CEP

MEASUREMENT OF THE COSTS OF LAND DEGRADATION IN THE MOUNTAINS OF THE REPUBLIC OF TAJIKISTAN

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ICARDA

I. LAND DEGRADATION: A GLOBAL CHALLENGE OF HIGH IMPORTANCE

- **Land** – source of essential building blocks for life:
  - Food, feed, and fiber, and many types of biomass;
  - Biodiversity and essential ecosystem services (carbon sequestration, regulation of the climate, water purification)
  - Cultural, esthetic and economic values
- **Land degradation** - the temporary or permanent decline in the productive capacity of land, and the diminution of its productive potential and its value as an economic resource. (M.A. Stocking, 2001).

- Land degradation is defined as the temporary or permanent decline in the productive capacity of the land, and the diminution of the productive potential, including its major land uses (e.g., rain-fed arable, irrigation, forests), its farming systems (e.g., smallholder subsistence), and its value as an economic resource. International Encyclopedia of the Social & Behavioral Sciences, 2001
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- O'Riordan T (2000) Environmental Science for Environmental Management OUP

...A GLOBAL CHALLENGE OF HIGH IMPORTANCE CONT'D

- Land degradation, climate change and biodiversity degradation - three faces of the same problem (IPBES, 2019).
  - If we reduce land degradation and let the land to regenerate, the other two will reduce substantially;
- Land degradation, poses significant challenges:
  - Food insecurity
  - Higher food prices
  - Climate change
  - Environmental hazards (flood, dust, drought, etc.)
  - General wellbeing of the world population (health, nutrition, esthetic assets, etc.)

…A GLOBAL CHALLENGE OF HIGH IMPORTANCE CONT'D

- **Land degradation is an old problem:**
  - Jacks and Whyte 1939: The rape of the earth;
  - Often-emotional revivals since the Dust Bowl era in the mid-West USA
    - Osborne, Fairfield. 1948. Our Plundered Planet.
    - Carson, Rachel. 1962: The Silent Spring.
    - Commoner, Barry. 1972. The Environmental Cost of Economic Growth.
    - Blaikie, Piers and Brookweld, Harold. (Eds.). 1987. Land Degradation and Society.
    - O'Riordan, Timothy. 2000. Environnemental Science for Environnemental Management

…A GLOBAL CHALLENGE OF HIGH IMPORTANCE CONT'D

- **Land degradation is also a current problem**
  - 75% of total land area has been degraded - affecting 3.2 billion people (IPBES, 2019)
  - O'Riordan (2000): Land degradation - 'the single most pressing current global problem' (O'Riordan, 2000);
  - Land degradation and desertification are some of the world's greatest environmental challenges in the light of a rapidly growing world population and increasing demand for food, fiber, and biomass energy (Tilahun et al., 2018).
  - Current estimates: 3 to 5 % loss in the GDP in affected countries
- How about the future?

- Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES, 2019)
- O'Riordan T (2000) Environmental Science for Environmental Management OUP
- Tilahun, M., Singh, A., Kumar, P., Apindi, E., Schauer, M., Libera, J., Lund H.G. (2018). The Economics of Land Degradation Neutrality in Asia: Empirical Analyses and Policy Implications for the Sustainable Development Goals. Available from **www.eld-initiative.org**

...A GLOBAL CHALLENGE OF HIGH IMPORTANCE CONT'D

- **Unabated, 95% of Earth's land areas could become degraded by 2050 (IPBES, 2019) endangering many more billions of people, animals and plants.**
- **The Good News:** There are many proven approaches to reversing these trends including:
  - Urban planning, **replanting with native species**, **appropriate management of agricultural lands**, green infrastructure development, remediation of contaminated and sealed soils (e.g. under asphalt), wastewater treatment, and river channel restoration.
  - **Land needs to be managed at a landscape scale**, where the needs of agriculture, industry, and urban areas can be balanced in a holistic way (Robert Scholes).
- In Asia, the cost of inaction in the face of land degradation is at least three times higher than the cost of action. And the benefits of restoration are 10 times higher than the costs (IPBES, 2019) .

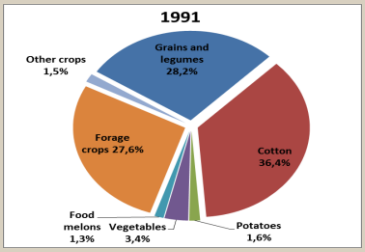
- Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES, 2019)

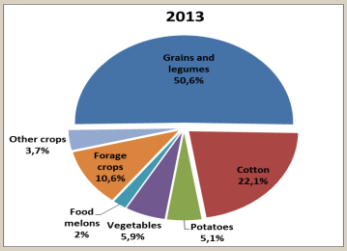
II. LAND DEGRADATION IN TAJIKISTAN

- Total area of 14.12 mill ha (2016 – Knoema world data atlas)
  - 4.82 mill ha - agricultural land (up from 33.1%in 2005 to 34.1% in 2016)
  - 0.42 mill ha - forest (up from 2.9%in 1997 to 3.0% in 2016)
  - 0.26 mill ha - inland water
  - 8.62 million ha of other land
- The positive trend in forest area – reduced land degradation associated with new deforestation
- Positive trend in the agricultural land - much needs to be done in preventing agriculture in marginal lands.

…LAND DEGRADATION IN TAJIKISTAN

- Major contributors to land degradation (UNDP-UNEP, 2011):
  - Agricultural production on steep slopes and marginal land,
  - Poor water management/irrigation practices (water-logging & salinization),
  - Overgrazing and
  - Deforestation





Source: Agency for statistics, Republic of Tajikistan (2014)

…LAND DEGRADATION IN TAJIKISTAN

- 11.6 million ha (82% of total area) suffers some level of erosion;
  - Erosion higher in farm lands - 88.7% (4.2 mil ha) suffers medium and high level of erosion (UNDP-UNEP, 2011).
- 97% in wheat farms (2016 – ICARDA-TAS survey)

soil depth	Freq.	Percent	Cum.
shallow	158	22.90	22.90
medium	510	73.91	96.81
deep	22	3.19	100.00
Total	690	100.00	

- 97% of farmlands affected by poor irrigation services and salinization (UNDP-UNEP, 2011).

III. VALUATION/COSTING METHODS

3.1 This study attempts to estimate costs of land degradation in:

- Forests
- Pastures
- Farm lands including abandoned lands;
- Infrastructure and services
- Human and animal health

… VALUATION METHODS CONT'D

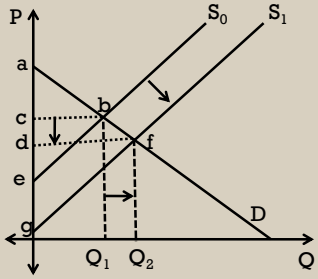
3.2 Why valuation NR and Environmental goods

- An attempt to put monetary values for benefits enjoyed/lost;
  - People with different background can understand;
- To show the importance of the issue at hand;
- Makes comparison between the investment cost of prevention/mitigation and the benefits to be expected easy;

… VALUATION METHODS CONT'D

3.3 Main approaches for valuation/costing

- **Market-based techniques:**
  - ➢ Market price approach:
    - ✓ Pollution permits, land prices, income changes
  - ➢ Appraisal approach for damages:
    - ✓ Health & infrastructure effects
  - ➢ Replacement cost
    - ✓ Cost of reforestation
  - ➢ Economic surplus measures
    - ✓ E.g. S&W conservation structures
    - ✓ Consumer, producer & social surplus



… VALUATION METHODS CONT'D

- **Non-marketed:**
  - Hedonic pricing – for amenities (House prices, apartment rent)
  - Contingent valuation: Asking people's willingness to pay
    - ✓Issues: stated and revealed preference
  - Travel cost (similar to hedonic pricing):
    - ✓For recreational resources (e.g. forest hiking)
  - Factor income approach
    - ✓Cost of additional factors needed to compensate
  - Choice modeling: Asking people to rank their preferences
    - ✓Ordered or conditional logit models
  - Sustainable development assessment
  - Cross-cutting methods

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Orthogonal fractional factorial design method (Ehmke, Lusk and Tyner, 2008; Boyle et al., 2001) used to randomly select among the possible combinations of attributes for the preference ranking.

... VALUATION METHODS CONT'D

3.4 CLASSIFICATION OF TYPES OF VALUES

I. USE VALUES

A. Direct use values

i) Consumptive uses

A.1.1 Commercial/industrial/household market goods

ii) Non-consumptive uses

- A.2.1 recreation (scenic views for residents, tourism revenue, wildlife photography, trekking, etc.)
- A.2.2 science/education.

. . . VALUATION METHODS CONT'D

B. Indirect use values

i) Watershed and soil protection: *reduced runoff and erosion*

ii) Soil improvement: *nutrient recycling, soil fertility, agricultural productivity enhancement.*

iii) Gas exchange (*e.g. carbon dioxide/oxygen****), contribution to climate stabilization and carbon storage.*

iv) Habitat and protection of biodiversity and species*.*

v) Aesthetic, cultural and spiritual values.

… VALUATION METHODS CONT'D

II. NON-USE VALUES

A. Option values

- *The option of using them in the future (e.g. as store of value)*
- *As an investment option*

B. Existence and bequest values

- *Existence - as status symbol in the society;*
- Bequest – as assets to be kept for their descendants;

… VALUATION METHODS CONT'D

3.5. Methods to be used in this study

- A combination of market and non-market methods
- Whenever possible/applicable, estimates for each theme:
  - Per unit area
  - Total provincial
  - Total national
- Two examples
  - Land degradation in forests
  - Land degradation in crop lands

… VALUATION METHODS CONT'D

A) Cost of deforestation

- **Deforestation includes**: logging, natural or human induced forest fires, collecting non-timber forest products and wood for fuel, construction or other uses, producing charcoal, forest products consumed (browsed) by animals, forest cleared for agricultural cultivation or for establishing settlements, factories, etc.
- Important parameters
  - Price of forest products (timber, fuel wood, …) in 2019, 2000, 1990
  - Annual discount rate (%)
  - Number of years needed to reforest an area

… VALUATION METHODS CONT'D

1. Direct Use value

1.1 Consumptive value

- Total value of biomass removed will be used as a proxy to the total cost of deforestation for consumptive purposes

Province	Total forest area (ha)	Percentage of forest area by deforestation level (sever deforestation, modest degradation, intact or low deforestation)				Average volume of biomass removed by deforestation (ton/ha) under each level of deforestation*			
		Low	Modest	Sever	Total	Low	Modest	Sever	Total
Sughd	**FS**	**A**	**B**	**C**	100%	**D**	**E**	**F**	**G= (A*D+B*E+C*F)/FS**
Khatlon	**FK**	**H**	**I**	**J**	100%	**K**	**L**	**M**	**N=(H*K+I*L+J*M)/FK**
GBD	**FG**	**O**	**P**	**Q**	100%	**R**	**S**	**T**	**U=(O*R+P*S+Q*T)/FG**
DRS	**FD**	**V**	**W**	**X**	100%	**Y**	**Z**	**ZA**	**ZB=(V*Y+W*Z+X*ZA)/FD**
Tajikistan	**FT**	**SUMPL**	**SUMPB**	**SUMPC**	100%	**SUMP**	**SUMP**	**SUMP**	**ZC=G*FS+N*GK+U*FG+ZB*FD/FT**

*If this is difficult, we will ask the volume of biomass that can be harvested from 1 ha of forest with low, modest and sever deforestation respectively. Then, the difference between the intact and medium or severe will represent what is removed from the modestly/severely deforested area.

... VALUATION METHODS CONT'D

Consumptive value of forests cont'd

- Parameters:
- Price forest products in 2019 (Somoni/ton) = PP

Province	Total volume of biomass removed by deforestation under each category of level of deforestation (tons)				Total value of biomass removed by deforestation under each category of level of deforestation (in Somoni/year)			
	Low	Modest	Sever	Total	Low	Modest	Sever	Total
Sughd	AC=A*FS*D	AD=B*FS*E	AE=C*FS*F	AF=AC+AD+AE	AG= AC*PP	AH=AD*PP	AI=AE*PP	AJ= AG+AH+AI
Khatlon								AK=
GBD								AL=
DRS								AM=
Tajikistan								AN=AJ+AK+AL+AM

... VALUATION METHODS CONT'D

1.2 Non-consumptive value

- This refers to revenue lost from recreation, education and research values including jungle cruises, wildlife photography, trekking, research and education, etc. due to deforestation.

Province	Total revenue (Somoni /year)	Percentage share of each category in total revenue (%)				Revenue per ha from non-consumptive uses			
		Low	Modest	Sever	Total	Low	Modest	Sever	Total
Sughd	RS	AR	BR	CR	100%	DR=AR*RS/A*FS	ER=BR*RS/B*FS	FR=CR*RS/C*FS	GR=A*FS*DR+B*FS*ER+C*FS*FF
Khatlon	RK	HR	IR	JR	100%	K	L	M	NR=
GBD	RG	OR	PR	QR	100%	R	S	T	UR=
DRS	RD	VR	WR	XR	100%	Y	Z	ZA	ZBR=
Tajikistan	RT	SUMPL	SUMPB	SUMPC	100%	SUMP	SUMP	SUMP	ZCR=GR*FS+NR*GK+UR*FG+ZBR*FD/FT

… VALUATION METHODS CONT'D

Non-consumptive value cont'd

- The loss in consumptive value in modestly/severely deforested lands is approximated by the difference between the revenue from consumptive value of the intact (or low deforestation area) and the revenue from the moderately/severely deforested area

Province	Annual loss of consumptive value due to deforestation (Somoni/year)			
	Low	**Modest**	**Sever**	**Total**
Sughd	DL=0	EL=(DR-ER)*B*FS	FL=CR*RS/C*FS	GL= DL+EL+FL
Khatlon	KL=0	LL	ML	NL=
GBD	RL=0	SL	TL	UL=
DRS	YL=0	ZL	ZAL	ZBL=
Tajikistan	SUMP	SUMP	SUMP	ZCL=GL+NL+UL+ZBL

… VALUATION METHODS CONT'D

2. Indirect Use value

- This is the most challenging part in valuation of deforestation!

Province	Value forgone due to the following in medium and severely deforested areas				
	Watershed & soil protection & nutrient recycling	Gas (carbon dioxide/oxygen) exchange, carbon storage & climate stabilization	Habitat and protection of biodiversity and species	Aesthetic, cultural and spiritual values	Total
Sughd					IVS
Khatlon					IVK
GBD					IVG
DRS					IVD
Total Tajikistan					IVT

… VALUATION METHODS CONT'D

3. Non-use values

- Simplifying assumptions:
  - Option/bequest/existence value is the negative of the additional value obtained by keeping forest for many years
  - Past annual increase in prices representative of the future
- Price forest products in 2019 and in 2000 (Somoni/ton) = PP & P2
- Discount rate = DD

	Option, existence, and bequest values calculated as the difference between value people expect by keeping it for future and its current value (Somoni/year)			
Province	**Low**	**Modest**	**Sever**	**Total**
Sughd	**OVL= AC*((PP-P2)/(1+DD)^(2019-2000))**	**OVM= AD*((PP-P2)/(1+DD)^(2019-2000))**	**OVS= AE*((PP-P2)/(1+DD)^(2019-2000))**	**OVSug=OVL+OVM+OVS**
Khatlon				OVK=
GBD				OVG=
DRS				OVD=
Total Tajikistan				**OVT= OVSug+OVK+OVG+OVT**

... VALUATION METHODS CONT'D

Summary

Summary of costs of Deforestation in Tajikistan (Somoni/year)

	Cost category				
	Consumptive uses	non-consumptive uses	Indirect uses	Non-use values	Total cost
Sughd	AJ	GL	IVS	OVSug	TVLDS=AJ+GL+IVS+OVSug
Khatlon	AK	NL	IVK	OVK	TVLDK=AK+NL+IVK+OVK
GBD	AL	UL	IVG	OVG	TVLDG=AL+UL+IVG+OVG
DRS	AM	ZBL	IVD	OVD	TVLDD=AM+ZBL+IVD+OVD
Total Tajikistan	AN	ZCL	IVT	OVT	TVLDT=AN+ZCL+IVT+OVT

… VALUATION METHODS CONT'D

B. Cost of land degradation in crop lands and abandoned lands

- A combination of market and non-market valuation methods will be used
- Household and plot-level survey data from 2016
- Three major wheat producing provinces: Khatlon, Sugd and Districts of Republican Subordination (DRS)
- 6 districts for our survey – 2 from each of the 3 provinces
- 17 communities and 41 villages
- 115 farm households from each district
- A total sample of 690 households

. . . VALUATION METHODS CONT'D

Table: Distribution of sampled farming households

Provinces	Districts	Community	N of villages	N of Households
DRS	Hissor	Durbat	2	29
		Mirzo Rizo	2	43
		Somon	2	43
Khatlon	Bokhtar	Mehnatobod	3	40
		Sarvari Istiklol	2	26
		Zargar	4	49
	Dusti	Dekhqonobod	2	35
		Gulmurodov	3	28
		Jilikul	4	52
	Khamadoni	Dashtigulo	2	40
		Mehnatobod	2	28
		Turdiev	2	47
Sugd	B.Gafurov	Ovchikallacha	4	84
		Yova	2	31
	Mastchoh	Mastchoh	2	39
		Navbahor	1	30
		Obburdon	2	46
Total			41	690

... VALUATION METHODS CONT'D

..Cost of land degradation in crop lands cont'd

- Simplifying assumptions:
  - Soil depth - a proxy for land degradation due to erosion (water and wind)
  - The difference between the value of production in deep soils and shallow soils represents the opportunity cost of soil erosion in cultivated fields
- Price of wheat in 2019 = Pw
- Total wheat area in Tajikistan with shallow soil =TWASS
- Total wheat area abandoned due to land degradation = TWAALD
- Econometric methods to determine the impact of soil depth on yield
- We will carry test of endogeneity (as we suspect it exists)
- If it exists, we will use Endogenous Switching Regression to correct for endogeneity

… VALUATION METHODS CONT'D

..Cost of land degradation in crop lands cont'd

The selection equation is specified as

- *Soil depth is observable as a dichotomous variable: D =1 if* $D_1^* > D_0^*$ *and D = 0 if* $D_1^* < D_0^*$,
- *Then it is modelled as:*

$$D_i^* = Z_i\beta + \varepsilon_i \text{ with } D_i = 1 \text{ if } D_i^* > D_0^*, \text{ otherwise } D_i = 0 \qquad (1)$$

Where β is a vector of parameters to be estimated, and ε_i *is a vector of error terms*

Z_i is a vector of explanatory variables including: Sex, Education, Age, AgExperience, total cultivated land, credit, TotLand, wealth2 wealth3, wealth4, soil type, locationWDN, Years of ssoilconserv, numberoftilledtimes, irrigationfreq

... VALUATION METHODS CONT'D

..Cost of land degradation in crop lands cont'd

The outcome equations (yield response functions) take the form

$$y_1 = X_1\omega_1 + \epsilon_1 \; if \; D = 1 \quad (2)$$

$$y_0 = X_0\omega_0 + \epsilon_0 \; if \; D = 0 \quad (3)$$

where y_i is a vector of dependent variables representing yield for adopters (y_1) and non-adopters (y_0), ω_i is a vector of parameters to be estimated, and ϵ_1, and ϵ_0 are error terms

X_i is a matrix of explanatory variables including: **Soil depth**, Sex, Education, Age, AgExperience, total cultivated land, number of tillage, irrigationfreq, variety, seedperha, Nfert, Phosphate, her, pest

… VALUATION METHODS CONT'D

..Cost of land degradation in crop lands cont'd

- The coefficient on soil depth in the outcome equation represents the yield (kg/ha) difference (YD) between deep and shallow soils holding all other things constant.
- Then we compute the total cost of soil erosion on wheat lands (TCSEWL) can be computed as: TCSEWL=YD*Pw* TWASS

… VALUATION METHODS CONT'D

..Cost of land degradation in crop lands cont'd

- **Total cost of soil salinity in crop lands (TCSSCL) = ???**
- **The non-use, indirect use values and non-use values (Total other values of soil in crop lands= TOVSCL) – still struggling to find a way to estimate???**
- Total cost of land degradation in abandoned wheat lands (TCLDAWL) can be computed as: TCLDAWL = Y1*Pw* TWAALD
- Total cost of degradation on crop lands TCLDCS is calculated as:

TCLDCS= TCSEWL+ TCSSCL+ TOVSCL+ TCLDAWL

THANK YOU
RAKHMET