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HYDRO POWER AND ENERGY PLANNING PROJECT (HPEP)

Cost–Benefit Analysis Model for the Enguri Watershed Area

August 12, 2014

OUTLINE

- Executive summary of main findings
- Introduction to the cost-benefit analysis
- Background of CBA Model for HPPs in the Enguri watershed area
- The process flow and steps
- Tentative results

EXECUTIVE SUMMARY OF MAIN FINDINGS

- Electricity Generation Project with limited environmental impacts does not exist.
- Externalities can be significant and are often not considered in feasibility studies nor IEAs
- All development projects should consider environmental and social concerns and they should be properly valued; impacts from the projects should be mitigated, rehabilitated and/or compensated; conservation measures planned and implemented
- EIA process improvement is recommended - CBA should be an input into the EIA process
- Establish sustainable environmental management practices (e.g. reflect environmental costs in electricity tariffs)
- Strategic Environmental Assessment is needed for the energy sector

EXECUTIVE SUMMARY OF MAIN FINDINGS (CONT'D)

- Data Gaps
- Reliability of Data
- Further improvement of CBA is recommended
- Further development of CBA requires significant data collection by Government of Georgia
- Establish a process of data collection and analysis, for the effective use of CBA tool
- Georgia-specific VoLL study/survey managed by GNERC

COST-BENEFIT ANALYSIS

Cost Benefit Analysis (CBA) is a technique for identifying, measuring and comparing the social benefits and costs of an investment project or program over a given time period.

IMPORTANCE OF CBA

- Whether or not project should be undertaken?
- Could the project be viable in the future?
- Which, among many competing alternatives and projects, should be funded?

THE PRINCIPLES OF CBA

- It is an economic technique for project/program appraisal
- Incorporates externalities (social/environmental costs) into the equation
- Time matters. Looks at discount rate

USES OF CBA

- It is used as a policy planning and decision-making tool
- CBA has traditionally been applied to large public sector projects, such as, new motorways, by-passes, dams, tunnels, bridges, flood relief schemes and new power stations.
- The basic principles of CBA can be applied to many other projects or programs. For example, public health programs (e.g. the mass immunization of children using new drugs), an investment in a new rail safety systems, or opening of a new railway line.

CBA IN GEORGIA

- Introduced in Georgia recently
- Very (few) limited number of CBA studies considering social and environmental costs done
- No CBA's done for any of the HPP Projects
- There is lack of expertise, and
- Need of extensive data
- No single model used to do CBA

REVIEW OF CBAS DONE IN GEORGIA

- 2000 (WB) – Revenue generation potential for the National Parks;
- 2000-2001 (WB) – CBA for the Establishment of Kolkheti National Park;
- 2003 (WB) – Forest ecosystems valuation;
- 2008 (USAID/Winrock) – CBA for Solar Water Heating Systems in Georgia;
- 2010 (UNDP) – Economic valuation of the Tusheti National Park and the Network of PAs in Georgia.
- 2011 (WB) – Valuation of the Contribution of Borjomi-Kharagauli and Mtirala National Parks Ecosystem Services to Economic Growth and Human Well-being.
- 2011-2014 (REC) – Development of Biodiversity Conservation and Practices in Mountain Regions of the South Caucasus
- 2011 (USAID) - Methodology for Evaluating the Economics, Financial Viability, and Environmental Consequences of Proposed Georgian Interconnection and Transmission Line Options

METHODOLOGIES USED

- Contingent Valuation Method (WB)
- Total Economic Valuation (TEV) Methodology
- Sector Scenario Analysis
- Polysun Simulation Software

Khudoni Working Group

- MOU Discussions
- The Need to do CBA for the Khudoni HPP

Netherlands Commission on EIA

- Advisory Review of the Environmental and Social Impact Assessment of the Khudoni Hydropower Project in 2013
- Recommendation: execute a social cost-benefit analysis for Khudoni HPP

USAID/HPEP

- CBA Model Development in the Enguri Watershed Area

PROCESS PARTICIPANTS

- Working Group of selected five NGOs:

CENN Caucasus Environmental NGO Network

Greens Movement of Georgia / Friends of the Earth International

Green Alternative

REC CAUCASUS

- TBSC Consulting
- Ministry of Energy & Ministry of Environment
- USAID/HPEP

MAIN OBJECTIVES OF THE CBA EXERCISE

- Develop a Cost-Benefit Analysis (CBA) Model of watershed-based hydropower development in the Enguri watershed area including assessment of the environmental and social costs
- Compare the total costs and benefits accrued from the social and environmental services provided by the watershed for a baseline scenario (existing/current use) compared to the scenario in which hydropower facilities are installed.

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HYDRO POWER AND ENERGY PLANNING PROJECT (HPEP)

Timeframe | Start: 08/01/2014 | January-February-March-April-May-June-July | Finish:25/07/2014

Phases

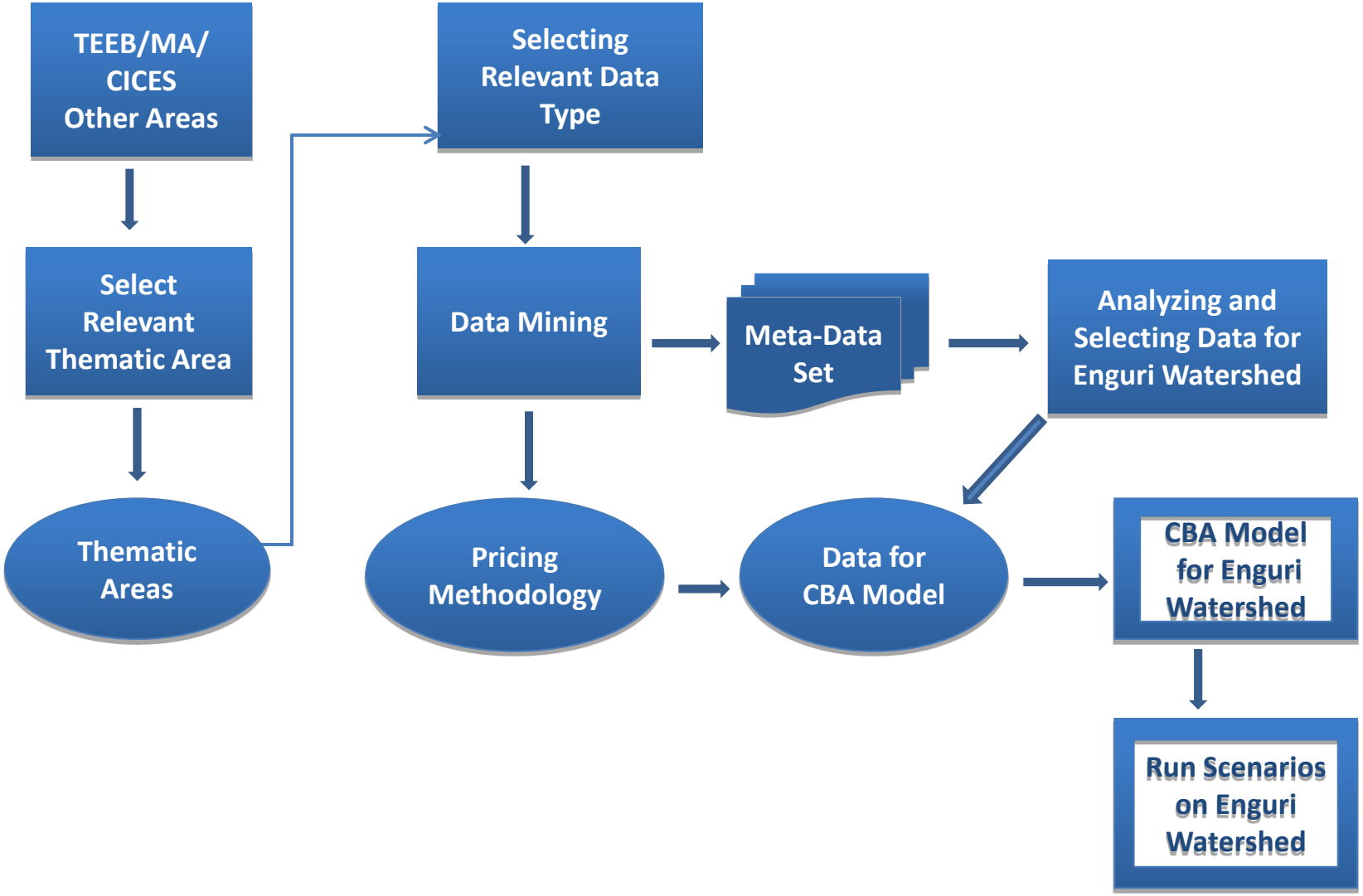
1. Design the Model
2. Demo Project
3. Data processing
4. Deliverables

Activities

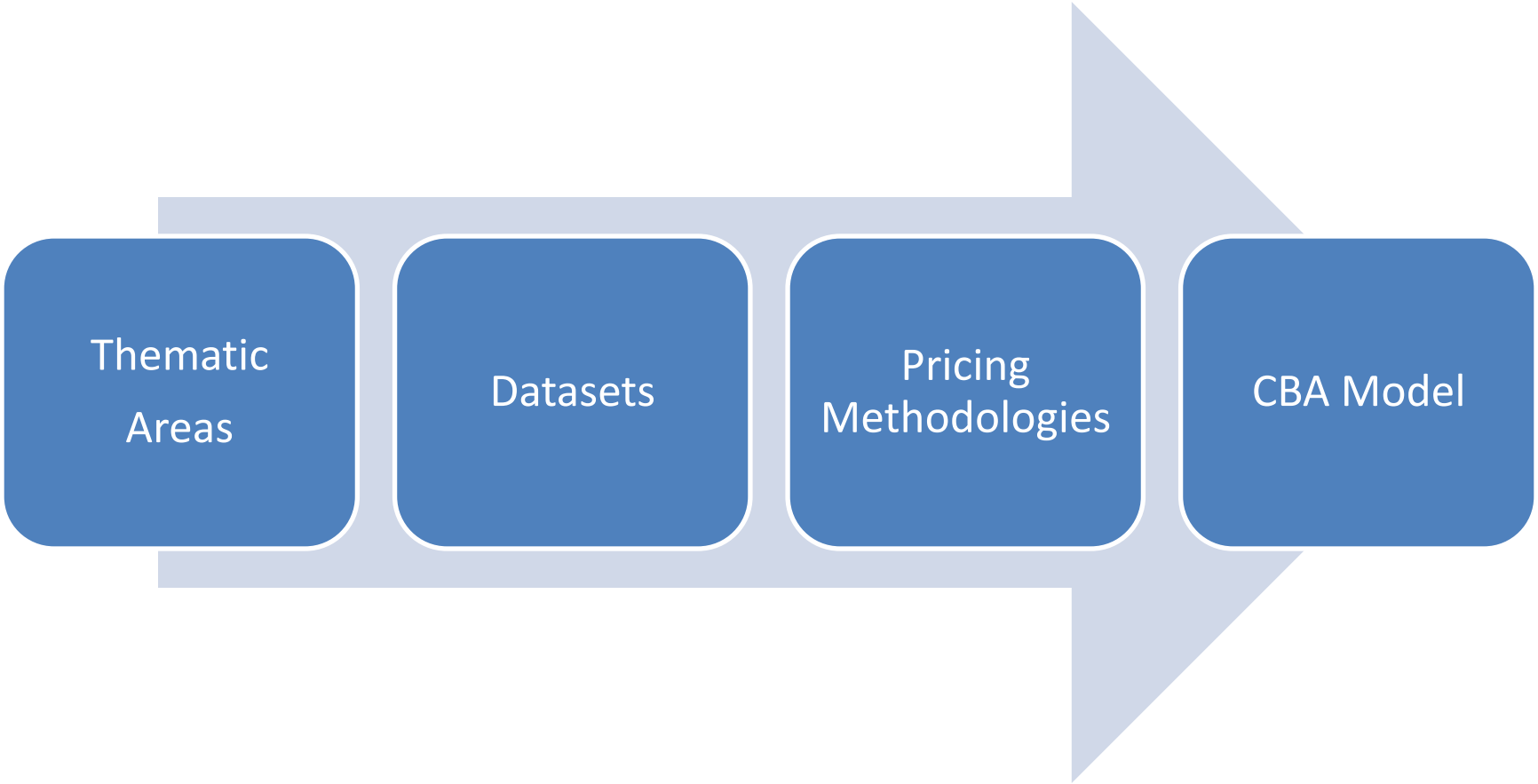
- Identify thematic Areas
- Elaborate methodology to screen TEEB/Other Areas
- Set Boundary Conditions
- Identify Datasets needed
- Review and Select Methodologies for CBA Analysis
- Develop Framework CBA Model
- Inventory of HPPs existing/planned in Enguri Watershed
- Analyze, prioritize and select HPP projects for further study
- Data gathering approaches
- Desk Studies/surveys /interviews
- Data Entry in Mini-Models
- Review and Analyze Database
- Compile Mini-models in a single Excel Model
- Framework CBA Model explaining the process flow
- Mini-models and Consolidated CBA in Excel
- Report on Policy and Ecosystem change analysis
- Summary report
- Presentation to relevant stakeholders

Preparatory Stages

- Establish a WG on CBA
- Define SoW for WG
- Develop List of Activities
- Allocate tasks between WG


TEEB/MA/ CICES Other Areas
Select Relevant Thematic Area
Thematic Areas
Selecting Relevant Data Type
Data Mining
Meta-Data Set
Analyzing and Selecting Data for Enguri Watershed
Pricing Methodology
Data for CBA Model
CBA Model for Enguri Watershed
Run Scenarios on Enguri Watershed

CORE OF CBA ANALYSIS



THEMATIC AREAS

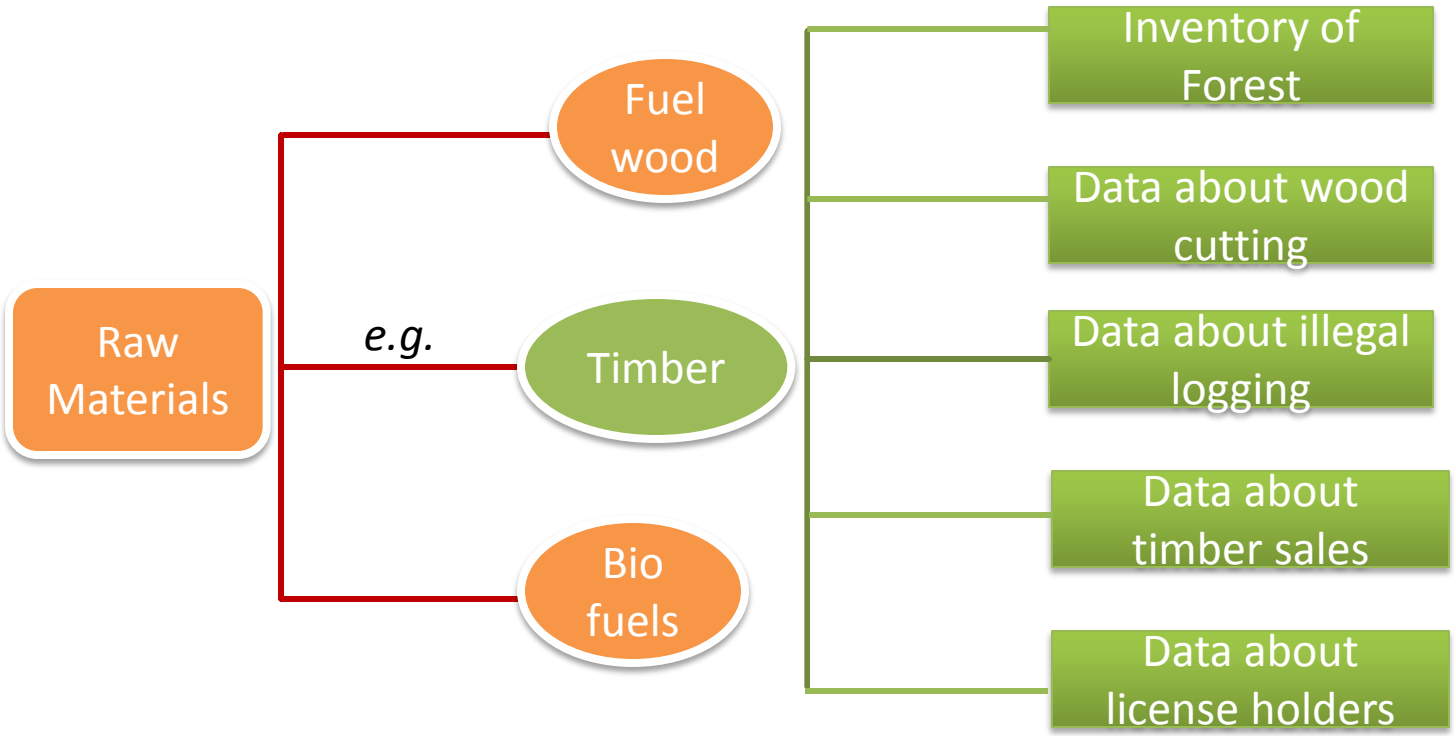
- TEEB (The Economics of ecosystems and biodiversity) Framework used to identify thematic areas.
- 25 Thematic Areas identified. 17 are from TEEB.
- ABC Analysis made for the selection of the relevant thematic areas.
- 13 Thematic Areas selected.
- 4 was monetized in the study.

DATA GAPS IDENTIFIED DURING CBA ANALYSIS

In the table areas highlighted in red were considered during CBA analysis

TEEB Ecosystem Services	Thematic Areas	Data
Provisioning Services	Food	Data on crops, livestock, grazing, fodder
	Raw materials	Timber, fuel wood, biofuels
	Fresh water	Data on groundwater, drinking water, mineral water, rivers
	Medicinal resources	Data on medicinal plants
Regulating Services	Climate	Data on climate, meteorological data
	Carbon sequestration and storage	GHG Emissions Inventory
	Waste-water treatment	Data on wetlands, soils, waste purifying organisms
	Erosion prevention and maintenance of soil fertility	Data on soil degradation, erosion
	Pollination	Data on pollinators (birds, bats, insects), wind patterns
	Biological control	Data on pests and diseases, data on natural controls (birds, frogs, fungi, bats, etc.)
	Moderation of extreme events	Data on avalanches, floods, rock falls, earthquakes, hails, sunder storms ,landslides
Supporting/Habitat Services	Habitats for species	Inventory of habitats and species depending on them
	Maintenance of genetic diversity	Inventory of genetic diversity
Cultural Services	Recreation and mental/physical health	Coverage of green spaces, inventory of places for recreation and sports
	Tourism	Tourism statistics
	Aesthetic appreciation/inspiration for culture, art and design	Data base of all potential natural monuments
	Spiritual experience and sense of place	Date base of all cultural monuments in the watershed, Inventory of Sacred places

EXAMPLE OF SET OF DATA NEEDED FOR ONE OF THE THEMATIC AREA



IMPACTS AND THEMATIC AREAS

LN	THEMATIC AREA	TEEB TERM	OTHER DESCRIPTION	BOUNDARY CONDITIONS	STATUS
1	Provisioning Services	Food		Watershed	TBD
2		Raw materials		Georgia	TBD
3		Fresh water	Quality of water; quantity of water	Georgia	TBD
4		Medicinal resources			TBD
5	Regulating Services	Local climate and air quality	Microclimates	Watershed	TBD
6		Carbon sequestration and storage	Global climate	The World	TBD
7		Moderation of extreme events	Disaster risk; water management and floods	Watershed	TBD
8		Waste-water treatment		Watershed	TBD
9		Erosion prevention and maintenance of soil fertility		Watershed	TBD
10		Pollination		Between watershed and local	TBD
11		Biological control		Between watershed and local	TBD
12	Habitat Or Supporting Services	Habitats for species	Rare species; wildlife habitats	Caucasus and Turkey	TBD
13		Maintenance of genetic diversity		Caucasus and Turkey	TBD
14	Cultural Services	Recreation and mental and physical health		Watershed	TBD
15		Tourism		The World	TBD
16		Aesthetic appreciation and inspiration for culture, art and	Cultural services	The World	TBD
17		Spiritual experience and sense of place		Georgia	TBD
18	Other Economic And Social Impacts	Economic development and employment		Region	Included
19		Loss of agricultural land and local settlement/resettlement		Watershed	Included
20		Existing infrastructure		Watershed	TBD
21		Sound/acoustic impacts		Very close	Excluded
22		Mineral resources		TBD	Included
23		Sunk costs		TBD	TBD
24		Sunk costs that require conservation		TBD	TBD
25		Quality of life		Watershed	Excluded

ABC ANALYSIS OF THE THEMATIC AREAS

LN	THEMATIC AREA	NGO					TBSC ADJUSTMENT	TOTAL SCORE	CATEGORY
		CENN	REC	EEC	GMG	GA			
1	Resettlement	A	A	B	A	A		14	A
2	Economic Development And Employment	A	C	A	A	C	1	12	A
3	Raw Materials	B	A	A	B	B		12	A
8	Moderation Of Extreme Events	C	A	B	A	A		12	A
4	Fresh Water	B	C	A	C	B	1	10	B
6	Spiritual Experience And Sense Of Place	B	A	B	C	A		11	B
7	Habitats For Species	A	B	B	A	C		11	B
9	Tourism	A	B	A	C	B		11	B
13	Mineral Resources	C	B	B	B	A		10	B
5	Local Climate And Air Quality	C	B	C	B	B		8	C
10	Maintenance Of Genetic Diversity	C	C	C	B	C		6	C
11	Erosion Prevention And Maintenance Of Soil Fertility	B	B	C	B	C		8	C
12	Carbon Sequestration And Storage	B	C	C	C	B		7	C

DATA MINING

- Identification of Data sources.
- List of the available data sets.
- Data mining was done for 27 datasheets.
- Summarize each data set in a meta-data sense.

META-DATA

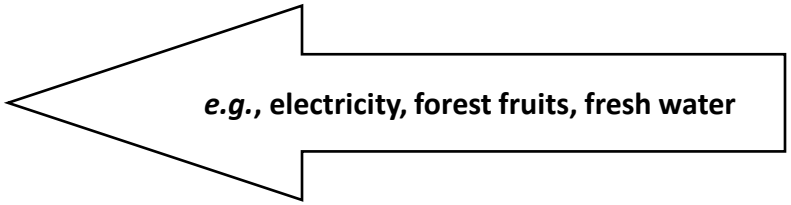
LN	THEMATIC AREA	DATA SET 1		DATA SET 2		DATA SET 3		DATA SET 4	
		Name	Who Do We Get It From	Name	Who Do We Get It From	Name	Who Do We Get It From	Name	Who Do We Get It From
1	**Resettlement**	Census data of local population (Khaishi community about 2000 people) - resettlement costs.	Land Owners Association	Annual report on hazard risks.	National Environmental Agency (NEA)	Atlas of Natural Hazards and Risks of Georgia	CENN	List of 27 potential hydro-power projects and their concepts.	HPEP; Deloitte
2	**Economic Development And Employment**	Projections of electricity output and benefit thereof.	HPEP	Khudoni EIA: number of employees and so on.	Transelectrica	Strategy of economic development; 2020	Government of Georgia	Strategy of Energy Sector Development (White Paper)	Ministry of Energy; HPEP
3	**Raw Materials**	Atlas of Natural Hazards and Risks of Georgia	CENN	Shape files of watershed	Public Registry	Forest Inventory	Ministry of Environment, National Forest Agency	Report on Central Caucasus Planned Protected Area	Agency of Protected Areas - APA (WB, Keti Skhireli)
8	**Moderation Of Extreme Events**	Atlas of Natural Hazards and Risks of Georgia	CENN	Annual report on hazard risks.	NEA				
4	**Fresh Water**	Water cadastre of Georgia	NEA, Hydro-Meteological Department	Amount of water in the reservoirs	Water Management Institute		Ministry of Education. Rustaveli Foundation	National Atlas of Georgia	Institute of Geography
6	**Spiritual Experience And Sense Of Place; Cultural Heritage**	Date base of all cultural monuments in the watershed.	Agency of Cultural Heritage	Sacred places	NALA - Local governments; Svaneti Tourism Center	Data base of all potential natural monuments	APA; Nakresi	Report on Central Caucasus Planned Protected Area	Agency of Protected Areas - APA (WB, Keti Skhireli)
7	**Habitats For Species**	Flora species present	Institute of Botanics	Fauna species present	Institute of Zoology		Biodiversity Conservation Service of Ministry of Environment	Research on biodiversity; high-value forests, eco-corridors	WWF
9	**Tourism**	Tourism research by Bank of Georgia	BOG website	Tourism Development in Georgia - Policy Brief; Giorgi Rajebashvili	Green Alternative	Svaneti tourism strategy; Georgia tourism strategy	GNTA website	The Georgian Way - New National Tourism Strategy; SW Associates	Available online: www.sw-associates.net
13	**Mineral Resources**	All information on the mineral resources across Georgia	NEA	Mineral resources data	GMG; Academy of Science	?	Caucasus Mineral Resources Institute (CIMS?)		Ilia State University; Earth Sciences Institute
5	**Local Climate And Air Quality**	Doctoral theses	Academy of Sciences; Kaldani, Abashidze		Khudoni EIA - sources on doctoral theses			Precipitation observations	NEA
10	**Maintenance Of Genetic Diversity**								
11	**Erosion Prevention And Maintenance Of Soil Fertility**	Cadastre; maps on soil, erosion	Ministry of Agriculture	Soil fertility maps	Agrarian University; Gizo Urushadze - Book on soils	Soil degradation	Institute of Geography	Atlas	CENN
12	**Carbon Sequestration And Storage**	GHG Emissions Inventory (Georgia)	Ministry of Environment	Report on Potential for Carbon Sequestration of Georgian forests	UNFCCC - Focal Point, Ministry of Environment		Lekso Gavasheli, Ilia State University		

TENTATIVE RESULTS

TBSC

PRICING METHODOLOGY

- Project impact equals change in Total Economic Value plus restoration of assets
- Total economic value is:
  - Sum of values …
  - Of all service flows …
  - That natural capital generates …
  - Now and in the future (appropriately discounted)
- Restoration of assets apply to
  - Assets held by households directly affected by projects
  - These assets are taken and need to be restored



WE NOTED SEVERAL TYPES OF ECONOMIC VALUES

VALUE TYPE	VALUE SUB-TYPE	MEANING
Use Values	Direct Use Value	Results from direct human use of biodiversity (consumption or non consumptive)
	Indirect Use Value	Derived from the regulation services provided by species and ecosystems
	Option Value	Relates to the importance that people give to the future availability of ecosystem services for personal benefit (option value in a strict sense)
Non-use Values	Bequest Value	Value attached by individuals to the fact that future generations will also have access to the benefits from species and ecosystems (intergenerational equity concerns)
	Altruist Value	Value attached by individuals to the fact that other people of the present generation have access to the benefits provided by species and ecosystems (intergenerational equity concerns)
	Existence Value	Value related to the satisfaction that individuals derive from the mere knowledge that species and ecosystems continue to exist

Timber (RECC)

Extreme Events (GA)

Very important but not considered by us

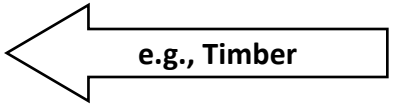
HOW DOES ONE VALUE AN ECOSYSTEM SERVICE (OR OTHER THINGS)?

Three general ways:

- Direct market valuation
- Revealed preferences
- Stated preferences

DIRECT MARKET VALUATION APPROACHES

- Market price based
  - Useful for provisioning services where outputs are sold (*e.g.*, forest fruits, fish)
- Cost based
  - Cost of re-creating the service in artificial manner
  - Three ways: avoided cost, replacement cost and mitigation or restoration cost
- Production function based
  - Value of other inputs to the production function due to the now more scarce (and more expensive) ecosystem service input (*e.g.*, greater use of steel-based construction materials if construction wood become less available)
- Some market values are distorted (e.g., subsidies) or unavailable

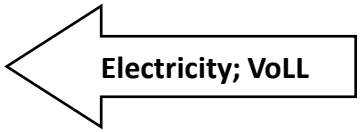


REVEALED PREFERENCES APPROACHES

- Individual choices (willingness to pay) reveal preferences
- Two methods
  - Travel cost; how much one pays to travel to the place to get the service (e.g., demand function for travel to a forest for recreation)
  - Hedonic pricing: value of an item that is affected by the ecosystem service (e.g., value premium for homes adjacent to a forest)
- As a rule, very hard to do
  - Policy choices distort prices
  - Need good data and complex statistical analyses

STATED PREFERENCES (SIMULATED VALUATION) APPROACHES

- Simulate a market and a value for ecosystem service
- Three methods
- Contingent valuation
  - Ask people how much they would pay
- Choice modeling
  - Model the decision process for individuals
- Group valuation
  - Add group considerations to the above (*e.g.*, social justice)



STUDY OUTLINE

- Review of meaning of value
- ***What we considered***
- The projects
- Tentative results

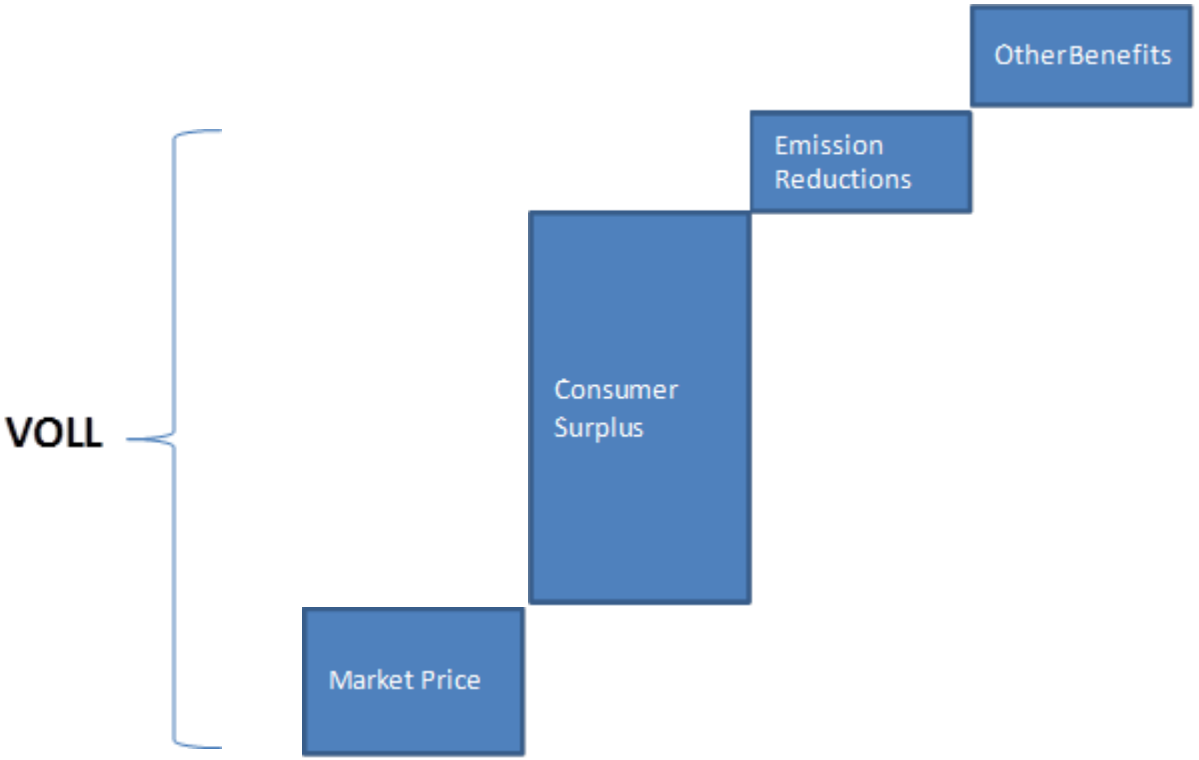
WE SIMPLIFIED THE PROBLEM

- Benefits
  - Only electricity, generally used outside the watershed
  - Valued at both tariff rate and the value of lost load (VoLL)
  - Not included in today's discussion
- Costs
  - Only within the watershed (*e.g.*, ignore global warming issues from loss of carbon sinks in watershed)
  - Prioritize thematic areas, and then within those choose only some costs
- Considered only some projects

WHAT IS VOLL?

- The value of lost load (VoLL) is a measurement of the economic value of electricity that is not delivered to consumers as a result of a planned or unplanned outage
- That is, the average willingness of consumers they are ready to pay to avoid an interruption
- VOLL is expressed in dollars per each megawatt hour ($/MWh) of electricity not delivered

WHAT IS VOLL? (CONT'D)



APPROACHES TO ESTIMATE

(1) **Revealed preferences method** (calculates expenses that customers incurred in purchasing back-up equipment)

(2) **Stated preferences method** (uses customer surveys and interviews to measure the VOLL. Respondents are asked to evaluate hypothetical outages in the future)

(3) **Macroeconomic analysis** (estimates VOLL as the ratio of Gross Domestic Product of a sector and the amount of electricity consumed by that sector. This gives the value this sector generates per kilowatt hour and is roughly equal to the value that would be lost in the case of an outage.

(4) **Case study analysis** (estimates costs from previous supply outages)

Stated preferences approach to estimate the VOLL works

VOLL FOR GEORGIA

❑ **Limitations** :

- Nonexistence of the concept & current value(s) of VOLL
- No surveys conducted before
- Non-existence of electricity data and GDP by sectors (thus, we cannot use production function approach)

❑ **Alternative:**

- Use other countries VOLL as a proxy for Georgia is the only viable option in these circumstances
- *Based on the literature review, the range we propose is applicable for developing countries – 1-5 $/kWh*
- *For CBA analysis 1 $/kWh is used*

EXAMPLE OF TARIFF CALCULATION

Feasibility Indicators, Key Results & Key Info

Mulkhura b

KEY TECHNICAL DATA	
Construction Period	4 Yr.
Plant Operational Life	20 Yr.
Installed Capacity	29.4 MW
Plant factor	49%
Annual Working Hours	4,269 h
Installed Cost - CAPEX per MWH ($ 000)	1,129
Electric & Mechanical Parts (Turn Key)	CH

Investment Terms & FEASIBILITY Indicators	Req Rate of Return	NPV $ 000	IRR	Invstment $000	% in Eequity
Equity Holder #1	15%	11,030	36.09%	8,819	100%
Equity Holder #2		-		-	
Total Project		19,614	18%	33,183	

Loan Terms & Indicators	
Loan Amount $ 000	24,364
Grace Period	
Loan Duration (Incl Grace)	20 Yrs
Loan Interest Rate	10%

WACC	10%
Min Debt Coverage Ratio is at Year 20	2.5

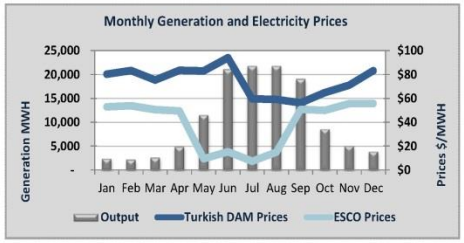
Pick Year for showing KEY Financial Ratios - Year	4 Y
GP Margin	98.42%
EBIT (Op pr margin)	73.31%
Net profit margin	39.57%
ROCE	14.50%
ROE	15.38%
Debt Coverage Ratio	2.8

BREAK EVEN INDICES	
Energy Output _sufficient to cover Fixed Costs & Debt Service	50,656 MWH
Plant Factor Sufficient to cover Annual Cash Outflow	20%
Output Safety Margin	40%
Nominal Payback Period (from Deployment)	5 Yrs

CAPEX Fundindg Facilities	Leverage
Loan	73%
Equity Holder #1	27%
Equity Holder #2	
Total Debt to Equity Ratio	73% : 27%

Key Operatinoal & CAPEX Indicators	Base Case Inputs	Escalation from Base Case	Current Inputs
Output	125,521 MWH		125,521 MWH
Sales price (weigh. ave) base year	$ 68.70		$ 68.70
GE Transmission tariff (base year)	$ 5.09		$ 5.09
TR Transmission tariff (base year)	$ -		$ -
Total CAPEX $ 000	33,183		33,183

CASH MANAGEMENT INDICES	Average	Op. Year 8
Annual Fixed Costs (Excl Depr & Fin Cost) $ 000	575	468
Annual Debt service (at full ds) $ 000	2,862	2,862
Cash Appl to Shareholder $ 000	4,722	4,249
Variable Cost/Per MWH	$ 0.85	$ 0.85
Contribution per CU (Price - Variable Cost)	$ 68	$ 68



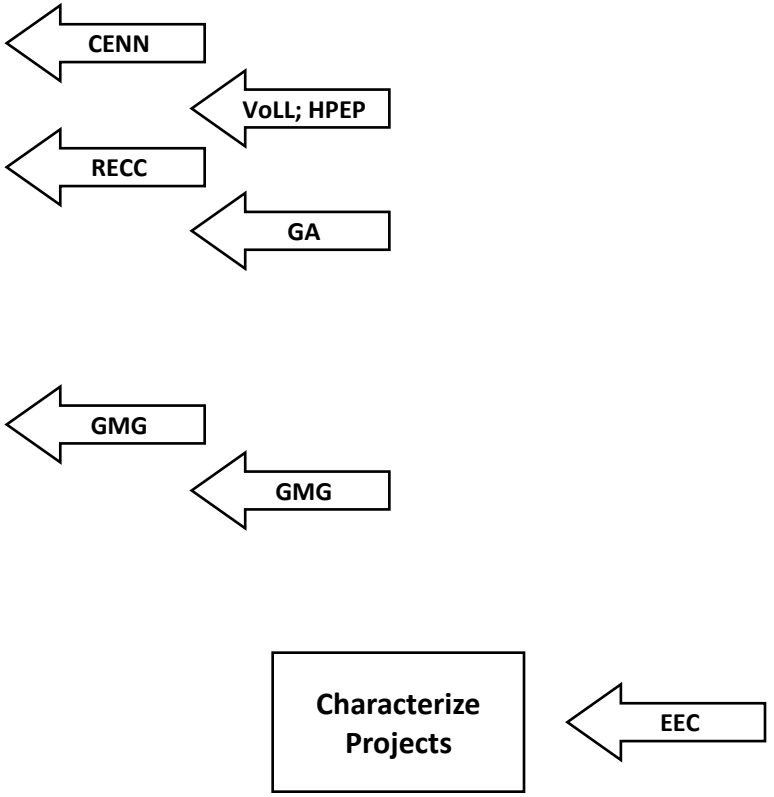
COST PER MWH _ Term Used Among ELECTRICITY INDUSTRY EXPERTS _ translate this term to financiers means _ MINIMUM ACCEPTABLE PRICE FOR INVESTOR

	Average	During Debt Service / if DS is Less Than Project Life	After Debt Service
Acceptable weighted average sales price for investor	$ 41.37		
ARR (Annual Required Revenue) $ 000	5,166		

Choose Option of Terminal Value Calculation and set Appropriate Rates		
Scrap Value _ % of Initail CAPEX	15%	(•) Scrap Value
Perpetuity of last Years FCF discounted at DF	20%	( ) Perpetuity Method

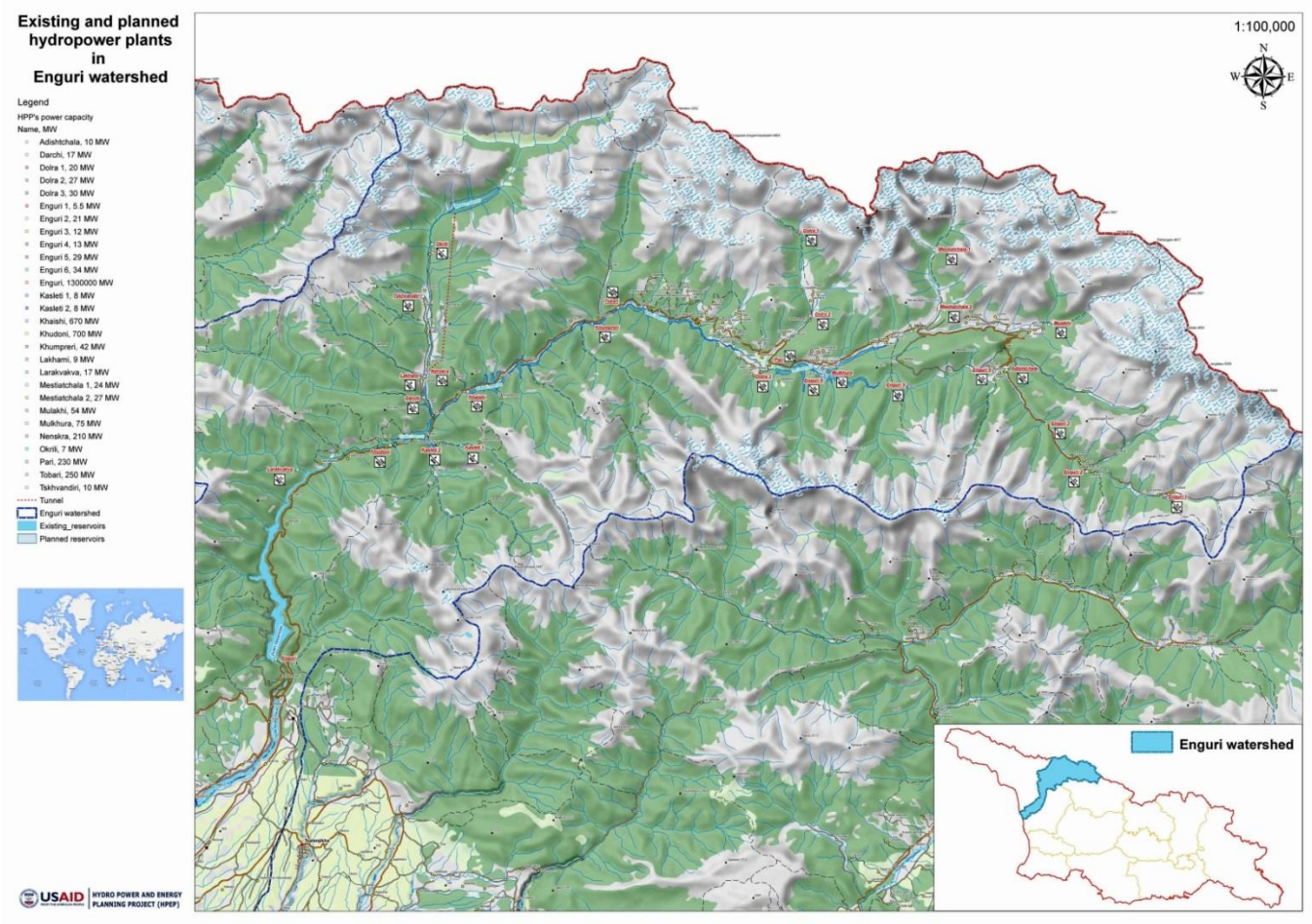
WE PRIORITIZED THE THEMATIC AREAS, AND THEN WITHIN THOSE CHOSE ONLY SOME COSTS:

LN	THEMATIC AREA	TOTAL SCORE	FINAL CATEGORY
1	Resettlement	14	A
2	Economic Development And Employment	12	A
3	Raw Materials	12	A
8	Moderation Of Extreme Events	12	A
4	Fresh Water	10	B
6	Spiritual Experience And Sense Of Place	11	B
7	Habitats For Species	11	B
9	Tourism	11	B
13	Mineral Resources	10	B
5	Local Climate And Air Quality	8	C
10	Maintenance Of Genetic Diversity	6	C
11	Erosion Prevention And Maintenance Of Soil Fertility	8	C
12	Carbon Sequestration And Storage	7	C



CONSIDERED ONLY THREE OF 27 PROJECTS IN THE ENGURI WATERSHED CONSIDERED A RANGE OF TYPES AND COMPLEXITIES

- Enguri6
- Mulkhura
- Pari



STUDY OUTLINE

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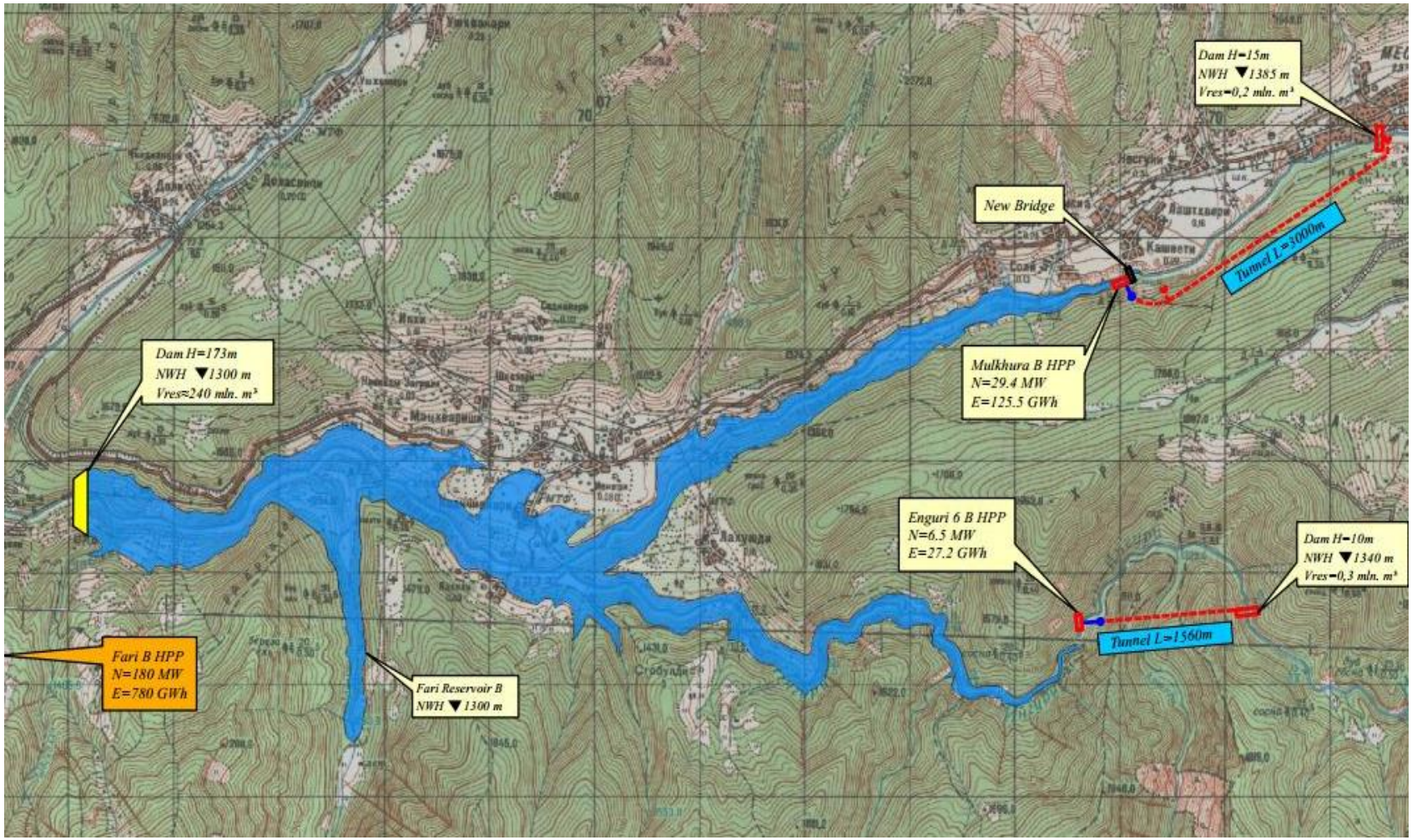
MAIN CHARACTERISTICS OF MULKHURA, ENGURI 6 AND PARI HYDRO POWER PROJECTS:

	Units	Pari HPP	Mulkhura HPP	Enguri 6 HPP
Upstream	masl	1,310	1,385	1,340
Downstream	masl	1,060	1,310	1,310
Head	M	250	75	30
Capacity	MW	180	29.4	6.5
Generation	GWH	780	125.5	27.2
Diversion length	M	n/a	3,000	1,700
Cost	MlnUSD	350	38.4	11.7
Unit Cost	USD/KW	1,944	1,305	1,800

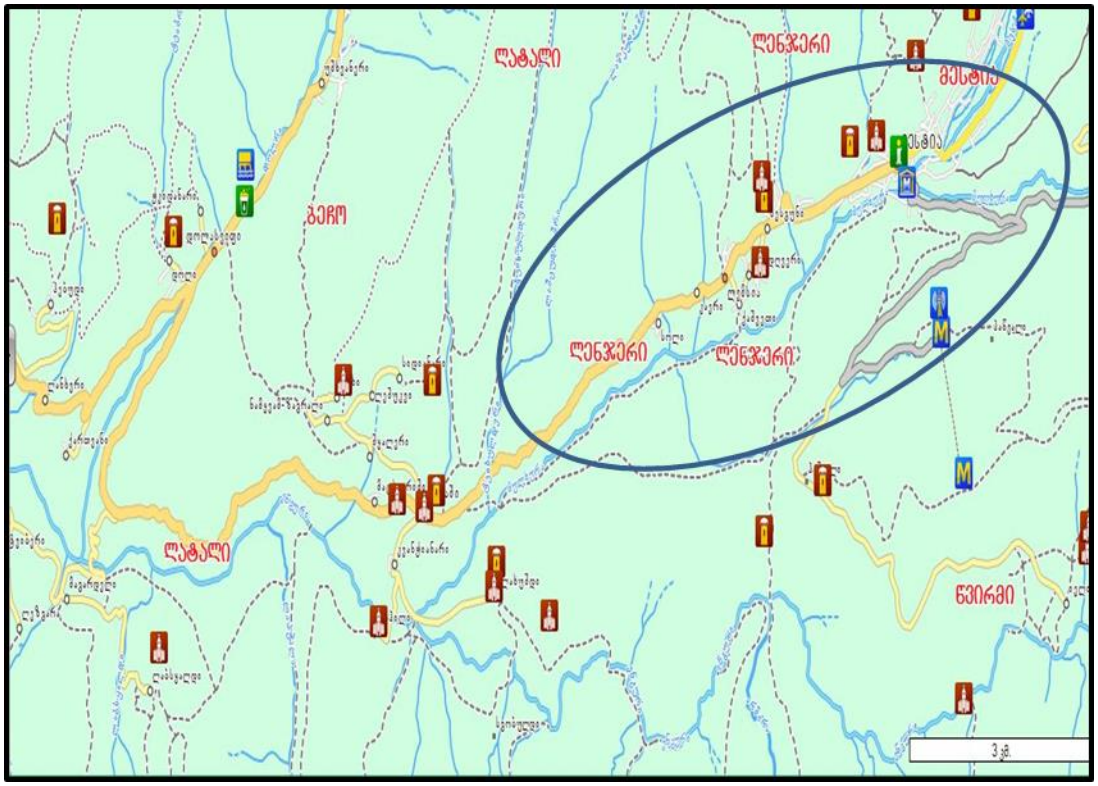
HPPs planned to be constructed on river Enguri in Mestia district northern Georgia's Samegrelo - Upper (Zemo) Svaneti Region



PARI

- Pari power plant has seasonally regulated reservoir of 240 mln m3
- Dam height – 173 m
- Discharge 103 m^3/sec
- Designed capacity 180 MW
- Generation 780 GWh

MULKHURA PROJECT AREA



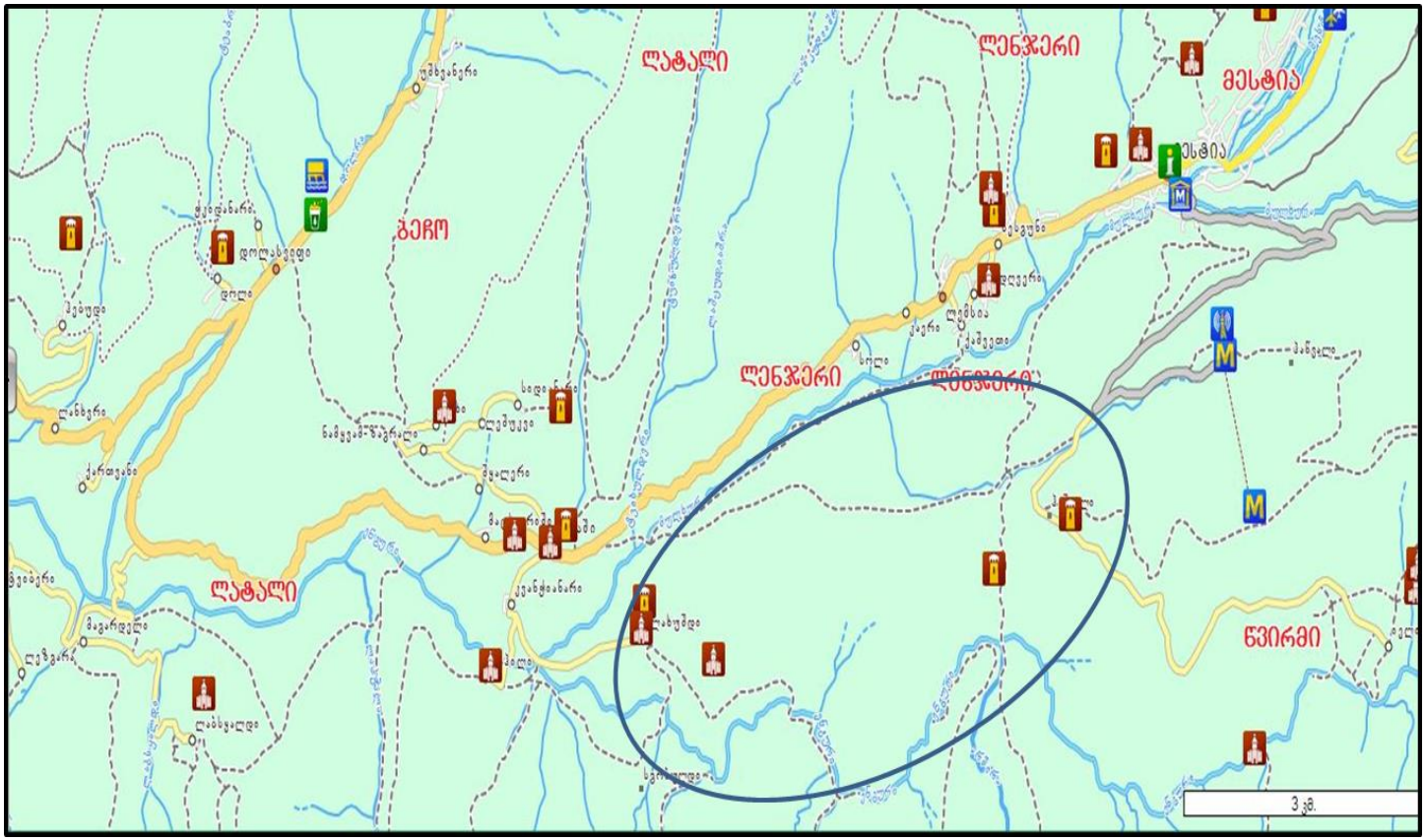
From central Mestia to Lakhusdi Village (within Latali community)

- Mulkhuri Power Plant project area extends from central Mestia to Lakhushdi Village.
- Lakhushdi village 11 km from Mestia has population -61 people
- Village is reach with cultural and historical monuments

MULKHURA

- Scheme – run-of-river HPP
- Head – 75 m
- Discharge – 50 m^3/sec
- Capacity – 29.4 MW
- Average annual generation- 125 GWh
- Project cost – 38.4 Mln USD
- Dam height – 15 m
- Tunnel length – 3,000 m
- 3 Turbines – 2 X 12.6MW+ 6.7MW Francis type

ENGURI 6



6-8 km southwest from Mestia.

ENGURI 6 (CONT'D)

- Scheme – run-of-river HPP
- Head – 30 m
- Discharge – 50 m^3/sec
- Capacity – 6.5 MW
- Average annual generation – 27.2 GWh
- Project cost – unknown
- Dam height – unknown
- Tunnel length – unknown
- Turbines – unknown

STUDY OUTLINE

- Review of meaning of value
- What we considered
- The projects
- *Tentative results*

THIS IS A FRAMEWORK; CONSIDER THE LIMITATIONS

- It shows costs for selected externalities; many if not most externalities are not considered
- It shows how one goes about estimating the cost of externalities
  - Items with large costs warrant more detailed work
- It is based on the data available
- It correctly estimates externality costs for the data provided
- There are some strange results
  - Hence our title – Tentative Externality Results
  - These should be cleaned up

Our philosophy:
If an estimate is not made,
then externality must have zero value

GENERAL METHOD

- Most externality costs are periodic and long-lived
  - Cost for a single year is estimated in a variety of ways
  - Turned into a 50-year annuity considering the time value of money (*i.e.*, 12 percent per year)
- Resettlement is a one-time cost
  - Amount is estimated without adjustments for time value of money
  - Resettlement includes 25,000 GEL per household that has income stream disrupted

EXTERNALITY COSTS WERE ESTIMATED IN FIVE AREAS

- Species: cost of mitigation of loss of plant species as proxy for value of species
- Extreme events: change in expected loss from extreme events
- Recreation: change in spending by visitors as proxy for change in value received plus change in value received by locals from visitors
- Change in income from timber, fuel wood and mushrooms at forest edge
- Estimates value of replacement land, structures, community assets and other private assets

SPECIES: COST OF MITIGATION OF LOSS OF PLANT SPECIES AS PROXY FOR VALUE OF SPECIES

- Three species selected for each project
- Portion of the species in Georgia that will be affected estimated
  - Percentage lost and adversely affected
- Cost of establishing same species in new but similar territory was estimated
  - Seed/seedling costs
  - Planting
  - Cultivation
- For example, 1.2 million for *Campanula trautvetteri* now spread over 1,800 ha in Enguri 6
- Results for three species taken as representative of 25 species for each project; value grossed up accordingly

SPECIES: LOSS OF HABITAT FOR MIGRATORY BIRDS AS NOT CONSIDERED

- Was not possible to value loss of habitat
- In any case, the loss is mostly outside the watershed so it is not an externality to include
- However, the loss of habitat is generally very important

EXTREME EVENTS: CHANGE IN EXPECTED LOSS FROM EXTREME EVENTS

- Create standard location with standard extreme events, standard frequency and standard losses from those events
- For settlements in Project areas estimate ex ante:
  - Relative size of settlement vis-à-vis the standard location
  - Relative frequency of the extreme event in those places vis-à-vis the standard location
  - Convert expected annual loss to a 50-year annuity
- Ex-post estimate change in frequency and severity of each event and convert expected annual loss to a 50-year annuity
- Compare ex post and ex ante annuity values; the numbers are large
  - For example, 13 million GEL for Pari

RECREATION: CHANGE IN SPENDING BY VISITORS AS PROXY FOR CHANGE IN VALUE RECEIVED

- Value of time and money spent as proxy for value received
- For each location:
  - Number of visitors by type, ex ante and ex post
  - Estimate travel time and time-in-location, and multiply by value of that time
  - Estimate travel costs
  - Add local spending by visitor
  - Add non-local spending by visitor
- Apply sum value as a 50-year annuity
- For example, loss of 25 million GEL for Enguri 6

RECREATION: CHANGE IN VALUE RECEIVED BY LOCALS FROM VISITORS

- For each location:
  - Number of visitors by type, ex ante and ex post
  - Estimate local spending by visitors and margin earned by locals
  - Estimate non-local spending by visitors, portion passed on to locals and margin earned by locals
- Apply sum value as a 50-year annuity
- For example, loss of 2,1 million GEL for Enguri 6
  - Reduced to 0,7 million GEL if double-counting of visitors is considered

RAW MATERIALS AND FOOD: CHANGE IN INCOME FROM TIMBER, FUEL WOOD AND MUSHROOMS AT FOREST EDGE

- Divide project territory into three areas:
  - Where production will fall to zero, where production will be adversely affected and other
- Estimate ex ante and ex post natural productivity in each area
- Estimate changes in access due to project
- Estimate forest-edge price and multiply by quantity and subtract collection costs to give ex ante and ex post value
- Apply annual sum as 50-year annuity
- For example, for timber, fuel wood and mushrooms in Pari-B the value is 142 million GEL

RESETTLEMENT: ESTIMATE VALUE OF REPLACEMENT LAND, STRUCTURES, COMMUNITY ASSETS AND OTHER PRIVATE ASSETS

- For each project:
  - Number of households and their local assets (*e.g.*, land of different types, homes, outbuildings, community fields)
  - Sum by type and apply an average value to give replacement cost
  - Add in costs for loss of income streams for affected households
- For example, 36 million GEL for Pari-B
  - 33 million GEL for asset losses and replacements
  - 3.3 million GEL for loss of income streams
- Enguri 6-B and Mulkhura appear to have no resettlement issues
- Note value based on replacement cost, not current value

IN TOTAL, ADD THE DIFFERENT ELEMENTS; FOR ENGURI 6:

TYPE OF EXTERNAL COST	CAPITALIZED VALUES (50 year annuity)			
	EX ANTE	EX POST	CHANGE	
Cost Of Mitigation Of Loss Of 25 Plant Species (sample of three plant species)	n.a.	n.a.	(11 589 300)	
Expected Loss From Extreme Events	(45 989 601)	(56 984 789)	(10 995 189)	
Value Received By Recreational Visitors	35 314 880	10 026 021	(25 288 859)	
Value Received By Locals From Recreational Visitors	2 939 792	830 118	(2 109 675)	
Value Of Timber	429 100 267	387 890 787	(41 209 481)	
Value Of Fuel Wood	470 799 666	425 585 503	(45 214 164)	
Value Of Mushrooms	7 566 423	8 074 106	507 683	
Cost Of Resettlement	0	0	0	
Partial Total For Externalities	**899 731 429**	**775 421 744**	**(135 898 984)**	
Present Value Of Construction Cost	n.a.	n.a.	(18 460 475)	**Benefit ÷ Cost**
Present Value Of Output Based On Tariff	n.a.	n.a.	27 777 279	0,180
Overall Present Value Based On Tariff	**899 731 429**	**775 421 744**	**(126 582 180)**	
Present Value Of Output Based On VoLL	n.a.	n.a.	394 871 124	2,558
Overall Present Value Based On VoLL	**899 731 429**	**775 421 744**	**240 511 665**	

Please recall:

- This shows costs for selected externalities; many if not most externalities are not considered
- This shows how one goes about estimating the cost of externalities
- This is based on the data available
- This correctly estimates externality costs for the data provided

ENGURI 6:

TYPE OF EXTERNAL COST	CAPITALIZED VALUES (50 year annuity)			COMMENT
	EX ANTE	EX POST	CHANGE	
Cost Of Mitigation Of Loss Of 25 Plant Species (sample of three plant species)	n.a.	n.a.	(11 589 300)	Cost probably paid by Government if it commissions replanting.
Expected Loss From Extreme Events	(45 989 601)	(56 984 789)	(10 995 189)	Cost covered by local citizens and Government, depending on adequacy of Government reparations.
Value Received By Recreational Visitors	35 314 880	10 026 021	(25 288 859)	Cost mostly borne by foreign tourists.
Value Received By Locals From Recreational Visitors	2 939 792	830 118	(2 109 675)	Cost entirely borne by local businesses.
Value Of Timber	429 100 267	387 890 787	(41 209 481)	Cost entirely borne by local businesses.
Value Of Fuel Wood	470 799 666	425 585 503	(45 214 164)	Cost entirely borne by local businesses.
Value Of Mushrooms	7 566 423	8 074 106	507 683	Cost entirely borne by local businesses.
Cost Of Resettlement	0	0	0	Cost probably borne by providers of capital.
Partial Total For Externalities	**899 731 429**	**775 421 744**	**(135 898 984)**	
Present Value Of Construction Cost	n.a.	n.a.	(18 460 475)	Cost borne by owner.
Present Value Of Output Based On Tariff	n.a.	n.a.	27 777 279	Entire benefit received by providers of capital
Overall Present Value Based On Tariff	**899 731 429**	**775 421 744**	**(126 582 180)**	
Present Value Of Output Based On VoLL	n.a.	n.a.	394 871 124	Most of benefit received by population (difference between this and present value of output based on tariff).
Overall Present Value Based On VoLL	**899 731 429**	**775 421 744**	**240 511 665**	

IN TOTAL, ADD THE DIFFERENT ELEMENTS; FOR PARI:

TYPE OF EXTERNAL COST	CAPITALIZED VALUES (50 year annuity) EX ANTE	EX POST	CHANGE	
Cost Of Mitigation Of Loss Of 25 Plant Species (sample of three plant species)	n.a.	n.a.	(24 731 667)	
Expected Loss From Extreme Events	(122 660 852)	(191 629 969)	(68 969 117)	
Value Received By Recreational Visitors	35 314 880	10 026 021	(25 288 859)	
Value Received By Locals From Recreational Visitors	2 939 792	830 118	(2 109 675)	
Value Of Timber	432 378 572	364 548 662	(67 829 910)	
Value Of Fuel Wood	474 396 552	399 975 021	(74 421 531)	
Value Of Mushrooms	8 439 836	8 647 342	207 506	
Cost Of Resettlement - Assets	n.a.	n.a.	(35 784 770)	
Partial Total For Externalities	**830 808 781**	**592 397 195**	**(298 928 022)**	
Present Value Of Construction Cost	n.a.	n.a.	(416 117 267)	**Benefit ÷ Cost**
Present Value Of Output Based On Tariff	n.a.	n.a.	759 952 671	1,063
Overall Present Value Based On Tariff	**830 808 781**	**592 397 195**	**44 907 381**	
Present Value Of Output Based On VoLL	n.a.	n.a.	11 316 154 471	15,826
Overall Present Value Based On VoLL	**830 808 781**	**592 397 195**	**10 601 109 181**	

Please recall:

- This shows costs for selected externalities; many if not most externalities are not considered
- This shows how one goes about estimating the cost of externalities
- This is based on the data available
- This correctly estimates externality costs for the data provided

IN TOTAL, ADD THE DIFFERENT ELEMENTS; FOR MULKHURA:

TYPE OF EXTERNAL COST	CAPITALIZED VALUES (50 year annuity)			
	EX ANTE	EX POST	CHANGE	
Cost Of Mitigation Of Loss Of 25 Plant Species (sample of three plant species)	n.a.	n.a.	(21 131 025)	
Expected Loss From Extreme Events	(80 401 305)	(113 755 210)	(33 353 905)	
Value Received By Recreational Visitors	35 314 880	10 026 021	(25 288 859)	
Value Received By Locals From Recreational Visitors	2 939 792	830 118	(2 109 675)	
Value Of Timber	429 100 267	387 890 787	(41 209 481)	
Value Of Fuel Wood	470 799 666	425 585 503	(45 214 164)	
Value Of Mushrooms	7 566 423	8 074 106	507 683	
Cost Of Resettlement	n.a.	n.a.	0	
Partial Total For Externalities	**865 319 724**	**718 651 324**	**(167 799 425)**	
Present Value Of Construction Cost	n.a.	n.a.	(53 801 020)	**Benefit ÷ Cost**
Present Value Of Output Based On Tariff	n.a.	n.a.	123 316 073	0,556
Overall Present Value Based On Tariff	**865 319 724**	**718 651 324**	**(98 284 373)**	
Present Value Of Output Based On VoLL	n.a.	n.a.	1 822 175 531	8,223
Overall Present Value Based On VoLL	**865 319 724**	**718 651 324**	**1 600 575 086**	

Please recall:

- This shows costs for selected externalities; many if not most externalities are not considered
- This shows how one goes about estimating the cost of externalities
- This is based on the data available
- This correctly estimates externality costs for the data provided

RESULT FOR ALL THREE PROJECTS TOGETHER

TYPE OF EXTERNAL COST	CAPITALIZED VALUES (50 year annuity)			
	EX ANTE	EX POST	CHANGE	
Cost Of Mitigation Of Loss Of 75 Plant Species (sample of nine plant species)	n.a.	n.a.	(57 451 992)	
Expected Loss From Extreme Events	(249 051 757)	(362 369 968)	(113 318 211)	
Value Received By Recreational Visitors	35 314 880	10 026 021	(25 288 859)	
Value Received By Locals From Recreational Visitors	2 939 792	830 118	(2 109 675)	
Value Of Timber	1 290 579 107	1 140 330 235	(150 248 871)	
Value Of Fuel Wood	1 415 995 885	1 251 146 026	(164 849 859)	
Value Of Mushrooms	23 572 682	24 795 555	1 222 872	
Cost Of Resettlement	n.a.	n.a.	(35 784 770)	
Partial Total For Externalities	**2 519 350 589**	**2 064 757 986**	**(547 829 365)**	
Present Value Of Construction Cost	n.a.	n.a.	(488 378 763)	**Benefit ÷ Cost**
Present Value Of Output Based On Tariff	n.a.	n.a.	911 046 022	0,879
Overall Present Value Based On Tariff	**2 519 350 589**	**2 064 757 986**	**(125 162 105)**	
Present Value Of Output Based On VoLL	n.a.	n.a.	13 533 201 126	13,060
Overall Present Value Based On VoLL	**2 519 350 589**	**2 064 757 986**	**12 496 992 999**	

EXAMPLE OF THE COST OF MITIGATION OF LOSS OF THREE PLANT SPECIES: PARI

LN	SPECIES	PREVALENCE IN GEORGIA		LOCATION					
				PORTION OF PREVALENCE AFFECTED BY PROJECT (d)					
		NUMBER	UNIT (a)	HABITAT LOST (%)	HABITAT MODERATELY AFFECTED (%)	HABITAT UNAFFECTED (%)	REST OF ENGURI WATERSHED (%)	REST OF GEORGIA (%)	TOTAL (100%)
1	Poligala amoenissima	2 200	ha	10%	80%	0%	5%	5%	**100%**
2	Gentiana schistocalyx	2 000	n/a	80%	10%	0%	5%	5%	**100%**
3	Sorbus caucasigena	400	ha	40%	20%	0%	30%	10%	**100%**

LN	SPECIES	AREA TO BE RECREATED (ha)	COST OF RECREATING (GEL)	COMMENT
1	Polygala amoenissima	1,100	1,140,100	Seed collection: 2200 * 13 = 28600 GEL Conservation: 2200 * 3 = 6600 (6 months) Land cultivation: 1000 GEL per ha Transportation: 500 GEL Sowing: 2200 * 5 = 11000 GEL Total: 47 700
2	Gentian schist calyx	1,700	1,761,700	Seed collection: 2000 * 13 = 26 000 Conservation: 2000 * 3 = 6000 (6 months) Land cultivation: 1000 per ha Transportation: 500 Sowing: 2000 * 5 = 10 000 Total: 43 500
3	Sorbus Caucasigena	200	66,000	Seedling breeding: 70 * 400 = 28 000; (3-5 years) Land cultivation: 400 * 15 = 6000 Transportation: 3000 Planting: 400 * 20 = 8000
		Total	**2,967,800**	

EXAMPLE OF THE INCREASE (OR DECREASE) IN EXPECTED LOSS FROM EXTREME EVENTS

LN	LOCATION (Community)	TYPE OF EVENT	SIZE OF LOCATION AS PERCENTAGE OF STANDARD LOCATION (a)	EX ANTE			
				FREQUENCY (b)	TYPICAL LOSS FROM ONE EVENT (GEL)	ANNUALIZED EXPECTED LOSS (GEL)	50 YEAR ANNUITY OF ANNUALIZED EXPECTED LOSS (GEL)
1	Mulakhi	Annual Flood	10%	100%	17 083	17 083	141 864
2	Mulakhi	Ten-Year Flood	10%	10%	111 781	11 178	92 829
3	Mulakhi	Moderate Landslide	60%	100%	670 687	670 687	5 569 716
4	Mulakhi	Large Landslide	40%	100%	1 335 278	1 335 278	11 088 811
5	Mulakhi	Snow Avalanche	25%	30%	2 032 222	609 667	5 062 976
Total		n.a.	n.a.	n.a.	n.a.	2,643,892	21,956,196

LN	LOCATION (Community)	EX POST				INCREASE IN ANNUALIZED EXPECTED LOSS (GEL)	50 YEAR ANNUITY OF INCREASED ANNUALIZED EXPECTED LOSS (GEL)
		FREQUENCY (b)	SEVERITY (c)	ANNUALIZED EXPECTED LOSS (GEL)	50 YEAR ANNUITY OF ANNUALIZED EXPECTED LOSS (GEL)		
1	Mulakhi	105%	110%	19 731	163 853	**2 648**	**21 989**
2	Mulakhi	15%	110%	18 444	153 167	**7 266**	**60 339**
3	Mulakhi	115%	110%	848 419	7 045 691	**177 732**	**1 475 975**
4	Mulakhi	105%	125%	1 752 552	14 554 065	**417 274**	**3 465 254**
5	Mulakhi	40%	150%	1 219 333	10 125 951	**609 667**	**5 062 976**
Total		n.a.	n.a.	3,858,478	32,042,727	1,214,586	10,086,531

EXAMPLE OF VALUE RECEIVED BY RECREATIONAL VISITORS AND LOCALS: ENGURI 6

LN	TYPE OF PERSON	NUMBER OF VISITORS (#/yr.)		INDIVIDUAL VALUE OF TIME SPENT RECREATING			INDIVIDUAL COST OF TRAVEL	
		EX ANTE	EX POST	ROUNDTRIP TRAVEL TIME (a) (hr.)	TIME SPENT RECREATING (b) (hr.)	INDIVIDUAL VALUE (GEL)	ROUNDTRIP TRAVEL DISTANCE (c) (km)	INDIVIDUAL VALUE (GEL)
1	Tbilisi Tourist; two days on site	500	200	16.00	16.00	80	250	125
2	Foreign tourist; two days on site	1,000	250	24.00	16.00	1,500	n.a.	1,200
3	Local tourist; two weeks on site	500	300	12.00	112.00	310	500	250
4	Winter tourist; two days on site	500	120	14.00	16.00	75	250	125
5	**Total**	**2,500**	**870**	**n.a.**	**n.a.**	**0**	**n.a.**	**0**

LN	TYPE OF PERSON	SPENDING RECEIVED BY LOCALS (h) (GEL)	EX ANTE		EX POST	
			VALUE RECEIVED BY VISITORS (GEL)	VALUE RECEIVED BY LOCALS (GEL)	VALUE RECEIVED BY VISITORS (GEL)	VALUE RECEIVED BY LOCALS (GEL)
1	Tbilisi Tourist; two days on site; four people travel together	120	277 500	60 000	111 000	24 000
2	Foreign tourist; two days on site; two people travel together	180	3 250 000	180 000	812 500	45 000
3	Local tourist; two weeks on site; two people travel together	20	305 000	10 000	183 000	6 000
4	Winter tourist; two days on site; four people travel together	208	420 000	104 000	100 800	24 960
5	**Total**	**n.a.**	**4 252 500**	**354 000**	**1 207 300**	**99 960**
	Total	**n.a.**	**4 606 500**	**n.a.**	**1 307 260**	
	Difference	**n.a.**	**n.a.**	**n.a.**	**(3 299 240)**	

EXAMPLE OF FUEL WOOD: ENGURI 6

LN		AREA (ha)	RENEWABLE RATE (m^3/ha)	SALES PRICE OF PRODUCT AT FOREST EDGE (GEL/m^3)	COLLECTION COST (GEL/m^3)	UNIT PRODUCT VALUE AT FOREST EDGE (GEL/m^3)	EX ANTE PRODUCT VALUE AT FOREST EDGE (GEL)
1	Area A (Immediate Area Affected)	0	200	300,00	50,00	250,00	0
2	Area B	954	150	300,00	50,00	250,00	35 791 875
3	Area C	557	150	300,00	50,00	250,00	20 900 250
4	**Total**	**1 512**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**56 692 125**
5	**Value Of 50 Year Annuity**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	470 799 666

LN	CHANGE IN ACCESS (%)	CHANGE IN RENEWABLE RATE (%)	EX POST PRODUCT VALUE AT FOREST EDGE (GEL)	CHANGE IN PRODUCT VALUE (GEL)
1	(100%)	0%	0	0
2	(20%)	10%	31 496 850	(4 295 025)
3	(10%)	5%	19 750 736	(1 149 514)
4	**n.a.**	**n.a.**	**51 247 586**	**(5 444 539)**
5	**n.a.**	**n.a.**	425 585 503	(45 214 164)

COST OF RESETTLEMENT ASSETS AND PRIVATE LAND: PARI

USE TYPE	CURRENT USE VALUE (GEL)	HIGHEST AND BEST USE VALUE (GEL)
Current Private Land	1 338 480	1 406 880
Current Structures	5 493 600	5 493 600
Current Community Property	2 498 340	2 498 340
Current Other Private Assets	2 679 000	2 679 000
Total	**12 009 420**	**12 077 820**

Latali Community

USE TYPE	UNIT	CURRENT USE AREA (ha)		HIGHEST AND BEST USE AREA (ha)	
		ALL SETTLEMENTS	SETTLEMENTS TO BE RESETTLED	ALL SETTLEMENTS	SETTLEMENTS TO BE RESETTLED
Seasonal Crops; Not Irrigated	ha	101	61	101	61
Seasonal Crops; Irrigated	ha	0	0	0	0
Grazing Grasslands	ha	2 880	960	3 019	1 032
Old Fruit Tree Orchard	ha	23	12	0	0
New Fruit Tree Orchard	ha	0	0	23	12
Grasslands	ha	139	72	0	0
Total	**n.a.**	**3 143**	**1 105**	**3 143**	**1 105**

USE TYPE	UNIT VALUE (GEL/unit)	CURRENT USE VALUE (GEL)		HIGHEST AND BEST USE VALUE (GEL)	
		ALL SETTLEMENTS	SETTLEMENTS TO BE RESETTLED	ALL SETTLEMENTS	SETTLEMENTS TO BE RESETTLED
Seasonal Crops; Not Irrigated	4 000	405 000	242 000	405 000	242 000
Seasonal Crops; Irrigated	6 000	0	0	0	0
Grazing Grasslands	1 500	4 320 000	1 440 000	4 528 350	1 548 000
Old Fruit Tree Orchard	3 000	69 750	36 300	0	0
New Fruit Tree Orchard	4 500	0	0	104 625	54 450
Grasslands	1 500	208 350	108 000	0	0
Total	**n.a.**	**5 003 100**	**1 826 300**	**5 037 975**	**1 844 450**

Lenjeri Community

Thank you for attention!

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