural hazard risk analysis.

Other types of information collected included maps and studies covering specific natural event occurrences, location of geologic faults and volcanoes, and deforestation, as well as inventories of agencies assigning responsibility for disaster relief activities. International programs covering agroclimate forecasting, seismic monitoring networks and tsunami research were also identified.

In no case were there found already-prepared individual or aggregate natural hazards risk maps or lifeline network maps. For example, in Honduras there is a lack of historical information, monitoring equipment, and technical data to determine possible hurricane surge tide levels and seismic risk. For St. Lucia, information is lacking to identify significant differ-

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cases in hurricane risk for different areas of the island. In Paraguay, basic flood plain definition information is lacking.

2.2 Use of Available Information by the Development Planning Process

The development planning process used by the OAS/DRD in its technical assistance activities in each of the pilot countries is, in general, expanding the focus of the existing process in that country. This is manifested in two important ways. The OAS/DRD development planning process is generating an understanding of the natural resource base upon which economically sustainable development activities should be identified. The NHP, in turn, is introducing into this process an evaluation of natural events and the risks, as well as the benefits, they present in order to have a better understanding of that resource base. Second, the process will generate a group or package of sectoral development investment projects which are interrelated. These projects are explained in terms of their use of the natural resource base and justified by their relationship to each other in space and in time. Thus these projects should contain those mitigation measures necessary to assure that the vulnerability of these projects is within social and economic parameters acceptable to the country.

The natural resource and hazard risk information available, while limited at the present time, can influence the development strategy proposed by the development planning study and the corresponding investment projects that are prepared for eventual financing and execution. The NHP is assisting the planning team in reviewing the available information so that the maximum use of its risk assessment information can be achieved.

To begin with, the NHP is identifying areas for natural phenomena research and risk assessment for use during the execution of the planning study and as part of long term investigations. Particular emphasis is being placed on:

(1) Reviewing past disaster damage reports and interviewing sectoral agencies and local populations about vulnerable areas and reoccurring repair and reconstruction needs of particular portions or segments of production facilities, infrastructure and settlements;

(2) Preparing initial single hazard risk assessment maps based on existing information while realizing that additional information will be needed to refine such maps;

(3) Preparing lifeline network maps for the production, infrastructure, and service sectors; and

(4) Making an initial determination of the most vulnerable portions of those lifelines to be identified as risks and the susceptibility of those critical portions to mitigation measures within the context of on-going development planning activities.

The available natural resource and risk assessment information has also permitted a determination, albeit at a very preliminary level, of the effect of existing natural hazards on possible development strategies for the planning areas. Such a determination has led the NHP to propose increased investigation of alternative cropping and irrigation patterns, soil conservation and reforestation techniques, farm to market road patterns, and new settlement location and existing settlement expansion programs. These programs have been identified previously as possible development activities given the natural resource potential and proposed public and private sector programs. Thus sectoral development planners such as water resource, agricultural, transportation and agricultural economic specialists have become aware in the resource evaluation stage that natural hazards may pose constraints to certain development activities and that mitigation measures will have to be part of overall development project design.

A third use of the available information is a further examination of the information itself to identify additional risk assessment information contained within it and to determine methodological development needs. For example, the methods used in preparing precipitation, geological, soil classification and land capability maps are being reexamined to determine the specific natural hazard risk assessment content of the maps produced.

On the basis of this examination and the general lack of particular risk assessment information available, several areas for development of methods have been identified. These areas were selected for their compatibility with traditional natural resource information collection and evaluation; their perceived cost effectiveness; and the ability to develop, test and introduce the methods into the three planning studies, thus affecting the development planning process in the short term. These areas are:

(1) *Flood plain mapping*: Additional remote sensing information will be used with available post-disaster evaluation studies and topographic information to prepare preliminary flood plain maps.

(2) *Landslide area identification*: Additional remote sensing information will be used with existing soil classification and geologic maps to identify landslide prone areas.

(3) *Incipient desertification mapping*: Additional remote sensing information with mapped precipitation, soil classification, water resource, vegetation and land use information will be utilized to identify the impact of cyclical and prolonged periods of drought, land use change and incipient desertification conditions.

(4) *Land use capability mapping*: Traditional methods for land use capability mapping will be examined for possible modification to more fully and clearly describe the constraints and opportunities that natural events present when defining different levels of possible agricultural production involving intensity of natural resource use and labor and capital investments.

The role individual specialists from the national counterpart technical teams, the OAS/DRD staff and natural hazard management consultants are playing should be noted at this point. Their initiative in questioning existing risk assessment methodologies and proposing new areas for investigation is critical to the development of the NHP. Their approach is pragmatic and firmly rooted in a desire to incorporate to the extent possible, risk assessment information in the natural resource evaluation and development strategy formulation stages.

2.3 Relationship of the Three OAS/DRD Planning Studies to National Mitigation Programs

The institutional, technical and financial support for the NHP at this time is due to the growing realization of the economic and social costs of natural disasters to development activities in the OAS Member States. The interest in this subject reached a level of critical concern in 1983 after reviewing the destruction caused by the flooding, drought and earthquake events in several countries. These events made more apparent than ever the need for preventive measures to lessen the vulnerability of large and small scale development activities.

Because of the circumstances, the NHP, which is primarily focused on prevention measures through the development planning process, has become a clearing house for varying types of disaster management activity information, requests and dissemination. The three OAS/DRD planning studies are assisting in the identification of resources and dissemination of information concerning research programs, training opportunities and disaster management publications while the individual national networks responsible for disaster management are organizing and strengthening their own efforts.

In respect to the overall activities being carried out by the OAS/DRD planning studies, national institutions and individual professionals who form part of the national counterpart are also the key players in the country's evolving national disaster management network. This is particularly true of the national planning agencies which often serve as the lead counterpart agency to the OAS/DRD planning study. The involved professionals, while working primarily in development planning activities, have also been named as participants in commissions and

working groups to address disaster preparedness and disaster mitigation issues at the national, regional and local level. The planning study itself and the specific NHP activities are providing information to, and requesting information from, planning agencies and sectoral development entities, thus demonstrating in a practical, operational sense, the needed linkages between development planning and disaster management.

3.6 Programmed Activities of the NHP in the Three Planning Studies

To reiterate, the NHP has dual roles of developing methods for natural hazard risk assessment and mitigation measure selection in the development planning process and providing technical information to the three ongoing OAS/DRD planning studies that are serving as pilot projects to test these methods.

A variety of activities have been programmed, each usually containing methods development and field testing-planning study of technical product components.

Some activities related to the natural resources evaluation and development strategy formulation stages have already been mentioned. These are flood plain mapping, landslide area identification, incipient desertification identification and land use capability determination. Throughout the development and testing of methods for these subject areas, the use of remote sensing information, and computer analysis and map printing will be examined.

These two elements are of particular interest because of their perceived cost effectiveness. As a target, it has been posed by the NHP that natural hazard risk assessment thematic maps such as those of flood plain definition can be generated at a cost of US 4 cents to 20 cents per square kilometer of area examined. If such costs can be achieved, one can realistically assume that such thematic maps can be included in the standard set of natural resource evaluation maps produced for development planning studies.

In addition to these thematic maps, methods for preparing a composite natural hazard risk assessment map will also be developed. Such a map will obviously draw heavily on the thematic maps as well as the synthesis land capability map. Another activity will include development of a methodology for preparing an initial lifeline network map. This map will include identification of critical production areas, infrastructure segments, and settlement facilities. All of these foregoing maps will contribute to the natural resource evaluation, development strategy formulation and investment project identification stages of the development planning process.

For the project formulation stage, methods will be examined for including the cost of possible natural disasters and the cost and benefits of mitigation measure in the justification of specific sectoral development investment projects. Special emphasis will be given to non-structural mitigation measures. It is hoped that increased damage information, particularly to the agricultural sector, will be available at that time to further justify the introduction of appropriate mitigation measures.

In addition to these activities, the NHP will continue to serve as best it can as a clearing house for information related to the development planning process and disaster management. The NHP has been promoting and will continue to identify and collaborate in the design and implementation of training courses aimed at introducing planning professionals and policy makers to the need and mechanisms for introducing natural hazard risk assessment and mitigation measure identification into larger scale development planning activities. A proposal for regional courses for South America, Central America, and the eastern Caribbean is in preparation. Near the end of the NHP, a workshop will be held to present and discuss the developed method and examples of technical information provided to the three pilot projects. This information will constitute a natural hazard risk assessment primer for development planners and will be prepared for international dissemination in English and Spanish. An initial version of the primer containing an orientation to basic natural hazard risk assessment techniques and

information needs will be distributed on a limited basis. Development planners receiving this initial version will be encouraged to comment on its contents and incorporate its findings into the respective development planning processes.

PART 4

CONCLUSIONS

As can be determined from the preceding discussion, the NHP has before it the completion of the majority of its activities. The experiences to date, however, provide some insights into the problems and opportunities for including disaster mitigation in the development planning process. By definition, disaster mitigation programs which are part of such a process stand the best chance of implementation. Economically sustainable development is the basic activity of the public and private sectors alike. To the degree that their planning decisions and the implementation of their development investment projects embody disaster mitigation measures, prevention of death and destruction will be enhanced, and the quality of life and the distribution of the benefits from development activities will be the highest obtainable.

4.1 Institutional Organization of Risk Assessment and Mitigation Measure Information

The NHP is attempting to work with the resources at hand—the development planning process, scientific research endeavors and incipient disaster management groups in a bottom up approach, learning by doing to effect change within the involved organizations. The development planning process is not formally charged with comprehensive disaster mitigation responsibilities. It must, however, expand its role. Beyond reacting to the challenges presented by post-disaster reconstruction situations the development planning process must act effectively in the area of disaster prevention. To do so, development planners must become completely familiar with the different elements of disaster mitigation, particularly in the way in which natural hazard risk assessment and mitigation measure identification should influence development activities.

The development planning process, particularly as carried out by the OAS/DRD, has to be extremely pragmatic given temporal, financial and technical constraints. The NHP and the three planning studies serving as pilot projects are highly focused on preparing development investment projects for the highest potential areas of the planning area. As such, they seek and prepare information directly related to those areas. This implies a challenge to scientific investigation and disaster management groups to prepare for, and receive from, planning groups, on a priority basis, information which is most directly applicable to making better planning decisions.

The NHP, in collaboration with these two groups, is attempting to identify information as to the vulnerability of existing and proposed development activities. Where such information does not exist, it seeks natural hazard risk information, and lacking this, it looks for descriptions of natural events that help define the natural resources of the country. The NHP activities described above focus on the need for increased information at all three of these levels. In carrying out these activities, it is requesting specific information from the other two groups. This creates an agenda for further investigation and evaluation without creating or imposing an organizational structure for natural science investigation or disaster preparedness, an issue which is outside the scope of the NHP and the planning studies. By creating the need and opportunity to generate this information, it is forging concrete, operational links, which will produce results while strengthening the national institutional structures of all three groups.

4.2 Relationship of Mitigation Programs to National, Regional, and Local Development Planning Processes

The first issue is one of geographical focus. The NHP is involved in a planning process that is directed at the national and regional scales and it seeks information at the corresponding level.

Natural hazard risk and development activity vulnerability information collected to date varies widely in geographical focus. Post-disaster studies may indicate areas where no, or extremely limited, development activities should take place regardless of the natural resource potential. More general natural phenomena and hazard studies identify potentially hazardous areas, but may lack adequate definition to evaluate existing or proposed development activities. In general, what is needed is further study of those most promising areas in terms of their natural resource potential in order to understand the limitations and opportunities the related natural events pose.

The second issue concerns the context and content of development policies, programs and projects. Development planning processes, in general, are more highly evolved and have more influence than disaster management processes at the present time in the three pilot countries, as elsewhere in Latin America and the Caribbean. Notwithstanding the risks posed by natural hazards, national governments will continue to make decisions concerning major investment projects with or without appropriate risk assessment and mitigation measure information. The NHP recognizes this situation and is attempting, through the planning studies, to make disaster mitigation part of policy, program and project issues.

At a policy level, it is requesting that the national counterpart strengthen efforts to include disaster prevention as a development policy issue. This is in recognition of the vulnerability of existing development activities, development capital needs, dependency on international investments, and disaster relief assistance, and anticipated increased risk assessment requirements from international lending and insurance institutions. At the development program level, the NHP will be discussing with sectoral agencies the impact of disaster-related damage and repair costs on yearly operating budgets and specific development programs. Besides identifying contingency funds for disaster relief and rehabilitation needs, the identification of prevention criteria and their cost, and the form of implementation will also be discussed. At the project level, the appropriate national counterpart institutions will be encouraged to include mitigation measures as part of project design and to identify those segments or portions of their development activities which are most vulnerable to natural hazards so that disaster preparedness actions may anticipate the location, type, and magnitude of possible damage.

A third issue is the identification of specific information that should be provided to and from the development planning process. Planning studies will continue to collaborate in the preparation of natural resource description and evaluation. They will also participate in initial natural hazard identification and risk assessment, hoping that these resource evaluation activities become on-going activities shared by sectoral development agencies and research entities. The NHP will collaborate in the preparation of initial lifeline network maps and vulnerability analysis, again hoping that this process will become an on-going activity. This information will be particularly valuable to disaster preparedness and relief activities.

On the basis of this diagnostic information, the development planning process will be more able to inform research institutions and disaster management groups as to the types and locations of natural hazard risks and the resulting vulnerability of production facilities, infrastructure networks and settlements. Obviously not all development activities can be freed from vulnerability. In some cases the social, economic and political costs involved in substantially reducing vulnerability to existing or proposed development activities will be too great to bear. In such cases, disaster preparedness activities must take the lead in mitigating against loss of life and property. But in the majority of cases, it is hoped that the mitigation measures built into the design of individual development projects will carry the brunt of mitigation responsibility.

In preparing such projects, the planning studies will use available non-structural and structural mitigation techniques including land use zoning, performance standards, building codes, material specifications, and taxation and insurance programs. When these are absent or inappropriate, the planning studies will collaborate in their creation or modification to fit national, regional and local needs. The cost of mitigation measures will also be included in the economic analysis of the projects at the prefeasibility stage.

4.3 Critical Areas for Information Generation

In summary, there are specific elements of basic planning documentation that should more clearly highlight natural hazard risks and development activity vulnerability to guide the identification, formulation, and implementation of mitigation measures in development projects. The NHP, through the planning studies serving as pilot projects, is attempting to prepare such documentation in collaboration with the national counterparts drawn from the countries' development planning groups and with linkages to natural science research and disaster management groups. Some necessary natural hazard risk assessment activities such as comprehensive seismic mapping, and tsunami and hurricane surge tide investigation are outside the scope of the NHP because of historical information, technical, financial and time considerations.

Other critical areas of information, however, can be investigated. To the extent possible natural science investigation efforts and disaster management activities, together with planning study efforts, are to be focused on the following areas:

(a) Natural event occurrence definition, and review and synthesis of existing natural resource and natural hazard information;
(b) Flood plain, landslide, and incipient desertification identification and risk assessment;
(c) Lifeline network mapping on a sector by sector basis;
(d) Review and synthesis of existing post-disaster damage assessment, including local interviews and oral histories;
(e) Initial lifeline network vulnerability mapping;
(f) Review and synthesis of existing structural and non-structural mitigation programs; and
(g) Modification of land capability mapping methodologies to more clearly manifest natural hazard information.

OAS/DRD NATURAL HAZARDS PROJECT
SYNTHESIS OF THE DRD DEVELOPMENT PLANNING PROCESS

COMPONENTS	STUDY DESIGN	STUDY EXECUTION		IMPLEMENTATION OF RECOMMENDATIONS
		PHASE I DEVELOPMENT DIAGNOSIS	PHASE II PROJECT FORMULATION AND PREPARATION OF ACTION PLAN	
Activities:	Receipt and analysis of request for cooperation Preliminary Mission - pre-diagnosis - preparation of cooperation agreement	Diagnosis of region - sectoral analysis - spatial analysis - institutional analysis - environmental analysis - synthesis: needs, problems, potentials, constraints Relation to national plans, strategies, priorities Development strategies - formulation and analysis of alternatives - identification of project ideas	Project formulation (profile or prefeasibility) and evaluation - production sectors (agriculture, forestry, agroindustry, industry, fishing, mining) - support services (marketing, credit, extension) - social development (housing, education, labor training, health) - infrastructure (energy, transportation, communications) - urban services - natural resources management Action plan preparation - formulation of packages of projects - policies for priority areas and sectors - enabling and incentive actions - investment timetable - evaluation of funding sources - institutional development and training - promotion	Assistance for specific programs and projects Assistance in incorporating proposed investments into national budget Advisory services for private sector actions Support to executing agencies Support in inter-institutional coordination
Products:	Signed cooperation agreement - definition of products of study - financial commitments of participants - preliminary workplan	Interim Report (Phase I Report) - diagnosis of region - preliminary development strategy - identified projects	Final Report - development strategy - action plan - formulated projects - supporting actions	Government execution of - feasibility and final design studies - implementation of projects - changes in legislation and regulations Improved operational capability of institutions
Time Frame:	3 to 6 months	9 to 12 months	12 to 18 months	Variable

FIGURE 2

OAS/DRD NATURAL HAZARDS PROJECT

GENERAL COMMENTS ON THE RELATIONSHIP OF NATURAL HAZARDS EVENTS AND DEVELOPMENT PLANNING PROCESS COMPONENTS

		EARTHQUAKE	VOLCANO	MAJOR FLOOD EVENT	HURRICANE	DROUGHT
Preliminary Mission	Objective:	Collection of information to establish the presence of hazards in the integrated regional development study area and the limits of risks posed.				
	Affect on development patterns:	Presence of hazards indicates the need for further qualitative and quantitative assessment as they affect natural resource and economic development potential.				
Development Diagnosis, Strategy Formulation, and Project Identification	Objective:	For those hazards present in the study area, assessment of the risk (risk hazard map) and identification of existing critical segments or elements of production facilities, infrastructure and settlements (lifeline network map). Inclusion of risk and vulnerability aspects in defining development potential and strategy (for example, flood plain, landslide area, incipient desertification identification, and land capability maps). Identification of alternative non-structural and structural mitigation measures in initial development project identification.				
	Affect on development patterns:	Presence of hazard will affect the formulation of the development strategy and the type and location of investment projects and suggest modification of the lifeline network.		Presence of hazard will affect overall strategy formulation and hazard mitigation should dominate identification of production sector projects, particularly agriculture.		
Action Plan Preparation and Project Formulation	Objective:	Determination of specific mitigation measures for selected investment projects and determination of critical lifeline network elements for disaster preparedness activities.				
	Affect on development patterns:	Presence of hazard will affect the action plan for project implementation and the specific site selection of investment projects at the local level, project engineering design and economic feasibility.				
Implementation	Objective:	Follow-through on implementation of mitigation measures and disaster preparedness.				
	Affect on development patterns:	Monitoring of natural phenomena for early warning against possible damage, and formulation of future risk assessment and disaster preparedness activities.				

Best Available Document

ANNEX III.2.3.- HANDOUT ON NATURAL HAZARDS AND INTEGRATED DEVELOPMENT PLANNING

ORGANIZACION DE LOS ESTADOS AMERICANOS
ORGANIZAÇÃO DOS ESTADOS AMERICANOS
ORGANISATION DES ETATS AMERICAINS
ORGANIZATION OF AMERICAN STATES

17th Street and Constitution Avenue, N.W. Washington, D.C. 20006

INTERNATIONAL SYMPOSIUM ON HOUSING AND

URBAN DEVELOPMENT

AFTER NATURAL DISASTERS: MITIGATING FUTURE LOSSES

WORKSHOP: POST-DISASTER PLANNING FOR ECONOMIC DEVELOPMENT

TOPIC: NATURAL HAZARD ASSESSMENT IN INTEGRATED REGIONAL DEVELOPMENT

October, 1985

(2)

STEPHEN O. BENDER
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Natural Hazards Risk Assessment and Disaster Mitigation
Pilot Project in Latin America and
the Caribbean Basin

(The views expressed in this paper are those of the author and do not necessarily represent the views of the General Secretariat of the Organization of American States)

Introduction:

Disaster mitigation programs which are part of an integrated development planning process stand the best chance of implementation. Economically sustainable development is the basic activity of the public and private sectors alike in developing countries. To the degree that their planning decisions and the execution of their investment projects embody disaster mitigation measures, prevention of death and destruction will be enhanced.

In the past, disaster management in Lesser Developed Countries (LDCs) has concentrated on reacting to the damage caused by natural phenomena. The reduction of the vulnerability levels of production facilities, infrastructure, and human settlements to natural hazard risks were frequently not explored. As a consequence, the need for massive local and foreign assistance for post-disaster relief and reconstruction has increased dramatically as ever larger segments of LDCs' population - particularly the poor - and ever greater portions of their productive capacity are affected each year by disasters. While disaster prevention is widely recognized as the most efficient and effective means of reducing damage and loss of life, mitigation measures have proved extremely difficult to implement. Mitigation implementation ought to be part of development activities and the development planning process must include natural hazard risk assessment and mitigation measure identification if significant reductions in the damage caused by natural phenomena are to be achieved.

Description:

The Organization of American States through its Department of Regional Development (OAS/DRD), with the support of the United States Agency for International Development and its Office of Foreign Disaster Assistance (USAID/OFDA), has undertaken an initiative to incorporate natural hazard risk assessment and mitigation measure identification into the integrated regional development planning process through the "Natural Hazard Risk Assessment and Disaster Mitigation Pilot Project in Latin America and the Caribbean Basin" (NHP).

With the intention of modifying development activities so that potential disasters can be avoided, the NHP seeks to:

1. Assess natural hazard risk as part of natural resource evaluation and development strategy formulation;
2. Identify and formulate mitigation measures for development investment projects;
3. Improve information interchange, and;
4. Inform planning technicians and decision makers about risk assessment and disaster mitigation techniques.

The NHP is bringing to the disaster management area a decidedly focused approach. It is an effort in researching, field testing and implementing disaster mitigation measures through integrating appropriate technical information into real technical assistance activities. The NHP,

recognizing the special role that integrated regional development planning plays in LDCs, is attempting to expand that role in the short term using the resources at hand while collaborating in drawing up an agenda for intermediate and long term mitigation research and implementation activities.

This approach is particularly relevant in post-disaster situations where tremendous pressures are brought to bear on local, national and international agencies to replace, preferably on the same site, destroyed facilities. All to quickly the lack of adequate natural event, hazard and risk assessment information, and its incorporation into the development planning process, become evident. In some instances, the disaster and the resulting reconstruction program dictates a reassessment of national or regional physical and economic plans and programs, such as in the case of Nicaragua. In other situations, regional and local plans and programs have to be reformulated to accomadate newly recognized disaster vulnerability, such as in case of Guatemala, Honduras, Peru, the Paraguay River Basin and several Caribbean Islands. In still other situations, the disaster, as devastating as it might be, is still overshadowed by pre-existing development problems, such as in the case of Mexico City.

Analysis of the Technique:

To address the disaster mitigation issue, specific information must be incorporated into the various stages of the integrated development

planning study, including a study carried out in a reconstruction context (see Figure 1). This information can be divided into four groupings.

1. Natural Events: As part of the natural resource investigation, the presence and effect of natural phenomena on the goods and services that natural resources provide must be determined.

2. Natural Hazard Assessment: As part of natural resource evaluation, hazard and risk assessment information qualifies the impact natural events have on possible development activities.

3. Post Disaster Investigations: Following the occurrence of natural events which result in disasters, be they major or not, post-disaster investigations further describe the qualitative and quantitative aspects of natural hazards, often supplanting the lack of historial observations and scientific research.

4. Lifeline Network Identification and Vulnerability Analysis: Lifeline networks for production facilities, infrastructure networks and support systems to settlements define those critical segments or components which should have the lowest damage vulnerability or which should be recognized as priority elements for rehabilitation following a disaster.

In accordance with these groupings, the NHP has identified key information pieces that are required for effective mitigation to take place through the planning process (see Figure 2):

a. In the Preliminary Mission, information concerning natural phenomena, the presence or absence of hazards, and post-disaster damage evaluation of the study area should be collected. The presence of hazards will indicate the need for further qualitative assessment as it affects natural resource management and economic development potential.

b. In Phase I an assessment of the risks that natural hazards present to the study area should be prepared. Existing critical segments or portions of production facilities, infrastructure and settlements in high risk areas should be identified through examining risk and lifeline network maps. The vulnerability of those segments or portions should also be determined. The development strategy is affected by the presence of hazards, and hazard mitigation is a consideration in the identification of sectoral development projects.

c. In Phase II specific mitigation measures for selected investment projects should be determined as well as vulnerable lifeline network elements for disaster preparedness activities. The

presence of hazards should affect specific site selection, project engineering design and economic feasibility of development investment projects.

d. In the Implementation Phase, the monitoring of mitigation implementation and disaster preparedness activities provides information for evaluation of development studies in execution and the formulation of new development studies and disaster management activities.

The information pertaining to these four stages is presently generated by three principal networks: international and national phenomena research and monitoring centers and universities, disaster management entities, and multisectoral and sectoral planning agencies and operational secretaries and ministries. The source of financial support, staff training, subject areas of responsibility, and the role in mitigation program implementation of these networks varies greatly from country to country, as does their interrelationship. The situation can be generally characterized, however, by an emerging disaster management programs, resource constraints in the area of natural phenomena research and monitoring, and a planning process that is under tremendous pressure to design and implement economic development programs in the absence of natural hazard information.

Essential Recommendations:

Based on the experiences to date of the NHP, particularly those where field testing of natural hazard and risk assessment, mapping, and project formulation methods have taken place, the following recommendations can be made. They are divided into two categories, those with an institutional and those with a technical focus.

A. Institutional Focus:

1. Give preference to existing planning and executing agencies for post-disaster damage evaluation, risk assessment, and reconstruction project formulation and implementation.

2. Insist on participation from all affected sectors in the above mentioned activities.

3. Define realistic budgets and ensure that approved reconstruction projects complement one another.

4. Insist that natural hazard risk assessment and mitigation measure selection are part of the planning process at the policy, program and project levels.

5. When necessary, insist that adequate risk assessment and mitigation selection technical assistance, including personnel training, is made available through reconstruction activities.

6. Ensure that disaster preparedness officials are made aware of the vulnerability levels of existing and proposed economic production, support infrastructure and human settlement projects.

The formulation of reconstruction programs following major disasters has had the greatest impact on national, regional and local development planning processes. The degree to which these programs have been integrated into existing planning processes varies considerably from country to country and occurrence to occurrence. The most typical response has been the creation of a reconstruction planning process in parallel with existing planning processes. Reconstruction programs are often supported by major international technical assistance and funding programs, and the preference has been to implement reconstruction programs outside of the mainstream of development activities in the hopes of expediting execution and avoiding existing bureaucratic delays.

The result of this dual development planning approach has often lead to sectoral reconstruction efforts taking place without an assessment of the overall post-disaster situation of the particular affected area. The natural event may have altered substantially the conformation of the natural resource potential, if by nothing other than making clearly evident the natural hazard risk and the vulnerability of pre-disaster development activities. The resultant damage from the event has almost always necessitated a re-evaluation of existing development policies and sectoral projects. In many cases, such policies and projects are no longer appropriate to the needs of the area, nor coincide with the best use of its natural resources. Reconstructing damaged production facilities, infrastructure and settlements without formulating a comprehensive development strategy based on the post-disaster situation

has often lead to missed opportunities for incorporating disaster mitigation measures and recognizing the influence natural hazard risks have on development planning decisions.

In preparing policies and programs, realist budgets should be drawn up which will permit an integrated package of reconstruction projects to be executed. This necessitates appropriating scare funds among sectors and programming sectoral activities to complement one another, a difficult task even in non-post-disaster circumstances.

At a policy level, reconstruction programs should strengthen efforts to include disaster prevention as a development policy issue. This is in recognition of the vulnerability of existing development activities, development capital needs, dependency on international investments and disaster relief assistance, and anticipated increased risk assessment requirements from international lending and insurance institutions. At the development program level, sectoral agencies should examine the impact of disaster-related damage and repair costs on yearly operating budgets and specific development programs. Besides identifying contingency funds for disaster relief and rehabilitation needs, the identification of prevention criteria and their cost, and the form of implementation should also be discussed. At the project level, the appropriate national institutions should be encouraged to include mitigation measures as part of projects design and to identify those segments or portions of their

development activities which are most vulnerable to natural hazards so that disaster preparedness actions may anticipate the location, type, and magnitud of possible damage.

The role individual specialists from national technical agencies will play is of utmost importance. Additional orientation and training in using existing risk assessment methodologies and proposing new areas for investigation are critical to reconstruction development programs. Thus, international technical cooperation should include a personnel training component so that their approach is pragmatic and firmly rooted in incorporating to the extent possible natural hazard and risk assessment information in the natural resource evaluation, and development and project formulation stages.

Finally, the information contained in lifeline maps identifying the critical components of infrastructural and production networks should be shared with sectoral and disaster preparedness agencies to ensure that those responsible for maintaining those networks in working order and those responsible for responding to an emergency situation are aware of the relative vulnerability of each of the networks' components.

B. Technical Focus:

1. Immediately prepare multisectoral damage assessment and reconstruction needs inventories and syntheses of same.

2. Define the precise geographical area for reconstruction activies and assign priorities.

3. Collect all available natural resource and natural hazard analytical information and assess the impact of the disaster on national, regional and local development policies, programs and projects.

4. Include natural hazard risk assessment and mitigation measure information in all sectoral reconstruction project formulation.

5. Insist that subsequent scientific research and disaster preparedness activities are focused on the geographical areas encompassing priority public and private sector investments.

Development planning processes, in general, are more highly evolved and have more influence than disaster management processes at the present time in Latin America and the Caribbean. Notwithstanding the risks posed by natural hazards, national governments continue to make decisions concerning major investment projects with or without appropriate hazard assessment and mitigation measure information Thus, post-disaster studies should recognize this situation and attempt to make disaster mitigation part of policy, program and project issues during reconstruction.

Following a catastrophic event, disaster management programs usually take the lead in generating damage assessments and relief need analysis, supported by sectoral studies for funding rehabilitation activities. These individual investigations can be quite detailed. But often their usefulness in formulating reconstruction programs in the context of integrated development planning can be limited if comprehensive conclusions are not drawn. Development planning studies must contain a comprehensive view of the impact of the disaster drawn from sectoral reports in order to define a precise geographical area for reconstruction activities and assign priorities based on modified predisaster needs.

Post-disaster studies should include timely multisectoral damage assessments, reconstruction needs inventories, and identify areas where no or extremely limited development activities should take place regardless of the natural resource potential. Previously available general natural phenomena and hazard studies may identify potentially hazardous areas, but often lack adequate definition to evaluate existing or proposed development activities. Needed then is further study of those most promising areas in terms of their natural resource potential and the limitations and opportunities the related natural events pose.

Such studies may lead to increased investigation of alternative cropping and irrigation patterns, soil conservation and reforestation techniques, farm to market road patterns, and new settlement location and existing settlement expansion programs. These programs may have been identified previously as possible development activities given the natural resource potential and proposed public and private sector programs. Thus, sectoral development planners such as water resource, agricultural, transportation and agricultural economic specialists must become aware in the resource evaluation stage that natural hazards may pose constraints to certain development activities and that mitigation measures will have to be part of overall development project design.

In preparing reconstructions projects, planning studies should use available non-structural and structural mitigation tecuniques including

land use zoning, performance criteria, building codes, material specifications, and taxation and insurance programs. When absent or inappropriate, the planning team should collaborate in their creation or modification to fit national, regional and local needs. The cost of mitigation measures should also be included in the economic analysis of the projects at the prefeasibility stage.

Research Priorities and Needs:

To the extent possible scientific investigation, disaster management, and reconstruction planning activities should be focused on the following areas:

1. Natural event occurrence, and review and synthesis of existing natural resource and natural hazard information;
2. Increased flood plain, landslide, and incipient desertification hazard assessment;
3. Lifeline network mapping on a sector by sector basis;
4. Review and synthesis of existing post-disaster damage assessment, including local interviews and oral histories;
5. Initial lifeline network vulnerability mapping;
6. Review and synthesis of existing structural and non-structural mitigation programs, and;
7. Modification of land capability mapping methodologies to more clearly manifest natural hazard information.

In carrying out these activities, an agenda for further investigation and evaluation is created without altering the existing organizational

structure for natural science investigation and disaster preparedness. By creating the need and opportunity to generate this information, these activities forge concrete, operational linkages which will produce results while strengthening the national institutional structures of all involved agencies.

FIGURE 1

OAS/DRD NATURAL HAZARDS PROJECT
SYNTHESIS OF THE DRD DEVELOPMENT PLANNING PROCESS

COMPONENTS	STUDY DESIGN	STUDY EXECUTION		IMPLEMENTATION OF RECOMMENDATIONS
		PHASE I DEVELOPMENT DIAGNOSIS	PHASE II PROJECT FORMULATION AND PREPARATION OF ACTION PLAN	
Activities:	Receipt and analysis of request for cooperation Preliminary Mission - pre-diagnosis - preparation of cooperation agreement	Diagnosis of region - sectoral analysis - spatial analysis - institutional analysis - environmental analysis - synthesis: needs, problems, potentials, constraints Relation to national plans, strategies, priorities Development strategies - formulation and analysis of alternatives - identification of project ideas	Project formulation (profile or prefeasibility) and evaluation - production sectors (agriculture, forestry, agroindustry, industry, fishing, mining) - support services (marketing, credit, extension) - social development (housing, education, labor training, health) - infrastructure (energy, transportation, communications) - urban services - natural resources management Action plan preparation - formulation of packages of projects - policies for priority areas and sectors - enabling and incentive actions - investment timetable - evaluation of funding sources - institutional development and training - promotion	Assistance for specific programs and projects Assistance in incorporating proposed investments into national budget Advisory services for private sector actions Support to executing agencies Support in inter-institutional coordination
Products:	Signed cooperation agreement - definition of products of study - financial commitments of participants - preliminary workplan	Interim Report (Phase I Report) - diagnosis of region - preliminary development strategy - identified projects	Final Report - development strategy - action plan - formulated projects - supporting actions	Government execution of - feasibility and final design studies - implementation of projects - changes in legislation and regulations Improved operational capability of institutions
Time Frame:	3 to 6 months	9 to 12 months	12 to 18 months	Variable

FIGURE 2

OAS/DRD NATURAL HAZARDS PROJECT

GENERAL COMMENTS ON THE RELATIONSHIP OF NATURAL HAZARDS EVENTS AND DEVELOPMENT PLANNING PROCESS COMPONENTS

		EARTHQUAKE	VOLCANO	MAJOR FLOOD EVENT	HURRICANE	DROUGHT
Preliminary Mission	Objective:	Collection of information to establish the presence of hazards in the integrated regional development study area and the limits of risks posed.				
	Affect on development patterns:	Presence of hazards indicates the need for further qualitative and quantitative assessment as they affect natural resource and economic development potential.				
Development Diagnosis, Strategy Formulation, and Project Identification	Objective:	For those hazards present in the study area, assessment of the risk (risk hazard map) and identification of existing criterial segments or elements of production facilities, infrastructure and settlements (lifetime network map).				
		Inclusion of risk and vulnerability aspects in defining development potential and strategy (for example, flood plain, landslide area, incipient desertification identification, and land capability maps).				
		Identification of alternative non-structural and structural mitigation measures in initial development project identification.				
	Affect on development patterns:	Presence of hazard will affect the formulation of the development strategy and the type and location of investment projects and suggest modification of the lifeline network.				
				Presence of hazard will affect overall strategy formulation and hazard mitigation should dominate identification of production sector projects, particularly agriculture.		
Action Plan Preparation and Project Formulation	Objective:	Determination of specific mitigation measures for selected investment projects and determination of critical lifeline network elements for disaster preparedness activities.				
	Affect on development patterns:	Presence of hazard will affect the action plan for project implementation and the specific site selection of investment projects at the local level, project engineering design and economic feasibility.				
Implementation	Objective:	Follow-through on implementation of mitigation measures and disaster preparedness.				
	Affect on development patterns:	Monitoring of natural phenomena for early warning against possible damage, and formulation of future risk assessment and disaster preparedness activities.				

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ANNEX III.3.1.- HANDOUT ON THE CONCEPT OF ECOSYSTEMS

MAN AND THE ENVIRONMENT

An introduction to human ecology and [illegible]

Arthur S. Boughey
Department of Population and Environ[illegible]
Biology [illegible]

ANNEX III.3.2.- HANDOUT ON NATURAL GOODS AND SERVICES

NATURAL GOODS AND SERVICES

GOODS/PRODUCTS

1. Potable water (surface and ground)
2. Industrial water (surface and ground)
3. Irrigation water (surface and ground)
4. Lumber and pulpwood
5. Firewood
6. Construction materials from wood (post, beams, etc.)
7. Ornamental plants (indoor, landscaping, dry)
8. Vegetable fibers (rope, cloth)
9. Medicinal plants
10. Food for human consumption (fruits, gum, honey, sap, shoots, seeds, nuts, leaves)
11. Food for human work, animal consumption
12. Food animals for human consumption (fish, fowl, etc.)
13. Aquatic plants for human consumption (algae, sponges)
14. Food condiments (spices, salt, bicarbonate of soda)
15. Plant chemical substances (dyes, stains, waxes, latex, gums, tannins, syrups, drugs, etc.)
16. Fertilizers (minerals, fishmeal, guano, other dung, etc.)
17. Aquatic precious/semiprecious materials (pearl, coral, conchs, mother of pearl)
18. Materials for artisan work (rock, wood for carving, fibers for basketmaking, etc.)
19. Metallic minerals (bauxite, ores, nuggets, etc.)
20. Non-metallic minerals (asbestos, clays, limestone, etc.)
21. Construction materials (sands, clay, cinders, cement, gravel, rocks, marble, etc.)
22. Mineral nutrients (phosphorus)
23. Mineral dyes and glazes
24. Hides, leather, skins
25. Other animal materials (bones, feathers, tusks, teeth, claws, butterflies)
26. Other vegetation materials (seeds, pods)
27. Live fish (ornamental, pets)
28. Live animals for pets and zoos
29. Live animals for human work
30. Live animals for research
31. Fossil fuels (crude oil, natural gas, coal)
32. Other fuels (peat, other organic matter, dung, biomass)
33. Livestock forage

ECOSYSTEM OPERATIONS, MAINTENANCE, ADAPTATION, AND EVOLUTION

1. Nutrient cycling
2. Nutrient storage
3. Nutrient distribution (floods, dust and sediment transport, etc.)
4. Photosynthesis-respiration
5. Adaptation
6. Self-regulation
7. Competition testing and design (population control evolution)
8. Mineral cycling
9. Habitat for local land, air, aquatic animals, insects, and other life forms (feeding, breeding, nursery, shelter, etc.)

NON-TANGIBLE GOODS AND SERVICES

1. Windbreak
2. Shade
3. Recreational use of water (swimming, boating, skating, water skiing, sailing, surfing, scuba)
4. Recreational use of land (hiking, spelunking, climbing)
5. Recreational use of air (flying, gliding, parachuting, kiting)
6. Recreational use of animals (sport hunting and fishing, insect collecting)
7. Recreational use of ecosystem (sightseeing, tourism)
8. Scientific tourism (exploring)
9. Value development and storage
10. Spiritual development and storage
11. Historical value
12. Cultural value
13. Early warning system (weather and climate change)
14. Moisture modification (humidity)
15. Temperature modification
16. Light modification
17. Ultraviolet and other radiation filtration
18. Storage of life form adaptive (genetic) information
19. Protection of indigenous cultures and customs

ECONOMIC SERVICES

1. Energy sources (wind, solar, hydro, tides, biomass, geothermal)
2. Dilution of contaminants
3. Decomposition of contaminants (oxidation, evaporation, dissolution)
4. Transport of contaminants (wind, water, animal consumption, air and watershed dilution of contaminants)
5. Erosion control
6. Sediment control
7. Flood control
8. Ground water recharge
9. Space for urban, industrial, agriculture occupations, roadways, canals, airports
10. Waste and contaminant storage
11. Physical support for structures
12. Climate control and protection
13. Disease control and protection
14. Storm buffer

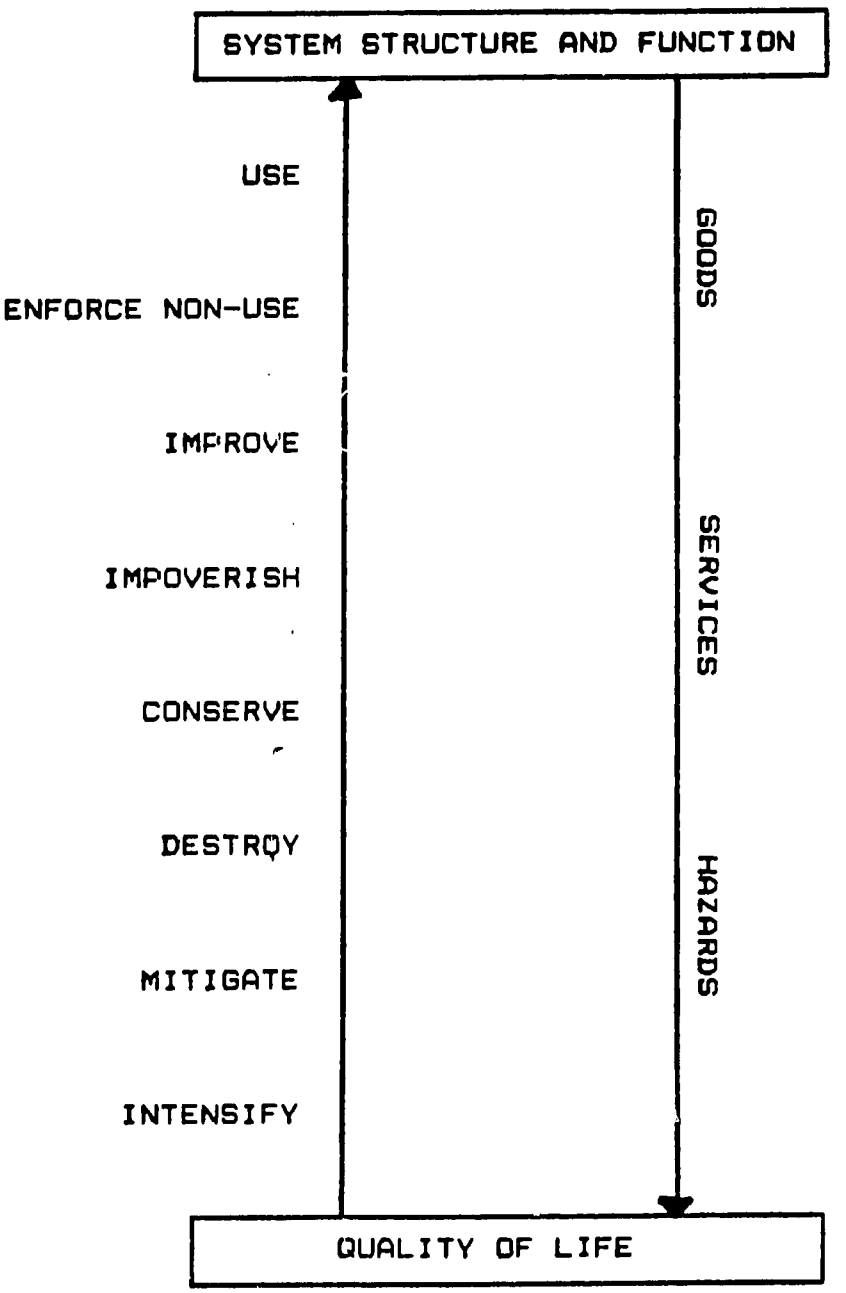
ANNEX III.3.3.- HANDOUT ON NATURAL HAZARDS

ANNEX III.3.3.- HANDOUT ON NATURAL HAZARDS

LIST OF NATURAL HAZARDS

1.- Diseases and plagues (virus, bacteria, flukes, parasites, fungus, etc.)
2.- Natural flooding
3.- Avalanches (land, snow, ice), land slips, mudflows, etc.
4.- Wind (tornados, hurricanes, cyclones, dust storms)
5.- Natural erosion/sedimentation
6.- Temperature extremes (duration, intensity)
7.- Extremes of humidity (duration, intensity)
8.- Drought
9.- Snow
10.- Ice
11.- Hail
12.- Fog, mist
13.- Frost
14.- Solar radiation
15.- Lightning
16.- Fire
17.- Toxic chemicals, gas concentration
18.- Nuclear radiation
19.- Earthquakes
20.- Noxious vegetation (poisonous plants, "invader" species)
21.- Poisonous animals (snakes, insects)
22.- Predators
23.- Volcanoes
24.- Tidal waves

ANNEX III.3.4.- HANDOUT ON ENVIRONMENTAL IMPACTS


SYSTEM STRUCTURE AND FUNCTION
USE
ENFORCE NON-USE
IMPROVE
IMPOVERISH
CONSERVE
DESTROY
MITIGATE
INTENSIFY
GOODS
SERVICES
HAZARDS
QUALITY OF LIFE

ANNEX III.3.5.- UNIT #3 HOMEWORK EXERCISE

ANNEX III.3.5.- UNIT #3 HOMEWORK EXERCISE

ENVIRONMENTAL MANAGEMENT AND NATURAL HAZARDS

Based on the material presented in class prepare a brief essay discussing the attached text. Be sure to note the terminology used in the text and to analyze the meaning of what the text presents in the light of the discussions held in class on the subject.

NOTE TO THE INSTRUCTOR:

The objective of this exercise is to have the participants analyze a standard piece of the literature on environmental management and identify for themselves the erroneous use of terms such as "environment," "environmentally sound ...," "environmental expert," etc.

What follows is an extract of an actual interview of a renowned expert in the subject of environment and development by the editor of an environmental NGO newsletter. Based on the discussions in class, critique both the questions and the responses. "E" is the editor and "I" is the interviewee.

E. "What are the basic fundamentals for considering the environment as an indispensible factor in the formulation of development policies?"

I. "You would have to start from the idea that the process of development transforms nature in unlimited ways. We have defined development as a process of transforming the natural environment to one that is constructed and artificial.

"For us development is not only the specialization of work, but also of nature, that is to say, the use of the environment.

"In economic liturature, it is shown that by specializing work, technology, and capital, productivity is increased; but, another part of the problem is left out, given that in this process, the use of soils, forests, crops, etc. is also specialized.

"In this process of specialization and transformation, ecosystems are altered when raw material, natural resources, energy, etc. are extracted from the natural environment, on the one hand. On the other hand, discharge of the residuals generated by the process of transformation again generates an alteration of the ecosystems.

"Begining with the concept expressed before, we can say that there are economic development problems that could have a better solution if the environmental dimension is taken into account in the process of development."

E. "Can you give us an example where both dimensions were taken into account?"

I. "We can imagine a project for the construction of terraces in eroded areas. This is a project of nature conservation which generates employment and improves soil productivity and, as a consequence, improves life conditions.

"With this focus we retreat from two typical positions: the economic or developmentalist that degrades the environment, and

the conservationist position that devalues development. Neither of the two options is logical nor sustainable. On the other hand, there are sustainable projects that meet economic objectives and which simultaneously preserve, amplify or evade environmental deterecoration. In the end, the environment is the fundamental social capital on which we construct everything else."

ANNEX III.10.1.- UNIT #10 CLASSROOM EXERCISE

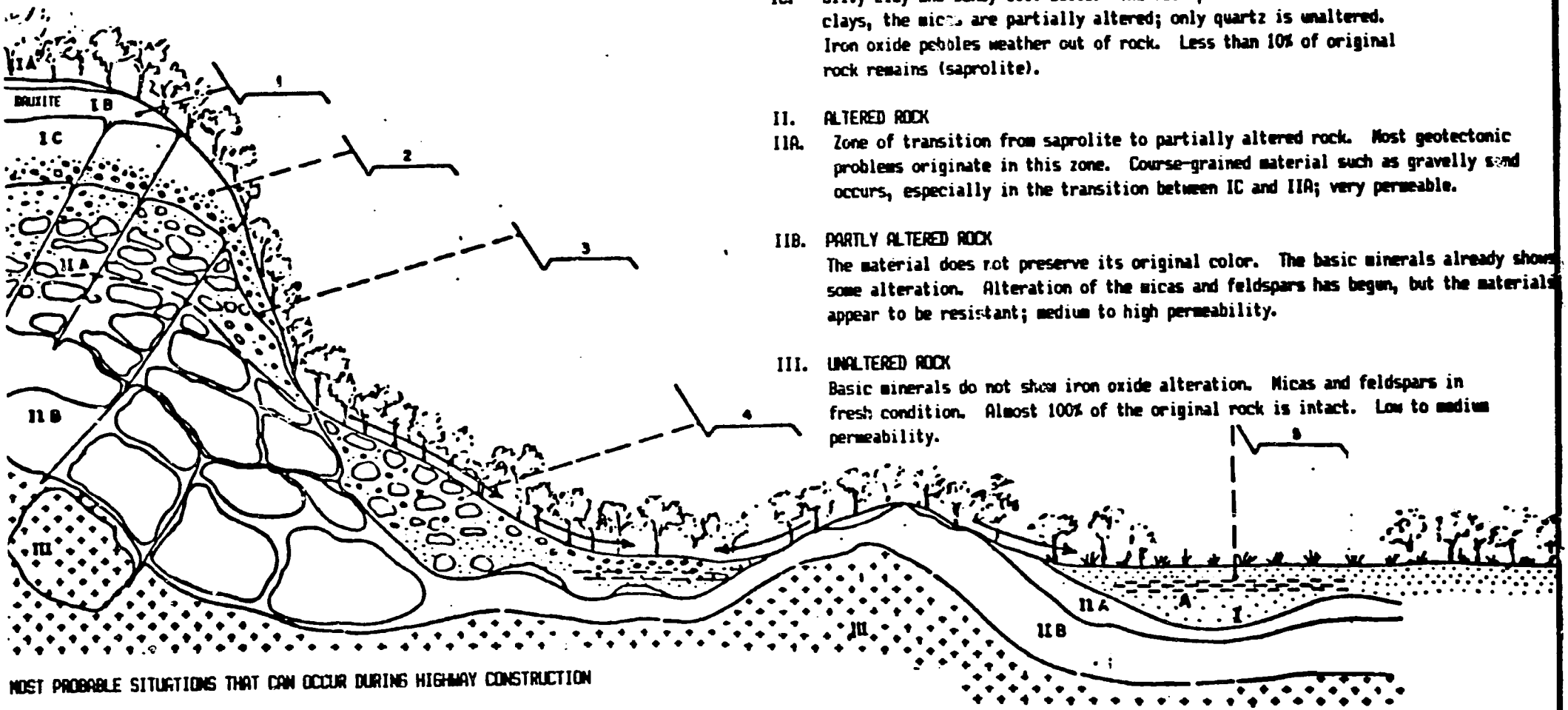
ANNEX III.10.1.- UNIT # 10 CLASSROOM EXERCISE

MASS-MOVEMENT HAZARDS

NOTE TO THE INSTRUCTOR:

Utilizing the exercise samples provided as a guide, develop a classroom exercise in which participants are required to use the different mass-movement hazards concepts presented in class in the analysis of specific projects such as the construction of a highway or a building. Provide both the necessary information and orientation to the exercise so that the participants can integrate technical, economic and social issues in resolving the problems presented.

DIAGRAM OF THE LEACHING PROFILE



I. RESIDUAL SOIL

IA. Organic layer and sandy soil (leaching zone)

IB. Deposition zone, rich in silica, alumina, and iron oxide concretions (bauxite).

IC. Silty clay and sandy silt soils. The feldspars have been converted into clays, the micas are partially altered; only quartz is unaltered. Iron oxide pebbles weather out of rock. Less than 10% of original rock remains (saprolite).

II. ALTERED ROCK

IIA. Zone of transition from saprolite to partially altered rock. Most geotectonic problems originate in this zone. Course-grained material such as gravelly sand occurs, especially in the transition between IC and IIA; very permeable.

IIB. PARTLY ALTERED ROCK

The material does not preserve its original color. The basic minerals already show some alteration. Alteration of the micas and feldspars has begun, but the materials appear to be resistant; medium to high permeability.

III. UNALTERED ROCK

Basic minerals do not show iron oxide alteration. Micas and feldspars in fresh condition. Almost 100% of the original rock is intact. Low to medium permeability.

MOST PROBABLE SITUATIONS THAT CAN OCCUR DURING HIGHWAY CONSTRUCTION

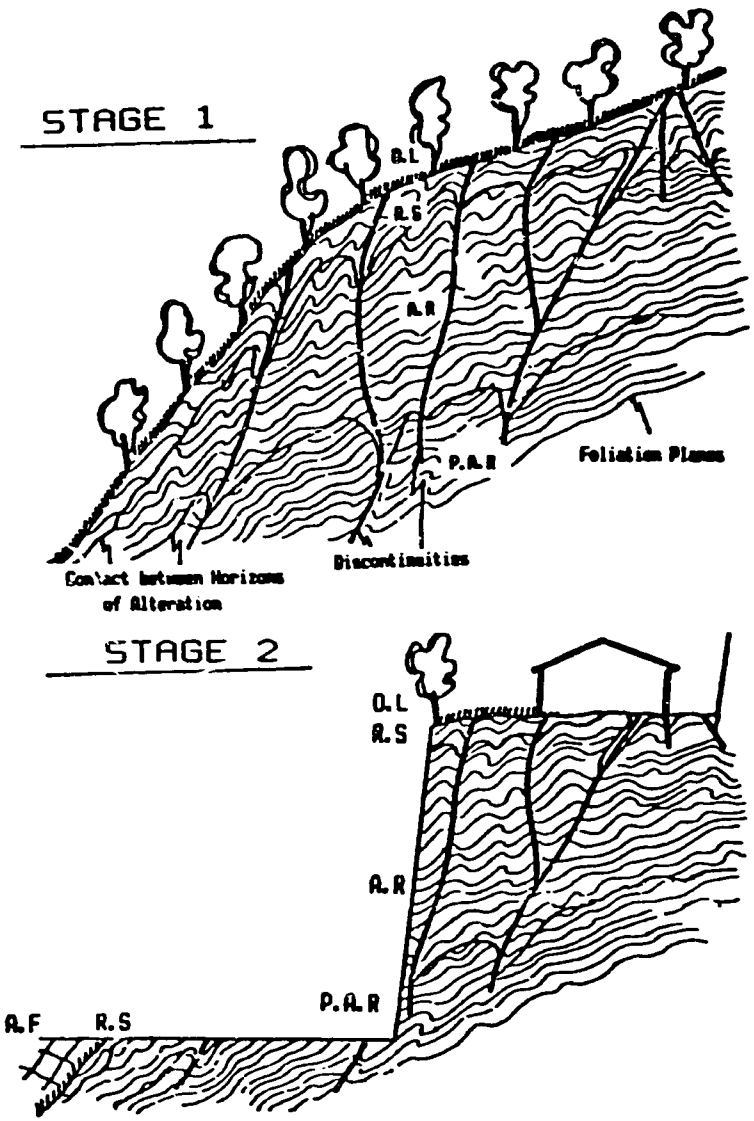
1.- Cutting the lateritic crest - upland sector - (Horizon IB).
2.- Cutting the clayey horizon of residual soil - slope sector - (Horizon IC or Saprolite)
3.- Cutting the gravelly sand horizon of residual soil and altered rock (especially especially Horizons IC - IIA).
4.- Cutting the coluvial material of the slope bottom (characterized by big blocks) and and alluvial sectors (Horizons IIA and C).
5.- Construction on alluvial and fine coluvial soils (sandy clays) and residual soils (IA and C).

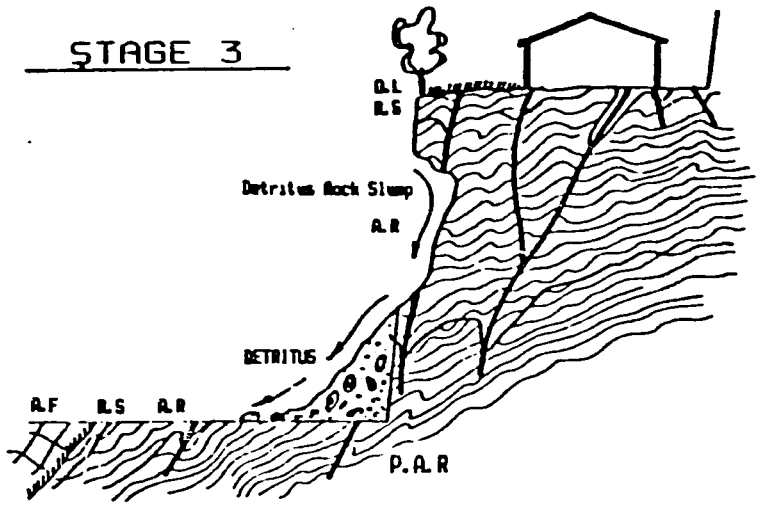
Stage 1: Natural conditions of the slope.

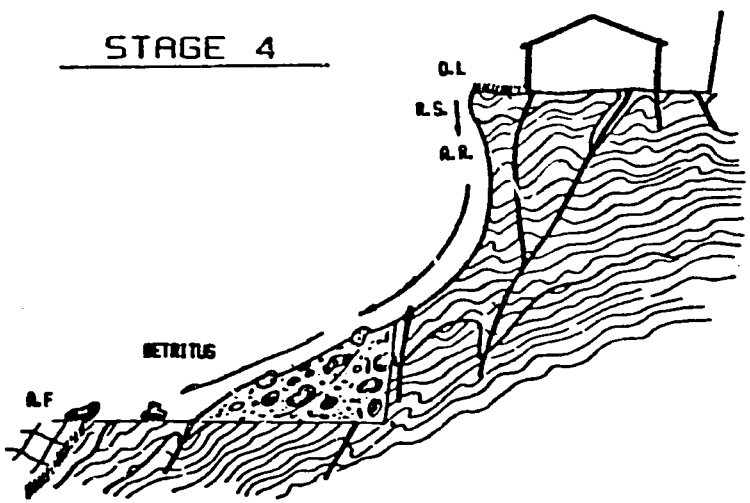
Stage 2: Human intervention: house and garden with an access road.

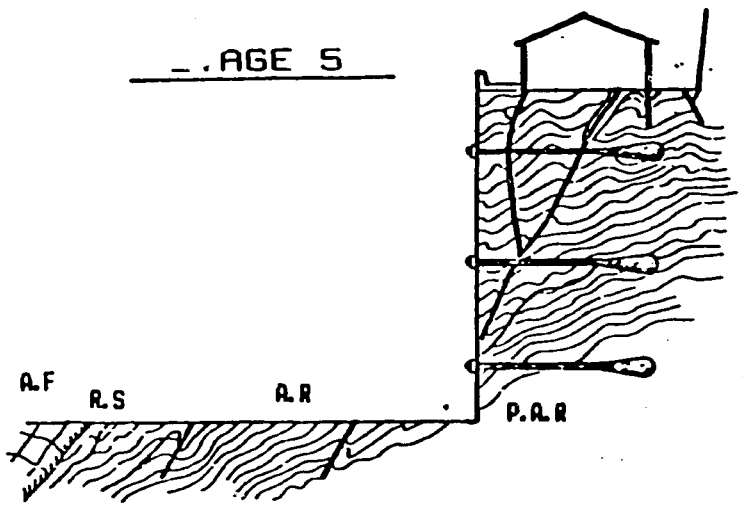
Stage 5: House with railed porch, bulwark with system of anchoring.
The cost of stabilizing the cut is several times greater than the investment to build the house.

Briefly explain the behavior of the land affected by construction between stage 1 and stage 5.









LEGEND

A.F.- Artificial Fill

O.L.- Organic Layer

R.S.- Residual Soil

A.R.- Altered Rock

P.A.R.- Partly Altered Rock

ANNEX III.12.1.- UNIT #12 CLASSROOM EXERCISE

ANNEX III.12.1.- UNIT #12 CLASSROOM EXERCISE

MULTIPLE GEOLOGIC HAZARDS AND LIFELINE NETWORK MAPPING

Based on the material presented in class and on reference maps prepare a draft lifeline network map and the corresponding text explaining the rational of your map. Be sure to include the explanation of any order of priority that you might have built-in to your lifeline network map.

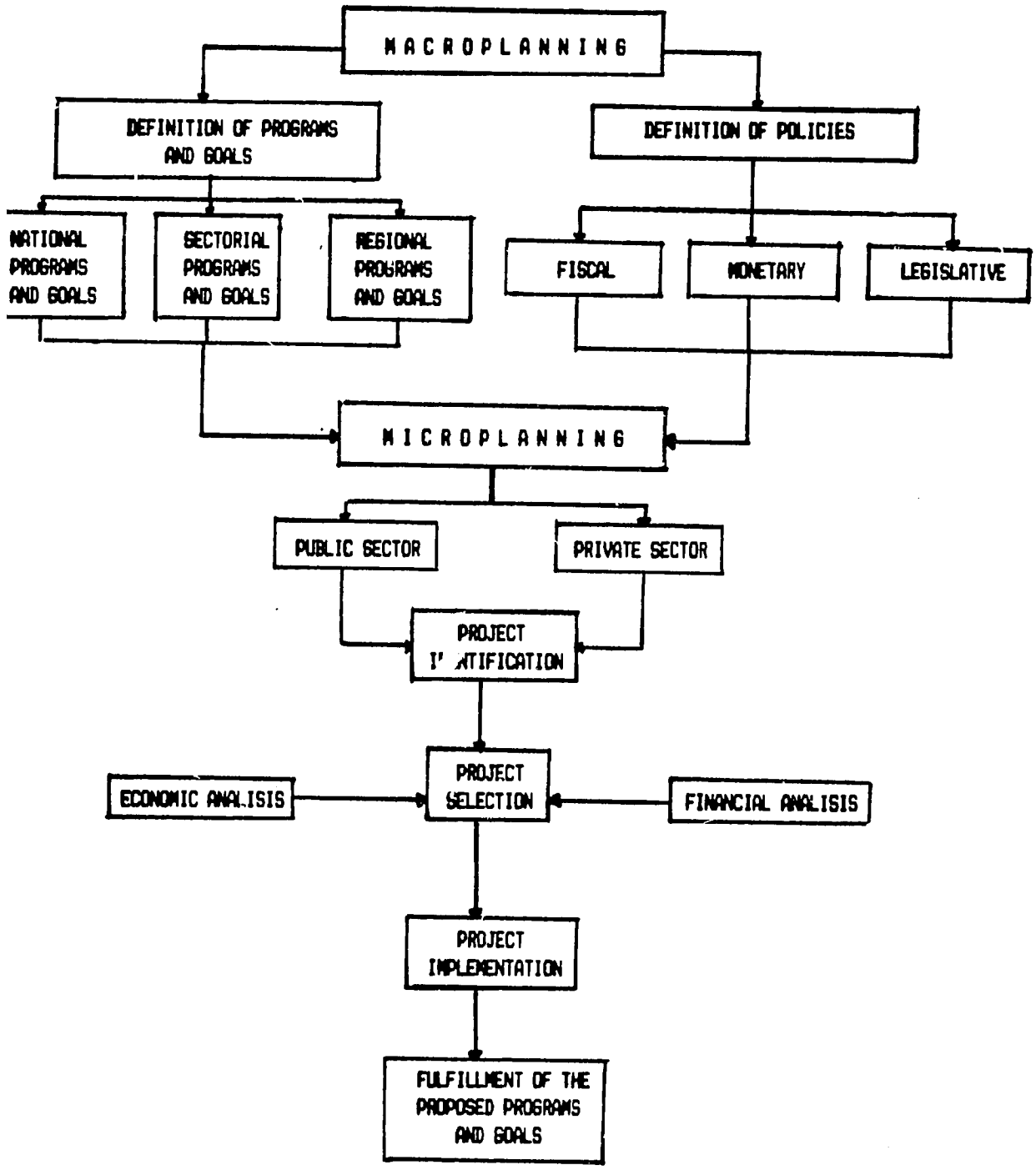
NOTE TO THE INSTRUCTOR:

Attach the following information concerning the city where the course is taking place so that participants can relate this exercise to the observations made during the Technical Field Trip I and their stay in the city:

a.- urban infrastructure map
b.- topography map
c.- natural hazards event maps and information records
d.- available multiple hazards risk and/or vulnerability maps

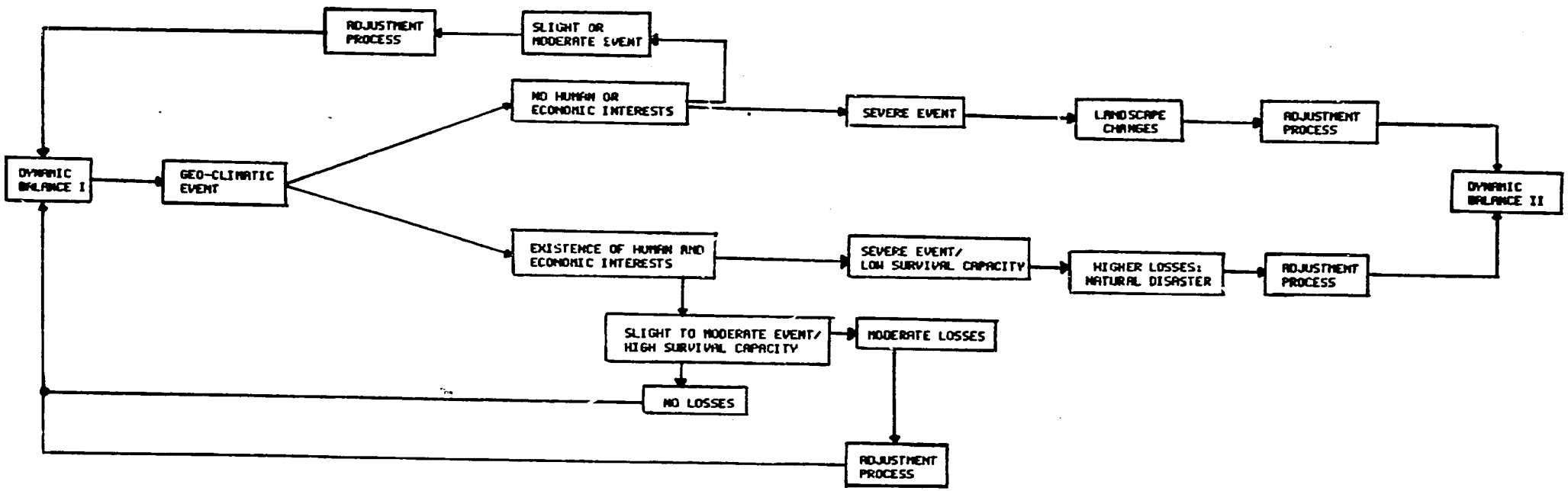
ANNEX III.15.1.- HANDOUT ON THE ECONOMIC PLANNING PROCESS

SIMPLIFIED DIAGRAM OF THE PLANNING PROCESS



ANNEX III.15.2.- HANDOUT ON NATURAL HAZARDS TRADE-OFF ANALYSIS

NATURAL DISASTERS IN AN ECONOMIC AND HUMAN INTERESTS CONTEXT



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ANNEX III.23.1.- HANDOUT ON NATURAL HAZARDS AND PROJECT EVALUATION

USE OF NATURAL HAZARD INFORMATION IN THE ECONOMIC ANALYSIS OF AGRICULTURAL SECTOR PROJECTS

Randall A. Kramer and Anna Lea Florey*

I. Objective

Natural hazards can have devastating and long lasting impacts on the economies of developing countries. The impacts are often severe for the agricultural sector which in many cases is the most critical sector in terms of employment, income, and export earnings. Therefore, economic analysis of agricultural projects should take into account the potential effects of natural hazards.

Major types of natural hazards periodically buffeting agriculture in developing countries include droughts, hurricanes, volcanic eruptions, earthquakes, tsunamis, and other floods. All of these natural hazards are probabilistic in nature, that is they occur with a certain frequency. In many cases it may be possible to relate information about the frequency, severity and duration of natural hazards to economic impacts. Therefore, natural hazard information can be used in the development planning process, particularly in assessing the feasibility of alternative investments.

This chapter discusses some of the economic impacts of natural hazards in developing countries. Emphasis is placed on the agricultural sector. Next, some risk and natural hazard concepts are defined and discussed. This is followed by a review of project analysis procedures. Several means of introducing natural hazard considerations into project analysis are presented and information requirements are discussed. It is argued that the presentation of risk information in project analysis can help decision makers assess the potential impacts of natural hazards on project outcomes. The overall objective of the chapter is to present guidelines for incorporating natural hazard information into economic analysis of agricultural sector projects.

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II. Economic Impacts of Natural Hazards

Agriculture in developing countries is particularly subject to natural hazards for two reasons. First, data from a variety of sources indicate that most natural disasters, approximately 90% of the global total, occur in developing countries.[1] Second, agriculture in developing countries is less protected from natural hazards by risk reducing institutions and infrastructure than in developed countries. In the United States, for example, risk protection is provided to farmers by institutions such as government sponsored crop insurance and disaster loans, and infrastructure such as the massive flood control civil works along the Mississippi River.

By the very nature of natural hazards, the economic damages they inflict are erratic and thus difficult to plan for. Because agriculture is the basic sector in many developing countries, disruptions caused by natural hazards can have far reaching consequences. In any country with a sizeable agricultural sector, serious shortfalls in the agricultural production can have ripple effects throughout the economy, affecting spending and employment in other sectors as well as available food supplies.

Consider some recent examples. When hurricanes David and Frederick struck the Dominican Repbulic in 1979, they caused an estimated $342 million in damage to the agricultural sector.[2] In a country where agricultural products account for 37 percent of Gross Domestic Product, and agriculture employs 40 percent of the labor force, these hurricanes destroyed 80 percent of all crops, and 100 percent of the banana crop. Agricultural production fell 26 percent in 1979, and continued to be down 16 percent in 1980.[3] In 1984, the worst floods in Colombia in a decade caused an estimated $400 million in damage to crops and livestock, while floods in Ecuador in 1982 and 1983 caused the value of the banana crop to decrease by $4.3 million.[4] These are only a few examples of the magnitude of direct agricultural losses resulting from natural disasters.

In addition to the direct impact on a nation's economy, disasters can affect employment, balance of trade, foreign indebtedness, and competition for scarce development funds. After Hurricane Fifi struck Honduras in 1973, employment in the agricultural sector decreased by 70 percent.[5] These sorts of effects have led

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[1] Frank Long, "The Impact of Natural Disasters on Third World Agriculture," American Journal of Economics and Sociology, Vol. 37, No. 2, April 1978, pp. 149-162.

[2] United Nations, "Case Report on Hurricanes David and Frederick in the Dominican Republic," Geneva, 1980, p. 6. (UNDRO)

[3] U.S. Agency for International Development, Office of Disaster Assistance. Countries of the Carribean Community. Washington, D.C., 1982, p. 209.

[4] United Nations, Economic Council on Latin America. Ecuador: Evaluation of the Effects of the 1982/83 Floods on Economic and Social Development. May 1983.

one observer to conclude that "the effects of natural disasters in disaster prone development countries tend to cancel out real growth in the countries."[6]

There are two types of measures which can be taken to mitigate the effects of natural disasters on the agricultural sector -- structural and nonstructural. (See Table 1.) Structural mitigation measures are physical measures or standards which lessen the vulnerability to natural hazards. For example, reservoirs can be constructed to store excess storm water. If linked to irrigation networks, the storage facilities can also be used to alleviate drought conditions. Nonstructural measures are practices and policies which reduce vulnerability. Examples of nonstructural practices include crop diversification and use of drought resistant varieties. There are a number of nonstructural ways that governments can encourage hazard mitigation including land use zoning, protection of coastal wetlands, relocation programs, and establishment of forecasting and warning systems.

If natural hazard mitigation is practiced, benefits can include:

- increased agricultural output and stability
- more efficient use of agricultural technology
- greater foreign exchange earnings
- improved development planning due to greater stability.[7]

This is not meant to suggest that every available natural hazard mitigation measure should be implemented. From an economist's point of view, mitigation should be practiced only as long as the benefits from doing so exceed the costs.

III. Risk and Natural Hazard Concepts

In order to facilitate discussion of economic methods to analyze natural hazards and their mitigation, several concepts are defined and explained below.

A. Probability

Probability is the likelihood of the occurrence of a particular event. This is often based on historical frequency, e.g., the probability of a hurricane striking an island this year could be considered to be 0.1 because hurricanes have struck in 2 of the past 20 years. Probabilities used in decisions, however, are rarely based strictly on historical information. Decision makers will usually adjust historical frequencies based on available current information; these are referred to as subjective probabilities. For example, an individual observing that tropical storms have recently occurred in other parts of the world, may want to assign a higher subjective probability to a local storm event than would be indicated by the historical frequency.

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[5] World Bank, "Memorandum on Recent Economic Development and Prospects of Honduras," 1979, p. 37.

[6] Long, "The Impact of Natural Disasters," p. 156.

[7] Long, "The Impact of Natural Disasters," pp. 160-161.

Table 1. Mitigation Measures for Agriculture

Mitigation Measure	Hazard	Structural	Non-Structural
Afforestation	Drought/Desertification Wind	X	
Animal Shelters	Hurricane Wind	X	
Coastal Break-Waters	Hurricane Tsunami	X	
Coastal Wet-Lands Protection	Hurricane Tsunami		X
Construction and Protection of Retention Basins	Hurricane Flood	X	
Contour Farming	Drought/Desertification Flood		X
Crop Diversification	All hazards		X
Crop and Live-stock Insurance	All hazards		X
Dam Construction and Inspection	Flood	X	
Forecasting and Warning	All hazards		X
Improved and Resistant Crop Varieties	Flood Wind Drought/Desertification		X
Land Use Zoning	Hurricane Flood Earthquake		X
	Drought/Desertification		X
Maintenance of Natural Runoff	Flood Drought/Desertification		X
Reforestation and Prevention of Deforestation	Wind Drought/Desertification Hurricane		X
Relocation	All hazards		X

Table 1 Continued.

Mitigation Measure	Hazard	Structural	Non-Structural
Stabilization Slopes	Landslide	X	
	Floods		
Stream Chanelization	Flood	X	
Terracing	Flood Drought/Desertification	X	
Windbreaks (natural and structural)	Hurricane Wind	X	

Source: Compiled by authors.

B. Risk

Risk is generally referred to as the probability of loss. In economic terms this would refer to declines in income, say, due to crop losses resulting from a natural hazard. In this chapter risk will also be used more generally to refer to uncertainty in key variables used in economic planning. For example, when assessing the benefits and costs of a planned irrigation project, it should be recognized that the prices and yields of agricultural crops may fluctuate over a wide range during the life of the project. These fluctuations can be caused by natural hazards but can also be caused by changing market conditions and weather cycles.

C. Risk Aversion

Risk aversion refers to an individual's attitude toward risk. Risk aversion is simply the desire to avoid taking risk. A risk averse individual is willing to sacrifice some amount of money to avoid risk. Risk averse farmers, for example, may purchase hail insurance for their crops if premiums are at "reasonable" levels. However, a risk averse individual will elect to take risks if the cost of avoidance is too high. Empirical evidence indicates that most, but not all people, are risk averse, but there is a wide range in the degree of risk aversion.[8] In other words, for a given level of risk, some people would pay more than others to avoid the risk. The question of whether a government should be risk averse will be discussed later.

D. Risk Assessment

Risk assessment refers to the quantification of a risk. It requires a determination of both the consequences of an event and the likelihood of its occurrence. For example, in considering the potential economic effects of an earthquake on an agricultural project, risk assessment would require a determination of (a) the impacts of the earthquake on agricultural activity and the structural components of the project (e.g., would crops be lost? would irrigation canals be destroyed?), and (b) the probability of an earthquake occurring in the region during the life of the project.

E. Risk Management

Risk management refers to actions taken to reduce the consequences or likelihood of unfavorable outcomes. Similarly, natural hazard management refers to activities intended to reduce the negative effects of natural hazards. A farmer may choose to plant a windbreak along his field to reduce the chances of wind damage to his sugar cane crop. While this may reduce his average income if land must be removed from production, it may still be undertaken as insurance against an uncertain but potentially costly event -- a major storm.

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[8] Hans P. Binswanger, "Attitudes Toward Risk: Experimental Measurement in Rural India." American Journal of Agricultural Economics, 62(1980):395-407; Douglas L. Young, "Risk Preferences of Agricultural Producers: Their Use in Extension and Research." American Journal of Agricultural Economics, 61(1979):1063-1070.

IV. Natural Hazards and Development Planning

A. Project Planning

An agricultural project is an investment of capital to create assets capable of generating a stream of benefits over time. Types of agricultural projects are as diverse as land settlement, rural education, irrigation, and soil conservation to name only a few. The project may be independent or a part of a package of projects comprising a multisectoral development effort. Although implementation of a project is perhaps the most difficult aspect of development administration, careful project planning is also of critical importance:

> for most agricultural development activities, careful project preparation in advance of expenditure is, if not absolutely essential, at least the best available means to ensure efficient, economic use of capital funds and to increase the chances of implementation on schedule.[9]

The primary aspects of project planning can be described in three parts: project profile, prefeasibility analysis, and feasibility analysis.[10] (Refer to Chapter One.)

1. Project Profile

This is a preliminary project proposal in which overall costs and benefits for a specific project are roughly estimated and alternative approaches are identified.

2. Prefeasibility Analysis

This is a preliminary evaluation of the technical and economic viability of a proposed project. Comparison of alternative approaches to various project elements are made and less promising alternatives are recommended for elimination. Development and operation costs are estimated for the project and benefits are assessed so that economic feasibility criteria can be evaluated.

3. Feasibility Analysis

This is the final determination of the viability of a proposed investment project. The need for the project is analyzed along with resource availability. Every aspect of the project plan is reexamined. Refined estimates are made of project benefits, costs (construction, operation and

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[9] J. Price Gittinger, Economic Analysis of Agricultural Projects, 2nd ed., Baltimore: Johns Hopkins University Press, 1982, p. 3.

[10] Organization of American States. Integrated Regional Development Planning: Guidelines and Case Studies from O.A.S. Experience, Department of Regional Development, January 1984, pp. 226-227.

maintenance), and evaluative criteria, that is, net present value, internal rate of return, and benefit-cost ratio.

B. Use of Natural Hazard Information

Although not widely done, project planning could be improved if analysts would incorporate natural hazard information at each project development stage. In a brief survey of current project formulation and development guidelines utilized by several development organizations and private lending institutions, the lack of risk information, especially about natural hazards, was evident. Most institutions do not require risk information in project preparation guidelines, except for engineering projects. Risk to the environment appears to be more of a concern than risk from the environment.

It is important to introduce risk information at the earliest levels of project planning. When this information is included at project formulation levels, the entire project design can be altered to accommodate the risk factors. If the risks are too great, an alternative project may be chosen. Risk information may be included at the project analysis stage, just before the project is implemented, but at this stage it may only be possible to take limited remedial action.

Natural hazards can be considered first at the profile stage. Risk maps and hazard event frequencies can be consulted. For example, a flood plain map produced by use of remote sensing techniques would depict areas that are prone to severe flooding. From the start of project planning, planners might want to avoid designating these flood-prone areas for agricultural activities requiring extensive capital investments such as buildings. Instead, an alternative land use, less sensitive to flooding, such as rice production could be considered. In view of the high flooding probability, the planner also might want to consider hazard mitigation practices which could reduce risk to acceptable levels.

At the prefeasibility level, more sophisticated consideration of natural hazards can be made. For example, a 100 year flood plain map could be developed. Probabilities of different hazards can be estimated and used to adjust cost and benefit figures. If a formal benefit-cost analysis is conducted, procedures discussed later in the chapter can be used to incorporate the natural hazard information directly into the analysis.

Finally, at the feasibility stage, the effects of natural hazards on benefits and costs can be more carefully evaluated. More detailed information on the likelihood and consequences of natural hazards can be collected and used to revise the benefit-cost analysis.

Natural hazard and other risk information needs to be considered explicitly in the form of probabilities and consequences of different outcomes. Otherwise, it will enter into the analysis implicitly. If an agronomist is asked to provide a single valued yield estimate he may account for risk by giving a pessimistic value, although if asked he could give pessimistic, optimistic, and most likely values, as well as assign probabilities to each value. An engineer will also take risk into consideration by selecting structural design criteria for a 20 year storm for example. Risk can be accounted for in a more systematic fashion by drawing these risk considerations out into the open.

V. Principles of Benefit-Cost Analysis

A. Introduction

Economic analysis is seldom the only criteria upon which project decisions are based. The choices made by decision makers also reflect the social and political aspects involved in project selection. One approach taken when considering several criteria for making decisions is a Multicriteria Analysis, which is an assessment of acceptable levels of each criteria. Although natural hazard risk information can be incorporated directly into an economic analysis, the probability of natural hazards could be considered as a separate decision making criteria. A Multicriteria Analysis would evaluate how much this criteria could be lowered before affecting other project criteria, and lead to a decision on acceptable risk. It is important to realize that project selection decisions, as well as alternative selections within a project, are made based on several criteria, including economic analysis.

Benefit-cost analysis is a method economists have developed to evaluate the efficiency of public sector activities. Although benefit-cost analysis is designed for evaluating nonmarket activities, economic information to conduct the analyses is frequently obtained from market activities. It is a practical technique for comparing the merits of different government projects over time. There are numerous variations of each economic analysis technique within a benefit-cost analysis, so project economists should seek to find the best method for each individual case. This section provides a very brief overview of benefit-cost analysis, which can be used as a general guideline, but readers are encouraged to review other literature.[11]

The point of view taken in benefit-cost analysis is that of society as a whole. This is what is referred to as accounting stance. When a private individual considers whether or not to make an investment, he or she considers only the benefits and costs that have a direct personal impact. When the societal perspective is taken, the accounting stance shifts to consider all benefits and costs affecting society.

Another important aspect of benefit-cost analysis is the with-and-without criteria. The analysis should assess the state of affairs with versus without the project in place. The with-and-without criteria is important in sorting out what should be counted as benefits and costs of a project. Suppose an irrigation project is being considered for an area where crop yields are showing an upward trend. The irrigation project will cause the yields to increase even more. When assessing potential project benefits, it would be erroneous to attribute to the project all of the growth in yields from before the project, to after it is constructed, since some of the growth would have occurred anyway.[12] In areas that are rapidly developing, it is particularly important to make sure that project benefits and costs are

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[11] For a more complete treatment see Gittinger, Economic Analysis of Agricultural Projects, and E. J. Mishan, Cost-Benefit Analysis: An Informal Introduction, 3rd ed., Boston: George Allen and Unwin, 1982.

[12] Charles W. Howe, Benefit-Cost Analysis for Water System Planning, American Geophysical Union, Water Resources Monograph 2, Washington, D.C., 1971.

properly accounted for and do not include changes that would have taken place without the project.

A benefit-cost analysis can be organized in three main steps:[13]

1. enumeration of all benefits and costs of a proposed project;
2. evaluation of all benefits and costs in dollar terms; and
3. discounting of future net benefits to put them into current dollar terms.

While these steps may appear simple, a thorough analysis requires considerable effort. The economist or planner carrying out the analysis should work with other specialists such as agronomists, engineers, and hydrologists to ensure that all relevant factors are taken into account and that technical production relationships are properly reflected. This integrated, interdisciplinary approach to planning has been advocated by OAS.[14]

Costs must be defined so as to weigh foregone alternative benefits if the project is selected. Benefits can include both direct and indirect effects resulting from the project. In comparing the benefit stream to the cost stream over time, all present and future values must be put into a common frame of reference known as "present value". This requires the choice of an appropriate discount rate.

B. Costs

In measuring the costs of a project, care must be taken to accurately reflect foregone alternatives. These are referred to as opportunity costs. In addition to foregone alternatives, a project may entail direct as well as indirect costs. Direct costs can include expenses incurred in material and administration, as well as the use of natural resources. Costs of natural hazard mitigation, such as canal systems, dams and windbreaks should be included. Non-structural mitigation measures, such as crop diversification and agricultural zoning, can also be considered. In addition, indirect costs must be taken into account. If a new project will draw water resources from nearby agricultural land, the resulting decline in agricultural production should be counted as project cost.

The analyst must also be aware that due to market distortions, prices of inputs may not reflect their true valuation by society. In these cases prices should be adjusted to correct for distortions. Prices so adjusted are referred to as shadow prices. As an example of adjusting market prices, consider the case of a government subsidy on fertilizer. The subsidy lowers the cost of the fertilizer used in the project. For a benefit-cost analysis, the market price must be increased by the amount of the subsidy to reflect its true cost to society.

[13] David N. Hyman, The Economics of Governmental Activity, New York: Holt Rhinehart, and Winston, 1973.

[14] Organization of American States. Integrated Regional Development Planning.

C. Benefits

The benefits in an agricultural project may result from either increased value of farm output or from reduced production costs. Benefits from natural hazard mitigation could be measured in terms of avoided agricultural income losses. In addition to direct benefits, projects generate indirect benefits. For example, an irrigation project might have the "spill-over" benefit of increasing the productivity of land adjacent to the land actually irrigated by the project.

An evaluation of the benefits of a project should only include real increases in output. A flood control project may lead to a higher value of farmland in the protected area. Because this higher value merely reflects the increased output potential of the land, counting the value increase as a project benefit would lead to a double counting of project benefits.

D. Discounting

After enumerating and evaluating all benefits and costs, the third step in project analysis is to discount future benefits and costs. This is accomplished through the use of a discount rate to convert future values into present values. The need to discount arises from the fact that money received today is worth more than an equivalent amount of money received in the future. This is because money received today can earn interest in the interim. An investment of $100 at an annual interest rate of 10 percent will be worth $121 at the end of two years. Future benefits and costs must be discounted in order to express them in a common denominator -- today's dollars or present value.

The project analyst must choose the discount rate, and often more than one rate is used in a project. Gittinger suggests three possible alternatives: opportunity cost of capital, borrowing rate for the capital used to finance the project, and social time preference rate. The opportunity cost of capital is the rate that will result in utilization of all capital in the economy if all possible investments are undertaken that yield as much or more in return. The opportunity cost of capital cannot be known with certainty, but in most developing countries, is considered to be between 8 and 15 percent in real terms.[15]

E. Evaluation

The discounted or net present value (NPV) of a project is represented mathematically as

$$\Sigma B_t/(1 + r)^t - \Sigma C_t /(1 + r)^t \qquad t = 1, 2, \ldots n \qquad (1)$$

where B = benefits, C = costs, r = discount rate, t = time period, n = life of the project in years, and Σ is the summation operator. After benefits and costs are evaluated and enumerated and a discount rate is selected, equation (1) will indicate the net present value (NPV) of the project under consideration. The economic decision criteria about the worth of a project is usually (a) the NPV is positive, and (b) the NPV is higher than that of alternative, competing projects. Another

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[15] Gittinger, Economic Analysis of Agricultural Projects.

way to consider the benefits and costs is to set equation (1) equal to zero and solve for the value of r. This is referred to as the internal rate of return (IRR).

To facilitate comparison of projects, expression (1) is often rearranged as a benefit-cost ratio:

$$\frac{\Sigma B_t/(1 + r)^t}{\Sigma C_t/(1 + r)^t} \qquad t = 1, 2, \ldots n$$

The higher the net present value of the project, the higher the ratio. A benefit-cost ratio greater than 1 indicates that the discounted benefits exceed the discounted costs.

VI. Incorporating Risk into Benefit-Cost Analysis

A. Introduction

Should risk be considered in benefit-cost analysis? Arrow and Lind have argued that even though individuals are risk averse, governments should take a risk neutral stance when evaluating projects.[16] They argue that since project benefits and costs are spread over a large number of individuals in the society, the element of risk facing each individual is negligible. Since project risks are widely shared, this would imply that a government should be indifferent between a high risk and low risk project which both have the same expected net present value. While there are a number of important qualifications to these well known theoretical results, for this discussion the most important point is that their argument only applies to risks which are actually borne by the government. Natural hazard risks are to a large extent borne by individuals and thus investments in projects which affect natural hazard risks should account for risk. Furthermore, in view of government debt problems, income distribution concerns, and other social and political concerns, governments are more likely to exhibit risk averse behavior than Arrow and Lind's abstract model would suggest.

Consider the example of how a single project with highly variable outcomes could have a significant impact on a particular region or group of people.[17] Suppose there are two projects under consideration in a coastal area of a country. Project A has a NPV of $2 million and project B has a NPV of $1.5 million. Now consider the variability in returns to both projects. Because project A has the highest NPV, it would be selected if risk was ignored. Project A is vulnerable to floods and thus could have an actual NPV of between $0.5 million and $2.5 million depending on the frequency and severity of future floods in the area. Project B is less susceptible to flood damages and therefore has a NPV range of $1.3 million to

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[16] K. J. Arrow and R. C. Lind, "Uncertainty and the Evaluation of Public Investment Decisions," American Economic Review, Vol. 60, 1970

[17] Warren C. Baum, "Risk and Sensitivity Analysis in the Economic Analysis of Projects," World Bank Central Projects Note 2.02, July 1980.

$1.7 million. Because the returns to project B are more stable, the residents of the coastal area might prefer the project with the lower NPV. They would probably be unimpressed by arguments about the merits of societal risk sharing, since the risks (variation in NPV) their cummunity bears from these projects are rather large.

In some cases, lending agencies may also take a risk averse stance. This is because they must take into account the probability of timely repayment of the project loan. However, they are more likely to be concerned about how macroeconomic risks will affect a government's overall repayment ability rather than how natural hazards will affect the return to a particular project.

Several methods for including risk considerations in benefit-cost analysis are available to analysts. The first category of methods can be applied when there is little risk or natural hazard information available. The second group of methods is appropriate when information on probability distributions can be obtained. All of these can be used in comparing different projects as well as comparing alternatives within a project.

B. Decision Criteria with Limited Information

1. Cut-off Period

The crudest procedure for incorporating risk into benefit-cost analysis is the use of a cut-off period.[18] This approach is primarily utilized by private investment agencies, whose main interest is in capital return rather than long-term development. Economic feasibility under the cutoff period requires that in a relatively few years, sufficient benefits must be accrue to more than cover project costs. For very risky projects, the cut-off period might be set as low as 2 or 3 years, whereas for low risk projects it would be much longer, say 30 years.[19] The underlying logic of a cut-off period rule is that benefits and costs are so highly uncertain beyond the cut-off date that they should be ignored in determining project feasibility. A cutoff period should be determined by the pre-feasibility stage of project development, at the latest.

Some information is necessary to determine the relative riskiness of the project. The most useful data would be a list of natural disaster events, or episodic information, as well as meteorological records, land use maps, agricultural cropping maps, and previous damage assessments, which could give the economist a rough idea of inherent risk. In addition, satellite photography of natural hazard impacts could be useful in making a decision concerning a cutoff period. In many cases, it would not be too difficult to obtain this information for the minimum required 2-5 year period.

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[18] Mishan, Cost-Benefit Analysis, p. 399.

[19] Even when benefits are expected to go on beyond 30 years, these benefits are hardly worth considering in a benefit-cost analysis because their present value is so low. For example, using a 10 percent discount rate, each dollar received in 30 years is worth only about 6 cents in present value.

A cutoff period should only be considered when few records are available, and the nature and magnitude of possible hazards could have great potential for agricultural damage, such as would be the case in severe storms and floods. It would be more difficult to dictate a cutoff period in the case of slow onset hazards, such as drought or desertification.

As an example of the cutoff period, this method could be applied to a vegetable and livestock farming systems project being planned for a developing country. The objectives of the project would be to increase cropping intensities and agricultural income. This project may be viewed as risky if the area is subject to frequent flooding. The flooding would damage crops and destroy livestock and thus reduce the project benefits. Therefore, one might choose a 2 or 3 year cutoff period for costs and benefits.

While this approach attempts to consider risk effects, it is rather unsatisfactory. Short cut-offs can ignore economic information associated with much of the life of projects. Rather than deal with risk directly, this method discards all information beyond the cut-off period. If benefits and costs are highly variable beyond the cut-off date, there are other methods which can be used to consider these benefits and costs while recognizing their inherent riskiness.

2. Discount Rate Adjustments

Another ad hoc way to reflect uncertainty in project analysis is to add a risk premium to the discount rate. The effect of increasing the discount rate is to give less weight to the increasingly uncertain costs and benefits in future time periods.[20] This is consistent with what has been observed in the private sector; when business investments are made, managers generally require higher internal rates of return for riskier investments.

In using this technique of economic analysis, the economist is faced with the subjective decision of determining an arbitrary risk premium to add to the discount rate. The same type of information that is useful for a cutoff period can be utilized to determine the discount rate. This information should be available by the pre-feasibility stage of project planning.

A subjective decision on the discount rate could include available information on the possibility of a slow onset hazard, such as desertification, as well as short-term, high immediate impact hazards such as severe storms and flash floods. Once again, this method should be employed as a last resort, when little or no information on natural hazards is available.

[20] Some writers suggest raising the discount rate for uncertain benefits and lowering it for uncertain future costs. See, for example, Lee G. Anderson, and Russell F. Settle, Benefit-Cost Analysis: A Practical Guide, Lexington Mass.: D. C. Heath, 1977. However, in some types of projects, costs will be less subject to uncertainty than benefits.

In reviewing the example farming systems project presented in the previous section, it can be seen that any indication of flooding would be viewed as making the project risky. If normal practice is to use a discount rate of 10% for the benefits, the discount rate for this particular project might be increased to 12% or 15%.

This approach is preferable to the cut-off period method because it does not ignore information about future benefits and costs. Yet, the amount of risk adjustment of the discount rate is arbitrary and the approach does not recognize risk differences across project components. More rigorous and defensible approaches which are capable of quantitatively assessing the uncertainty in benefits and costs over time are discussed below.

3. Game Theory Approaches

When there is no reliable information on probability distributions of hazards, two strategies from game theory have been suggested, the maximin-gain strategy and the minimax-regret strategy. Both can be applied at the earliest stages of project formulation, as the necessary information becomes available. The types of information required for each are records of historical events, climatological and meteorological data, and previous natural hazard damage records for the sector in question; for example, crop damage data in the agricultural sector. Using this information, it is possible to estimate the benefits resulting equivalent project alternatives under varying degrees of severity of the natural hazard. The game theory approaches are better suited for short term, high immediate impact hazards, which can easily be divided into least/most damage scenarios.

To illustrate the maximin-gain approach, which derives its name from maximizing the minimum gain, an example will be given. Suppose that a decision has been made to augment the earlier discussed farming systems project with a structural, natural hazard mitigation measure. Three alternative flood control projects, (A, B, and C) with equal cost are under consideration.[21] For convenience it is assumed that there are two possible states of nature; heavy rainfall and normal rainfall. If heavy rainfall occurs, the net present value of benefits from the three projects are $100 million, $120 million, and $150 million respectively. If there is normal rainfall, the projects will provide irrigation and other discounted benefits of $30 million, $60 million, and $120 million respectively. Project benefits will be greater in the case of heavy rainfall, since the primary benefit of the flood control projects is prevented flood damage. The various outcomes are summarized below:

[21] This example is similar to one in Anderson and Settle, Benefit-Cost Analysis, pp. 103-104.

Benefit Matrix for Three Hypothetical Flood Control Projects

	Heavy Rainfall	Normal Rainfall
Project A	$100 million	$30 million
Project B	$120 million	$60 million
Project C	$150 million	$20 million

Applying the maximin-gain strategy would result in choice of project B since its minimum benefit is $60 million as compared to $30 million for project A and $20 million for project C.

The maximin-gain strategy has the drawback of basing project selection completely on security and is very conservative. Even if project benefits for A and C were 10 times larger than for project B under heavy rainfall, B would still be selected. Thus, it can lead to selection of projects which most people would agree are inferior. Therefore an alternative approach has been proposed: minimax-regret.

The minimax-regret strategy is to minimize the maximum regret or loss that could be realized. This strategy can be illustrated with the three project example above. If heavy rainfall does occur, project C would have resulted in the greatest benefit, $150 million. If project A had been selected the regret or foregone benefits for not selecting C would have been $50 million ($150 million - $100 million) and if project B had been selected the foregone benefits would have been $30 million ($150 million - $120 million). If instead of heavy rainfall, there was normal rainfall, project B would have produced the most benefits, $60 million. In that case the foregone benefits would have been $40 million for project C and $30 million for project A. Now considering both possible weather events, heavy and normal rainfall, it can be seen that the maximum regret (foregone benefits) would have been $50 million, $30 million, and $50 million respectively for projects A, B, and C. Therefore, a minimax-regret strategy would lead to a choice of B since it has the smallest maximum regret.

4. Sensitivity Analysis

Another method to allow for risk consideration in benefit-cost analysis is sensitivity analysis. Analysts change key parameter values subject to risk to determine their effects on the NPV of a project. Usually, the values are changed one at a time, but sometimes they are changed in combination with one another. This can be useful if there is information that can indicate how much each parameter should be changed, for example, plus or minus one standard deviation.[22] More typically the values are varied by an arbitrary

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[22] George Irwin, Modern Cost-Benefit Methods, London: MacMillan Press, 1978, p. 52.

percentage, say 10 percent. This will not be informative about the degree of dispersion in NPV and does not take into account the amount of uncertainty in the key parameters, e.g. crop yields.

Sensitivity analysis can help identify project elements worthy of more indepth consideration, and thus could be used at the project profile stage to precede more sophisticated risk analysis. In addition, sensitivity analysis can be used to identify areas where hazard mitigation measures can be applied. A sensitivity analysis is suited to all types of hazards, even when minimal information is available. The types of information that are useful for this analysis are event histories, climatological and meteorological data, and previous damage reports. Such data would assist an economist in estimating percentage variations in parameters from previous hazard information. If probabilistic information such as episodic data is readily available and reliable, a more complete risk analysis can determine frequency of hazards for assessing their efforts on economic variables used in NPV calculations. This type of analysis will be discussed later.

The example farming systems project presented earlier can be utilized to demonstrate the application of sensitivity analysis methods. With the aid of a personal computer or even a hand calculator, a sensitivity analysis can be performed on each cost and benefit to determine their effects on the rest of the project. For example, a sensitivity analysis performed on crop yields may demonstrate that if production falls by 40% in the first year as the result of an intermediate-level flood, the overall project benefits may be greatly decreased, or that it would take much longer to recover the costs.

The best way to report the results of sensitivity analysis is by means of "switching values.[23] These are the values of the key variables at which the NPV of the project becomes zero (or the benefit-cost ratio falls below one). Switching values can be presented as follows:

Switching Values of Key Variables

Variable	Switching Value
Price of Corn	-60%
Yield of Corn	-20%
Construction Costs	+50%

In this example, the information on switching values tells us that corn yields would only have to decline by 20 percent from their expected value to make the project NPV zero.

[23] Baum, "Risk and Sensitivity Analysis," pp. 5-6.

C. Decision Criteria With Probabilistic Information

If probability distributions for key natural hazard and other variables are available, a more rigorous consideration of risk can be carried out. The probability distributions may be based on the subjective assessments of experts or on historical information such as episodic, climatological, meteorological, agronomic, and geological data. For example, if adequate data are available, the probability distribution for crop yields can be estimated from historical farm or experiment station records. In many cases, such data are not available. An alternative approach would be to elicit subjective probabilities from farmers, extension agents, or agronomists. One relatively simple way to obtain subjective probabilites is the triangular distribution method. An individual is asked the most likely yield and the best possible and worst possible yields. Formulas can then be used to estimate the mean and variance of the probability distribution.[24] Experts could be asked to provide subjective distributions of yields with and without natural hazard mitigation measures in place.

Because natural hazards can affect the benefits of a project (for example, by destroying crops) as well as the costs (for example, by damaging irrigation systems), in some cases it may be desirable to obtain probability distributions of natural hazard events. The availability of probabilistic information on natural hazards will depend on the quantity and quality of natural hazard information collected. More accurate records will lead to better probability distributions, and thus a better overview of the hazard situation. Probabilistic information can be obtained from any type of natural hazard with measurable magnitude and frequency.

In estimating the probability distribution of the NPV (or other economic feasibility measure), typically, only a select number of variables are considered random, or subject to fluctuations. Others are considered fixed for purposes of the analysis. The variables allowed to vary may be those identified from sensitivity analysis as important or those known from observation to fluctuate widely. The various probability distributions can be combined to form a probability distribution of NPV either mathematically or with computer simulation methods. The latter is generally the easier approach.[25]

Available computer routines will repeatedly sample values of the random variables (taking into account interrelations among them). These random draws can then be used to calculate NPV. The resultant large number of NPV values will then approximate the probability distribution of the NPV. The distribution conveniently conveys information about the riskiness of projects.

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[24] For additional details, see Jock R. Anderson, John L. Dillon, and J. Brian Hardaker, Agricultural Decision Analysis, Ames: Iowa State University Press, 1977.

[25] For details on procedures, see Shlomo Reutlinger, Techniques for Project Appraisal Under Uncertainty, (World Bank Staff Occasional Paper, No. 10), Baltimore: Johns Hopkins University Press, 1970. If more than one random variable is used, covariances between random variables (e.g. prices and yields) should be specified. Otherwise, results can be misleading.

After the probability distributions have been calculated, one could compare the mean or average values of each distribution to select between projects, or between alternatives within a project. This is essentially the commonly used procedure of utilizing most likely values of the key economic variables. This would be a risk-neutral approach; that is, even though risk information was used to estimate the NPV probability distribution, the final decision would ignore the relative riskiness of the project. It was argued earlier, though, that there are a number of reasons why governments or lending agencies should take risk into account in comparing projects. Therefore, only considering the average NPV is inadequate and it also discards useful information contained in the probability distribution. Two methods of summarizing the risk information in a probability distribution -- mean-variance analysis and safety-first analysis -- will be discussed below.

1. Mean-Variance Analysis

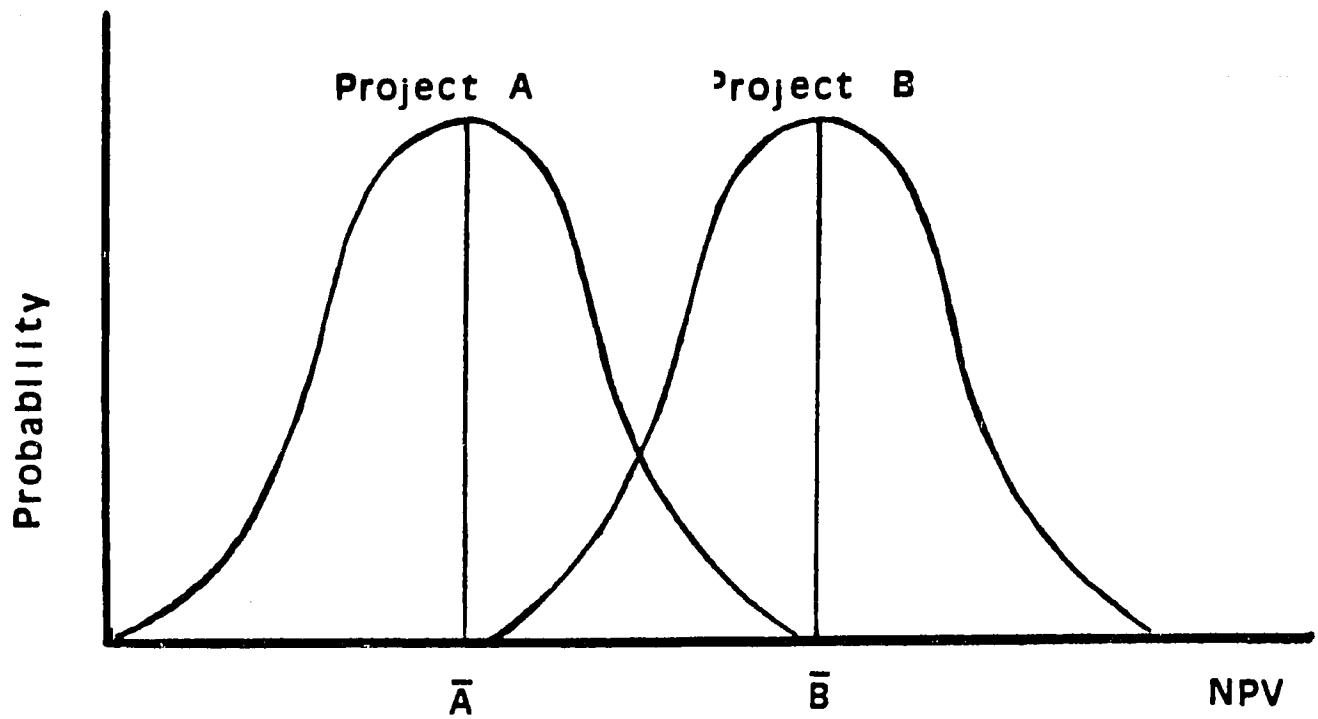
Mean variance analysis can be applied in the pre-feasibility stage in project development. Comparison of projects can proceed by graphing the NPV probability functions. In Figure 1, several probability functions are displayed for different projects. In the top part of the figure, project A and project B have similar probability distributions, but the one for project B is further to the right, indicating that the average or mean NPV is greater; $\bar{B} > \bar{A}$. Both projects have the same risk, because the variance or dispersion around the mean is the same. Project B would be preferred over A because the expected NPV of B is greater and the risk is the same.

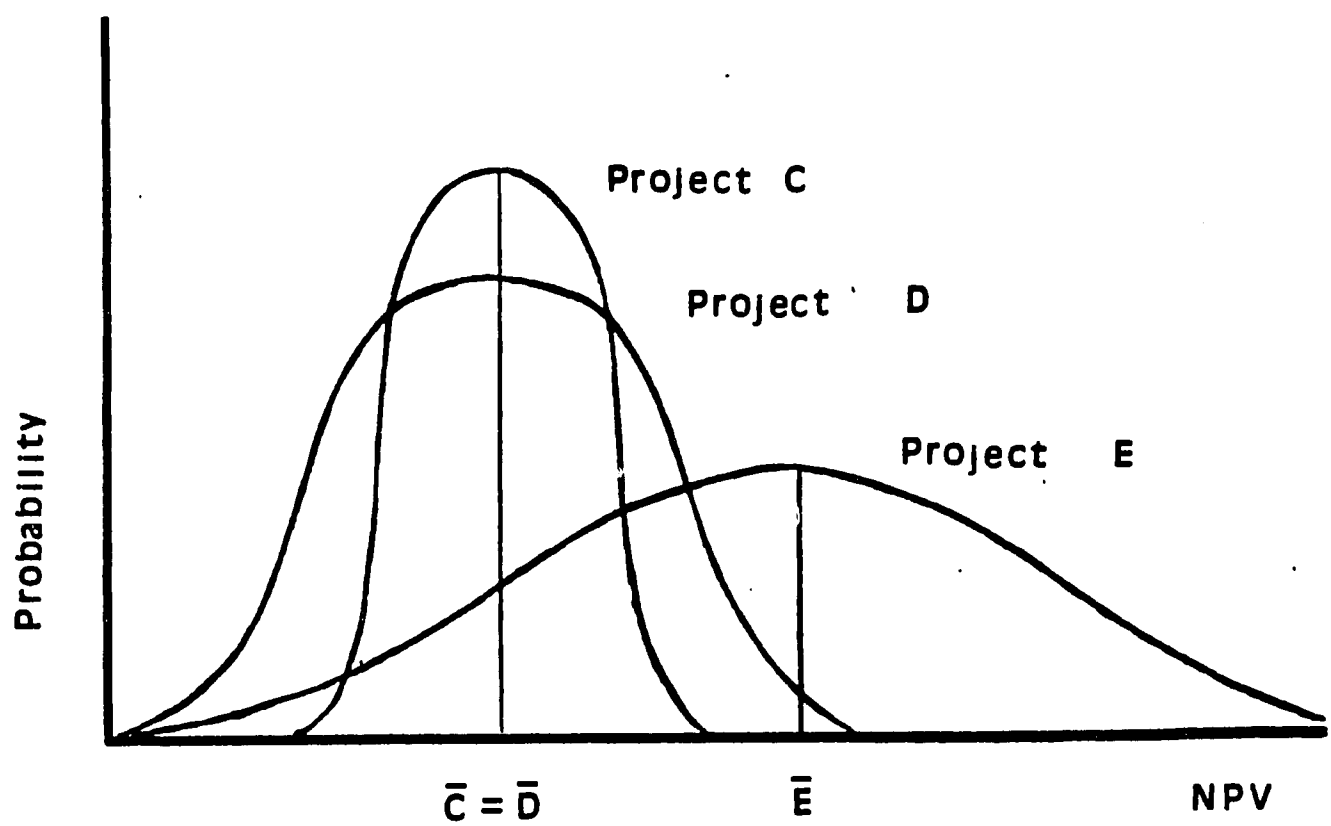
Several other project comparison cases are depicted in the lower half of Figure 1. Projects C and D have the same mean, but project D is riskier because it has a greater dispersion around the mean. If only the mean values of the project's NPV were considered, society would be indifferent between projects C and D. However, if society (or the lending agency) is risk averse, then project C would be preferred because there is less chance of the NPV falling below the mean.

The comparison of project C to project E is less clear cut. Project E has a much higher mean than project C, but its variance is also greater. There is clearly a tradeoff between a higher expected NPV and accepting greater risk. The decision maker (not the analyst) will have to decide what weights to apply to higher mean NPV versus greater risk.

A mean-variance analysis can be easily applied to the example flood control project presented earlier. The information needed to proceed with the analysis is historical data on past heavy rainfall or floods--magnitudes as well as frequency of occurrence. Statistical means and variances can be calculated from this information. Sufficient data would then be available for a determination of the probability of the hazard, in this case a flood. A project planner can view this information when making a decision. In addition, this information can be used to calculate the probability distribution of the NPV of alternative flood control projects. The probability distribution can then be used to calculate the means and variances of the projects' NPV. The project planner can view the variance, or the risk, of the NPV resulting from flood events.

FIGURE 1. Probability Distributions of NPV for Different Projects





2. Safety-First Analysis

The variance of a distribution reflects dispersion around the mean, both positive and negative, yet risk management is primarily concerned with reducing losses and thus is more focused on the left hand side of a distribution. If the probability distribution is symmetric, like a normal distribution, then decisions based on the variance will be suitable for risk management because negative and positive fluctuations around the mean are equally likely. However, some probability distributions, such as the beta, are not symmetric. Some real world phenomenon of interest to risk analysts appear to follow distributions that are skewed in one direction or the other. For example, if corn yields average 100 bushels per acre, a drought that occurs every 5 years could cause yields to fall as low as zero. Yet one would probably never observe yields fluctuate equally far above the mean to 200 bushels. Thus, analysts may want to choose a decision criteria that focuses on the lower tail of a distribution. An additional advantage of such an approach is that it lends itself more easily to discussions of minimizing losses. This can be useful when considering hazard mitigation measures for minimizing agricultural losses. Safety first criteria could be applied to relatively frequent natural hazards, such as floods and severe storms, but may not be as useful for low frequency catastrophic events such as volcanic eruptions and tsunamis.

A popular risk analysis method which focuses on the lower tail of probability distributions is known as safety-first analysis. This can be readily applied to benefit-cost analysis. A safety-first approach could be stated as:

$$\text{Maximize } \overline{NPV}$$

$$\text{subject to } P(NPV < C) \leq a$$

where $\overline{NPV}$ = mean net present value, P = probability, C = a critical threshold value, and a = a small probability value. The decision criteria is to maximize expected NPV subject to a constraint that says the probability is small that NPV will fall below a critical value. For example, the decision maker might choose the project with the highest expected NPV as long as the probability of it falling below zero was less than 5 percent.[26]

In Figure 2, the cumulative probability of the NPV for two projects is depicted. Suppose the safety-first criteria is established as: maximize $\overline{NPV}$ subject to a no more than 20 percent chance of NPV falling below $20,000. As the graph indicates, the probability of falling below the critical value is 40 percent for project A and 15 percent for project B. The safety-first criteria would eliminate A from further consideration. If there were other projects with a less than 20 percent chance of having a NPV smaller than $20,000,

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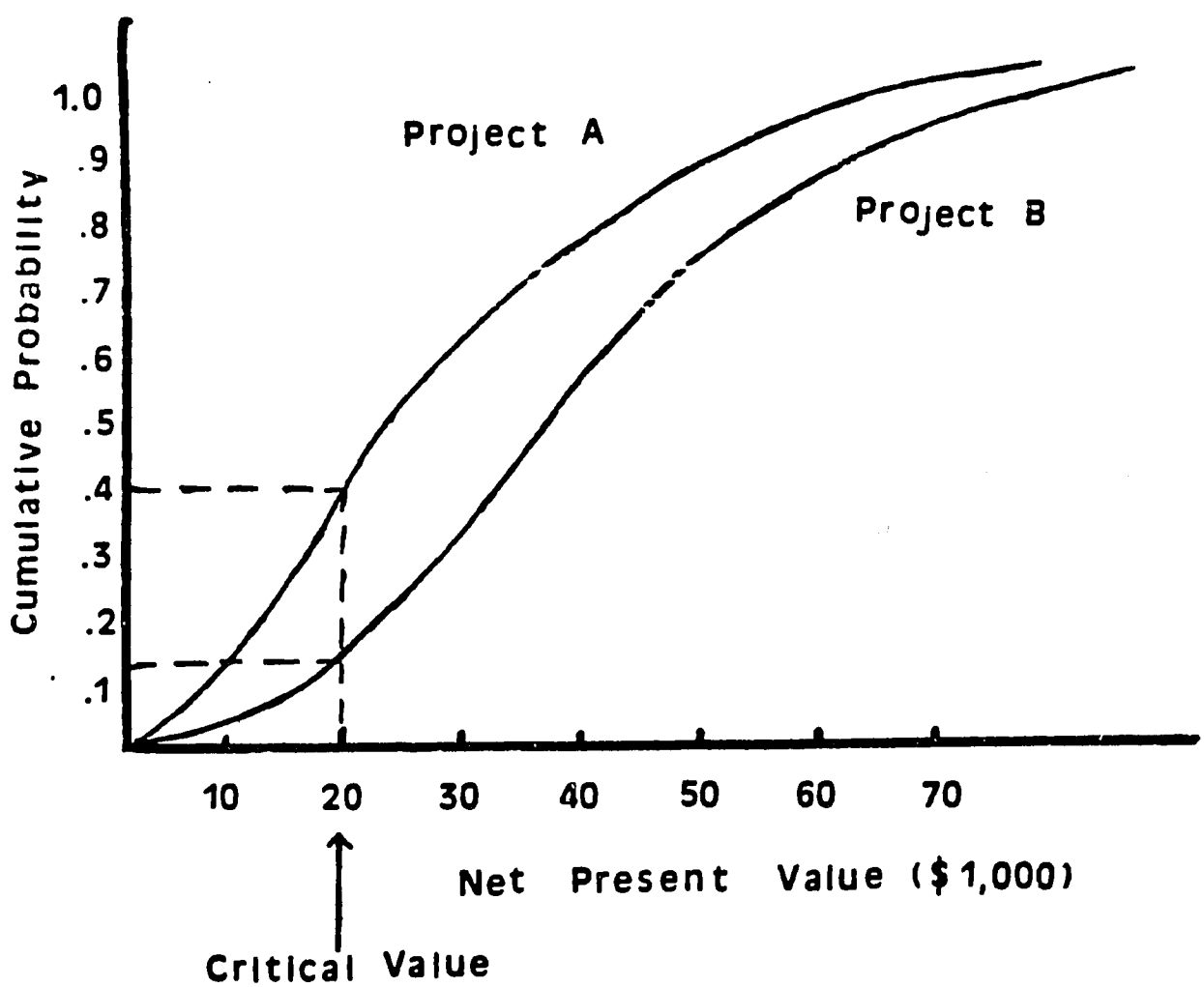
[26] For an illustration of applying this approach to the appraisal of an irrigation project, see Sushil Pandey, "Incorporating Risk in Project Appraisal: A Case Study of a Nepalese Irrigation Project," A/D/C - APROSC, Research Paper Series No. 18, Kathmandu, March 1983.

FIGURE 2. Cumulative Probabilities of Project NPVs



then the one with the highest expected NPV would be recommended for implementation.

A safety-first approach can be applied to the flood control example presented earlier. At this stage, the project planner can decide what level of NPV is the absolute minimum for the project to continue. If the minimum acceptable NPV is $1 million and the probability of NPV falling below $1 million, is 40%, 20%, and 70% respectively for the different flood control projects, the one with the smallest probability might be preferred.

VII. Conclusions

Natural hazards can have considerable economic impacts on agricultural sectors in developing countries. The effects can be direct in terms of crop and livestock losses and indirect such as employment and spending declines. Natural hazards and other forms of risk can make the outcomes of development projects uncertain. Some of this uncertainty can be reduced by hazard mitigation measures. Traditional methods of project analysis produce single values of evaluative criteria, the most widely used being net present value, benefit-cost ratio, and internal rate of review. These values are inadequate for judging projects whose benefits and costs fluctuate widely. A variety of methods are available to analysts to incorporate natural hazard and other risk information into project analysis. Presenting probability distributions to decision makers, allows them to better able assess the effects of risk on project outcomes. When risk information is limited, cut-off periods, discount rate adjustments, and sensitivity analysis can be used to crudely assess risk. However, these approaches have several drawbacks. When better probability information is available, probability distributions of net present value as well as other feasibility criteria can be generated by computer simulations and other methods. These probability distributions can then be used to compare projects based on mean-variance and safety-first analysis.