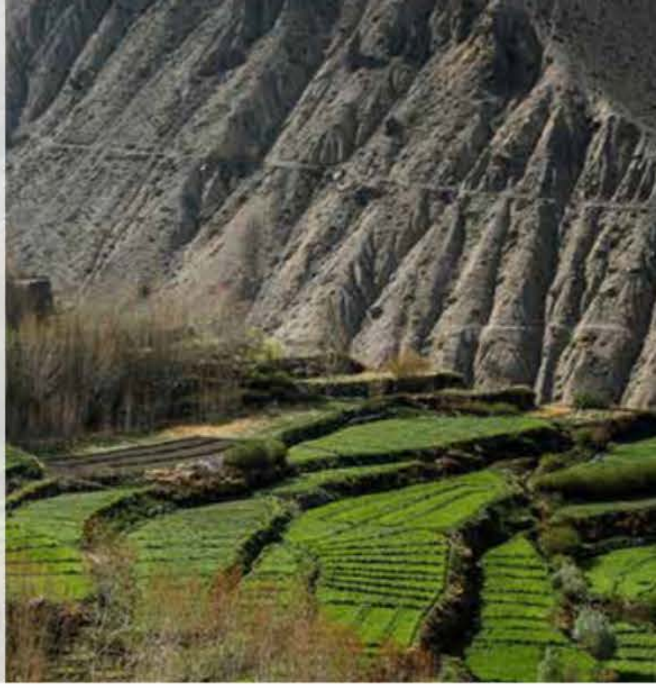
EMBEDDING ECOSYSTEM SERVICES INTO POLICY LEARNING SERIES

Session 3: Economic Valuation of Investments in Reversing Land Degradation – Madagascar Case Study



about our workshop

The session will help participants grasp economic valuation for landscape analysis, simplify the concept, and illustrate its practical use in Madagascar while exploring its potential applications in Zambia.

Keywords: Economic Valuation, Environmental Analysis, Landscape Analysis

learning objectives

- Understand the use of economic valuation for landscape analysis
- Define and explain economic valuation
- Show the application of economic valuation in the Country Environmental Analysis done in Madagascar
- Show the utility and potential uses for Zambia

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Carlos Solís is an Environmental Economist with extensive experience leading research and capacity building projects related to cost-benefit analysis, ecosystem valuation and climate change through the Americas. He has led data collection processes in rural and urban areas in several countries in Latin America. He is currently supporting the World Bank as an analyst consultant in economic valuation and has experience working with USAID, Solimar International, Friedrich Ebert Stiftung, Fairtrade and the University of Florida, among others. He holds an MSc degree in Food and Resources Economics from the University of Florida and a Bachelor's degree in Economics from San Simon University in Bolivia.

GPS
Global Program on Sustainability

Economic Valuation of land degradation impacts: A case study in Madagascar

Carlos Solís

Content

What is economic valuation

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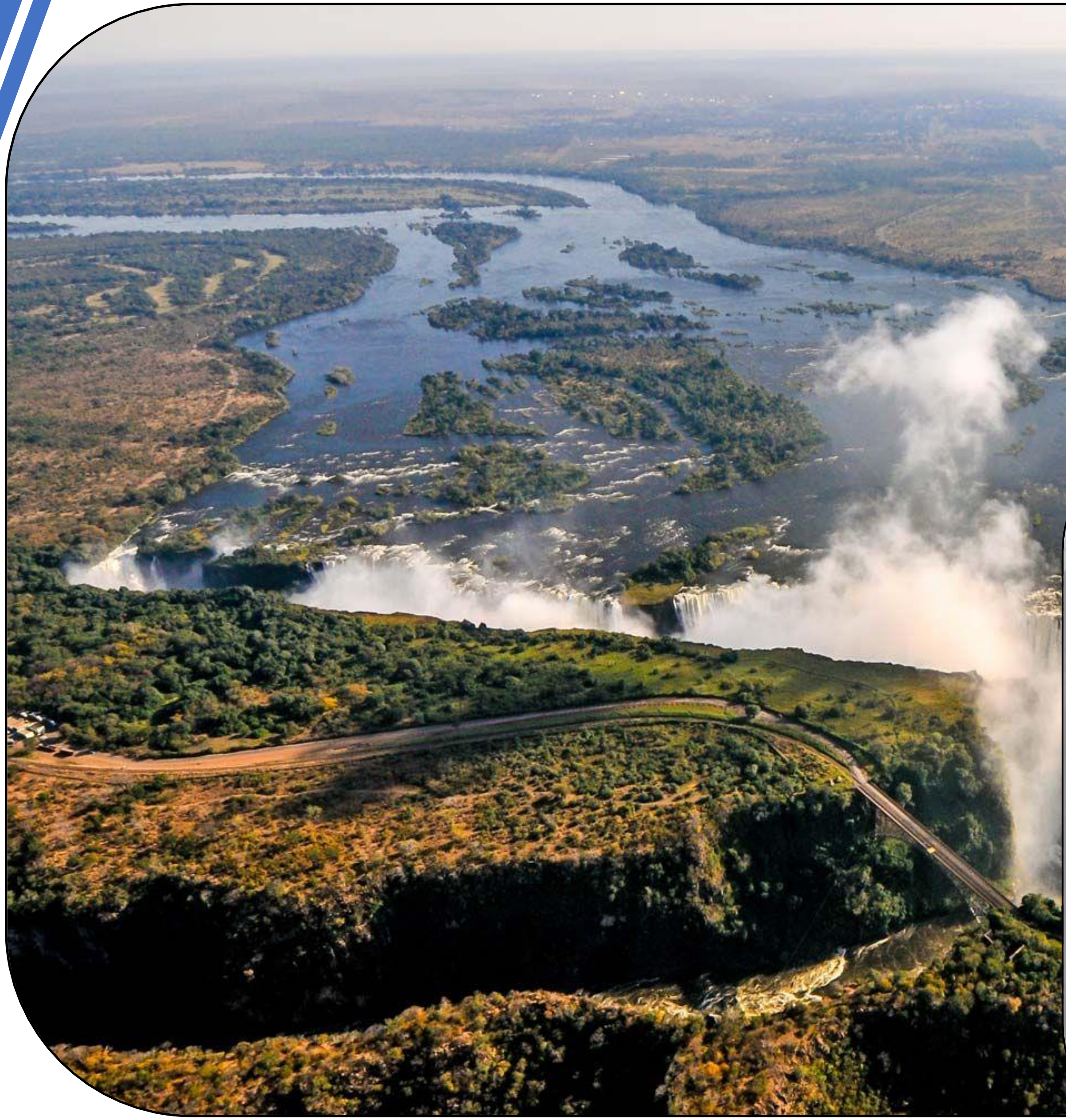
Author: dennisvdw . Getty Images/iStockphoto



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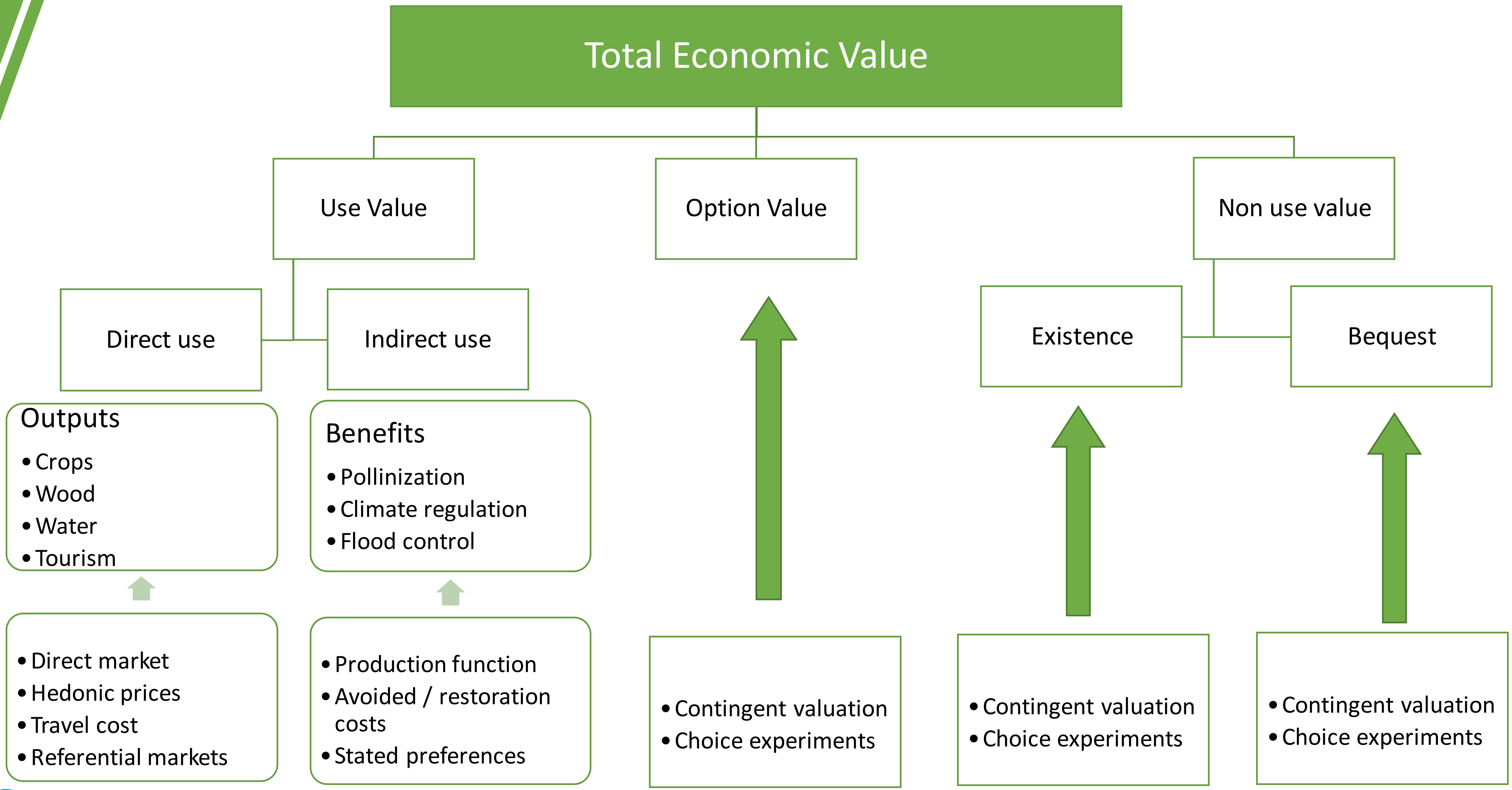
https://www.heleninwonderlust.co.uk/



Total Economic Value
Use Value
Option Value
Non use value
Direct use
Indirect use
Existence
Bequest
Outputs
• Crops
• Wood
• Water
• Tourism
Benefits
• Pollinization
• Climate regulation
• Flood control
• Direct market
• Hedonic prices
• Travel cost
• Referential markets
• Production function
• Avoided / restoration costs
• Stated preferences
• Contingent valuation
• Choice experiments
• Contingent valuation
• Choice experiments
• Contingent valuation
• Choice experiments

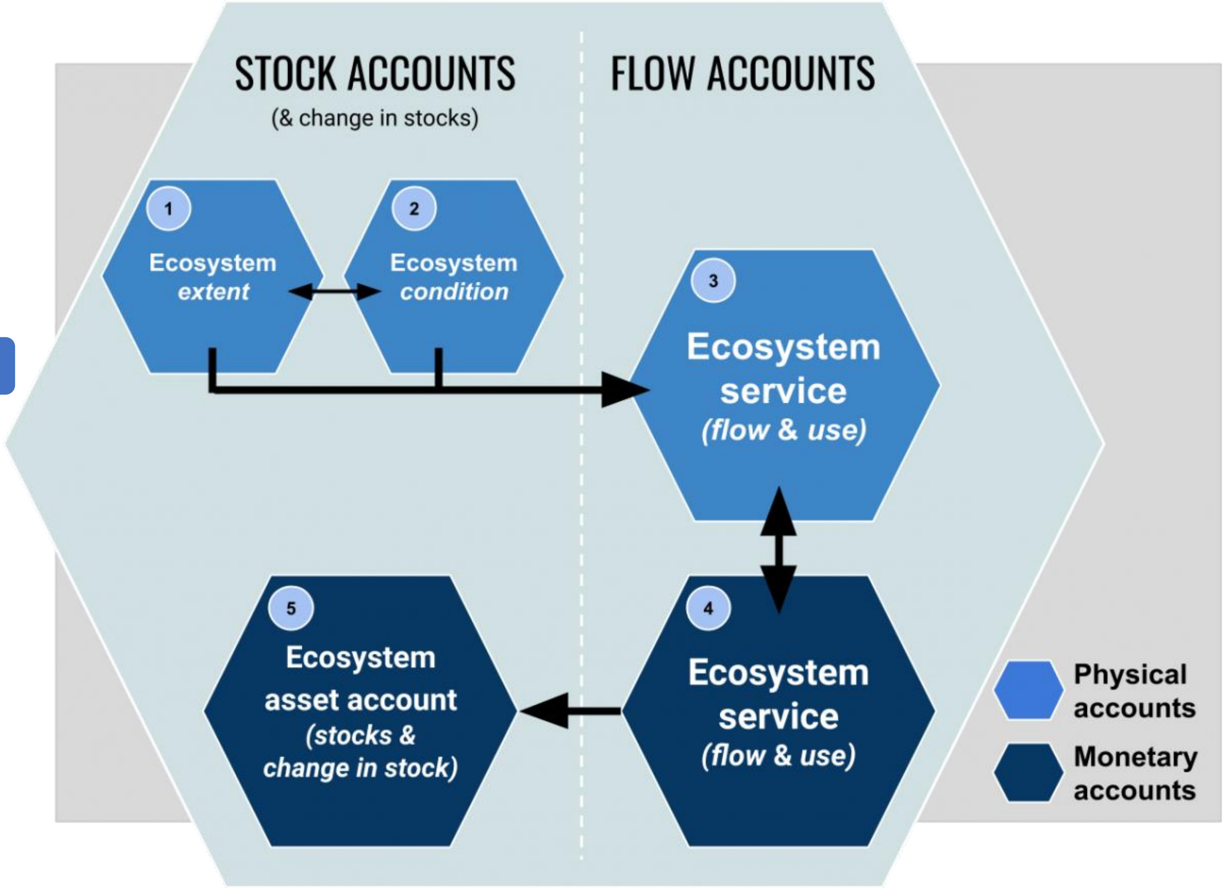
Sectors Economic Valuation Methods

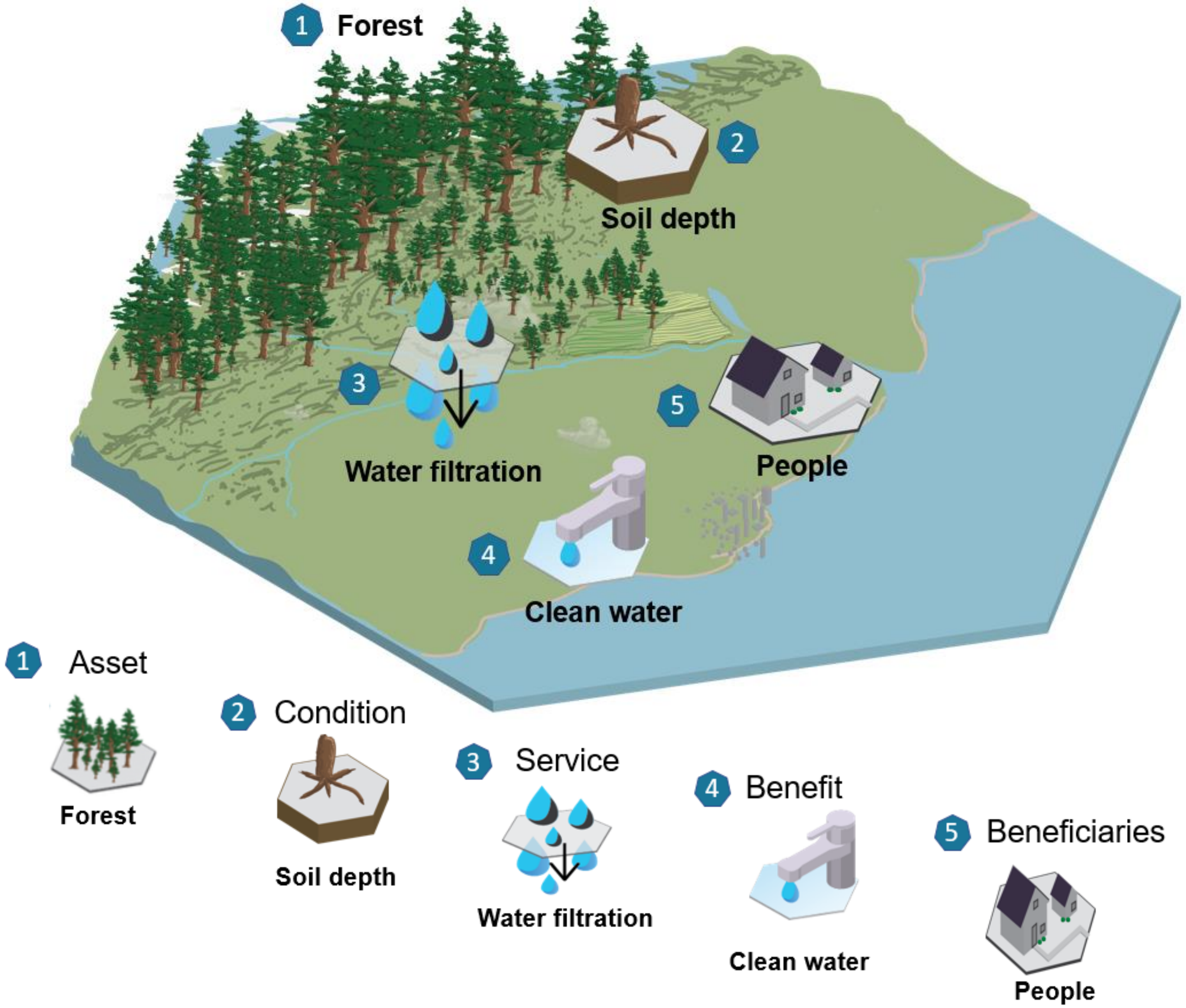
SECTOR	IMPACTS	VALUATION METHODS
Agriculture	Loss of agricultural yield	Production function; market prices; benefits transfer
	Soil nutrition depletion	Replacement cost
	Salinity	Avoided cost of desalination
Water	Siltation of rivers and reservoirs	Replacement cost(cost of dredging) Avoided damage cost (Increased water purification cost), Production function (loss of agricultural output due to reduced irrigation)
	Aquifer depletion	Opportunity cost of increased water collection time
	Health impacts due to water pollution	Cost of illness for morbidity
Energy	Carbon emissions	Market prices, social cost of carbon
	Loss of hydropower efficiency	Replacement cost (least costly energy generation alternative)
Biodiversity	Loss of biodiversity	Stated preference methods
Tourism	Decrease of visitor number	Travel cost
Forests	Loss of production of fuel wood, NTFP and watershed services	Replacement cost, benefits transfer, opportunity cost of additional collecting time
Coastal zones	Vulnerability increase	Hedonic prices, benefits transfer, stated preference methods

Source: Based on Amman et al., 2013; Bolt et al., 2005; and World Bank, 2020

ES accounting

SYSTEM OF ENVIRONMENTAL ECONOMIC ACCOUNTING (SEEA)
UNITED NATIONS ORGANIZATION





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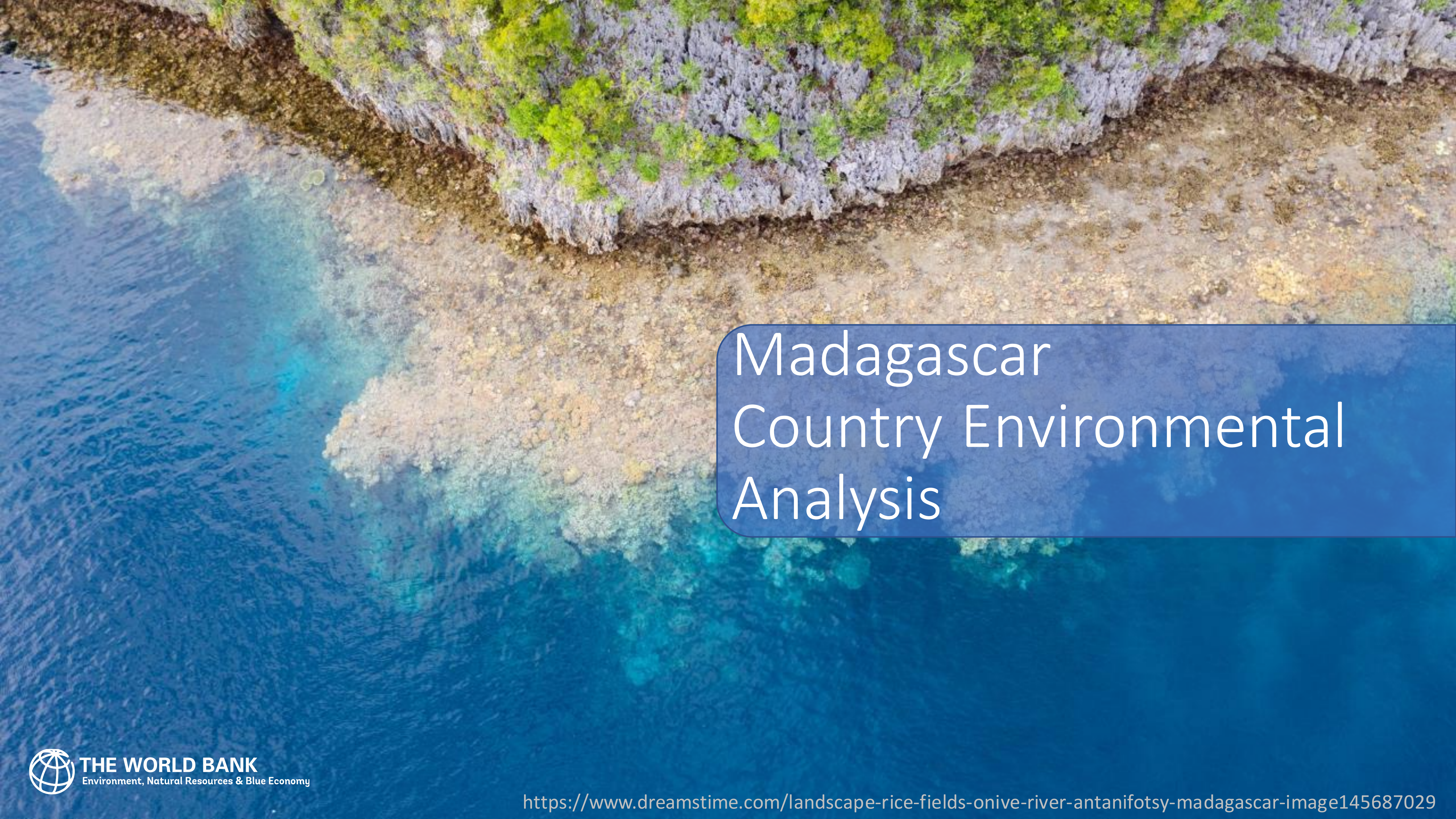
Source: https://seea.un.org/ecosystem-accounting



Madagascar Country Environmental Analysis

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https://www.dreamstime.com/landscape-rice-fields-onive-river-antanifotsy-madagascar-image145687029

Country Environmental Analysis

World Bank Country Environmental Analysis (CEA)

- Guidance for integrating information
- Environment-development priorities
- Analytical information

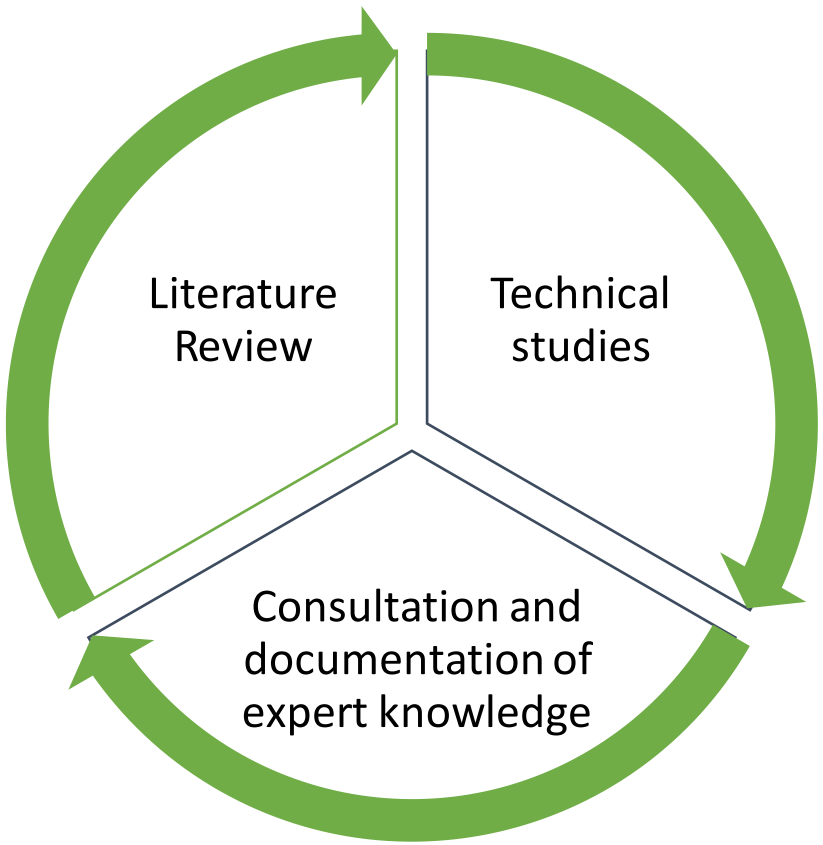
Country Assistance Strategy

- Environmental and sustainability indicators
- Strategic environmental assessments
- Capacity-building

Strategic approach to the management of environmental issues

- Analysis about environment-development links
- Decisions at the country and sectorial levels

CEA Methodologies

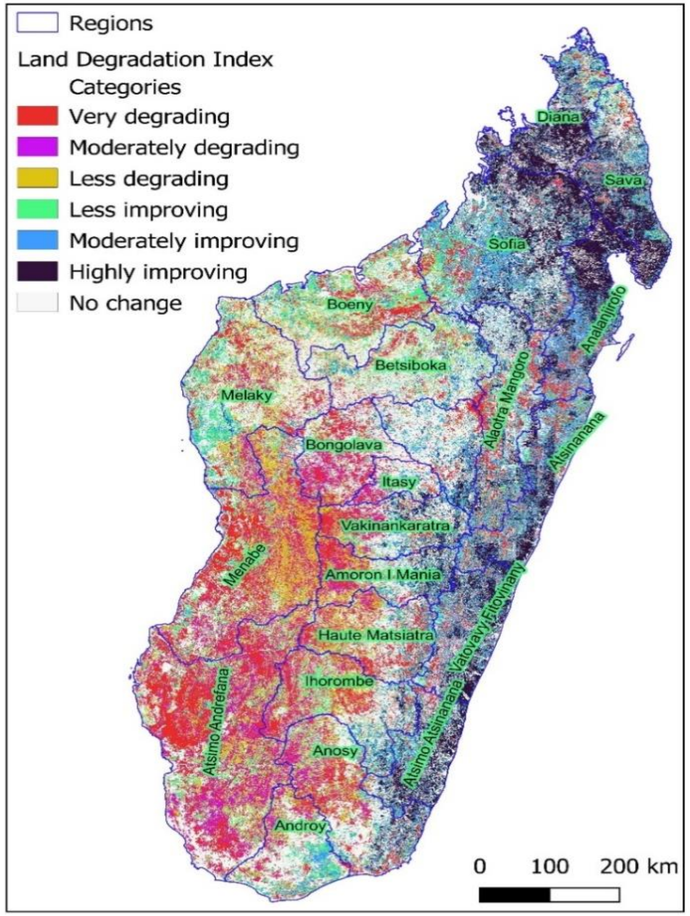


Integrated Landscape Analysis

Spatial approach Data → Geographical, environmental, ecological, and economic information → Landscape management Nature Based Solutions (NBS)

Vegetation health (NDVI)
Carbon storage (NPP)
Soil erosion control
Water availability
Seasonal flow patterns

Land Degradation Trends in Madagascar 1990-2020



Source: World Bank Team Estimation.

Application to Madgascar

- 29-year period 1992 - 2020
- Historical costs and future savings
- Land degradation and land use change
- Public available economic information

Key Sector	Impacts	Valuation approach
Agricultural	Loss of agricultural yield	Loss in productivity for selected crops due to erosion + potential dredging cost of irrigation dams
Hydropower	Loss of hydropower efficiency	Loss in power generation due to water scarcity + potential dredging cost of hydropower dams
Carbon	Carbon emissions	Opportunity cost of unrealized carbon credits due to deforestation
Social cost of carbon		Global social cost of carbon not absorbed due to degradation

Economic valuation of land degradation impacts

https://www.madamagazine.com/en/das-korn-des-lebens-reisanbau-auf-madagaskar/

Hydropower

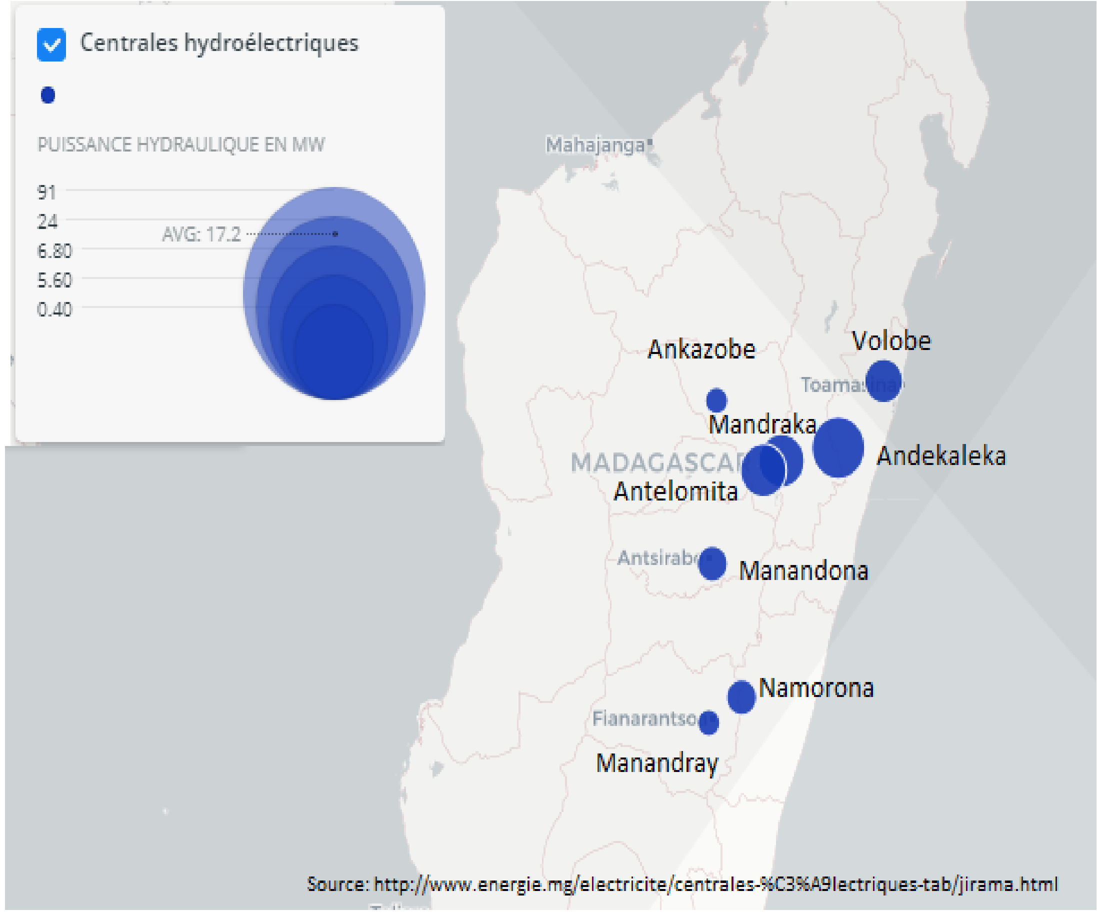
Antananarivo Interconnected Network (RIA) 70%

Andekaleka Antelomita Mandraka

Poor efficiency

Lack of rehabilitation

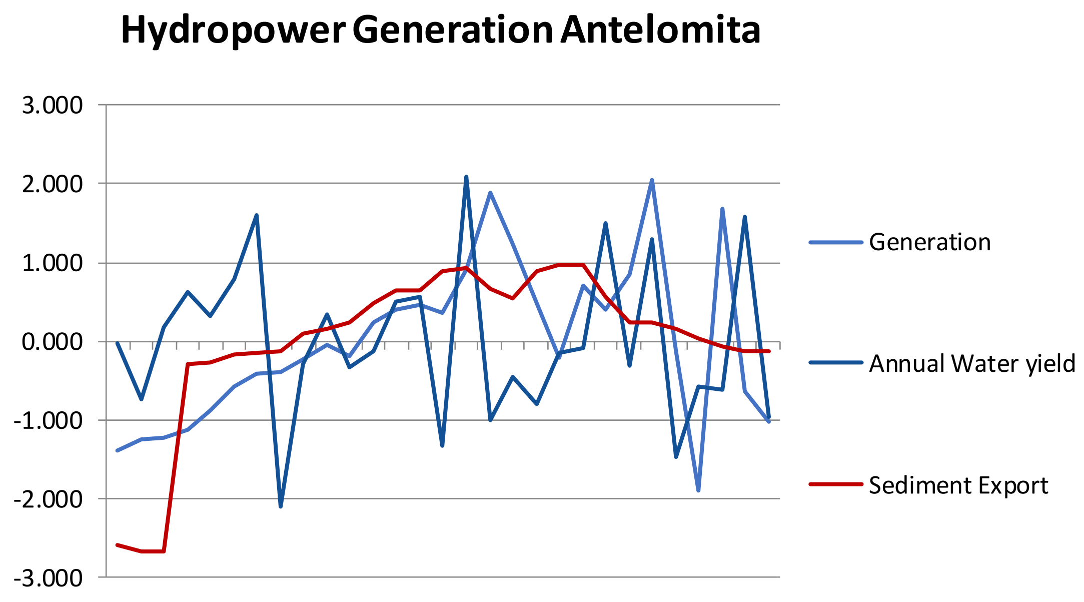
Isolated Mini grids 30%



Hydropower

Land degradation on watersheds that feed the reservoirs

- Bigger discharge of sediments
- Lower reliability on water availability



Hydropower production loss

- Office de Régulation de L'électricité Madagascar
- Historical generation of electricity
- Historical Tariffs

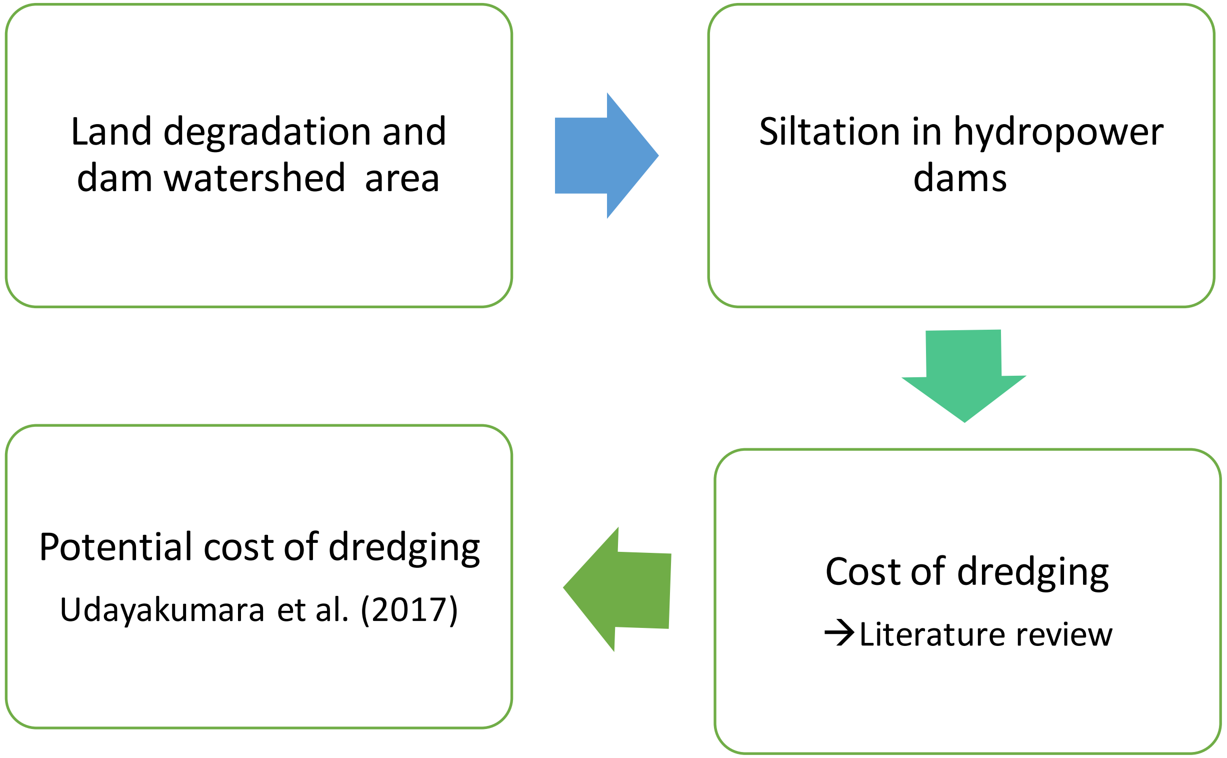
Generation losses

- Adeoyung et al. (2016)
- Suboptimal hydrological provision 19%
- Sedimentation 6%

$$HPL = ICG - HPG_t$$

$$C = \sum_{t=1}^{n} HPL_t \cdot WMD \cdot P_t$$

where
HPL: hydropower production loss, measured in kWh
ICG: Installed capacity hydropower generation, measured in kWh
HPG: Hydropower generated in period t
C: Cost of hydrological hydropower production loss, measured in 2020 USD
WMD : Hydrological factor in hydropower loss
p: Selling price of electricity for t period, measured in 2020 USD per kWh



Potential cost of dredging

$$C = S * D$$

where
C: Cost of dredging reservoir, measured in 2020 USD
S: Total sediment trapped in reservoirs, measured in tons
D: Cost of dredging, measured in 2020 USD per ton

Hydropower results

Loss in power generation due to water scarcity
Adeogun et al.(2016)

Accumulated in Million USD 2020		Annual average in Million USD 2020	
High	243.33	High	7.71
Av.	220.49	Av.	7.27
Low	197.64	Low	6.83

Potential dredging cost of hydropower dams
Udayakumara & Gunawardena (2017)

Accumulated in Million USD 2020		Annual average in Million USD 2020	
High	219.10	High	7.56
Av.	159.85	Av.	5.51
Low	100.61	Low	3.47

Total Loss Hydropower Sector

	Accumulated in Million USD 2020	Annual average in Million USD 2020
Loss in power generation due to water scarcity + Potential dredging cost of hydropower dams	380.34	12.78

Alternative to value the impact of water outages due to land degradation

Replacement cost

Alternative sources of energy

→

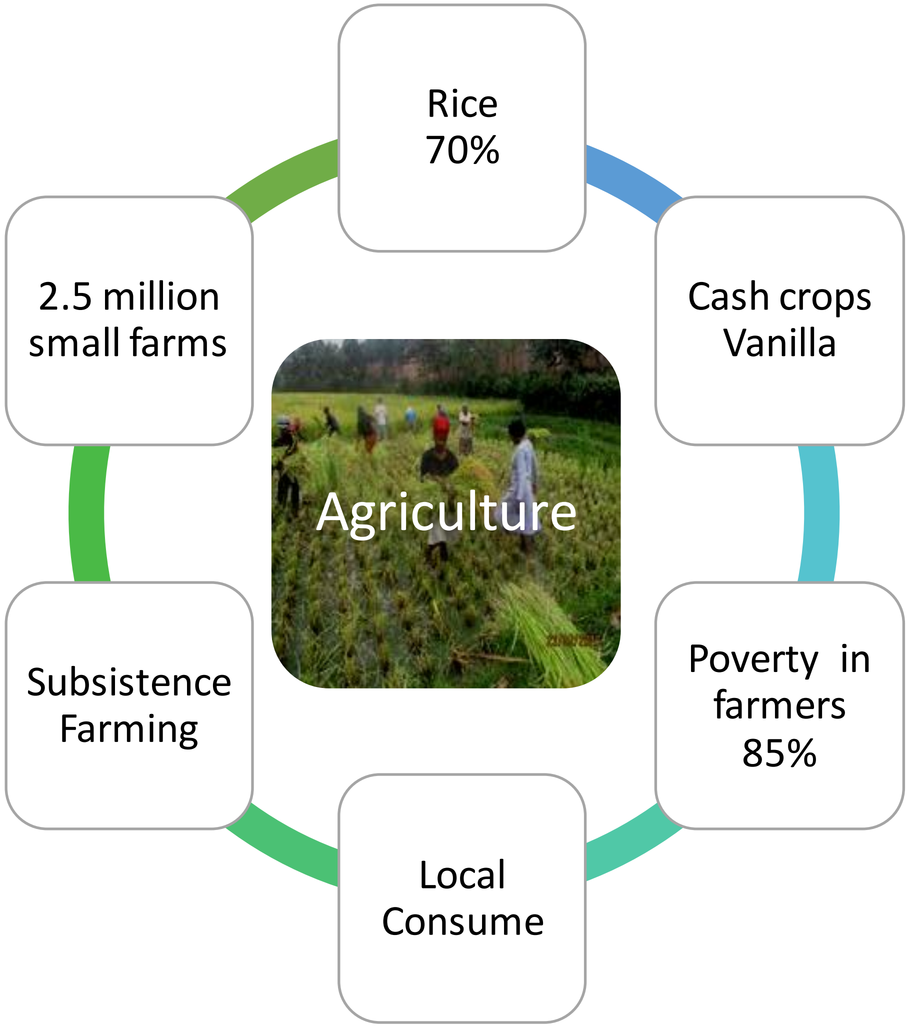
Diesel heavy fuel oil plants

Diesel fuel oil plants.

→

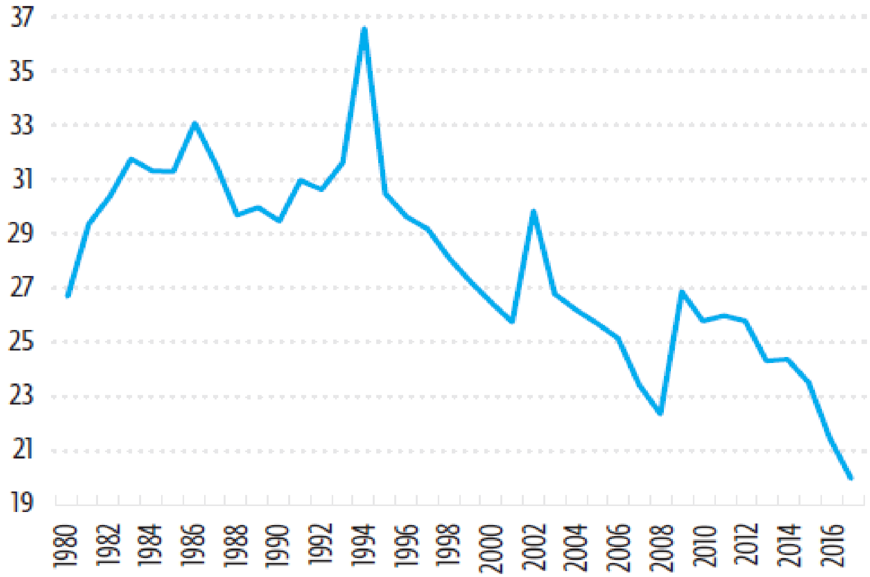
Cost of energy increases in 30% and 67%

Agriculture



a. Agriculture contribution to GDP, 1980–2017

% of GDP



Source: World Bank, World Development Indicators data.

Note: GDP = gross domestic product.

Literature review on land degradation and agricultural yields

Global

Sartori et al. (2019)

- Areas of severe erosion
- → **8% mean crop yields loss**

Pimentel et al. (1995)

- Areas of severe erosion
- → **8% crop productivity loss**

Africa

Lal, R. (1995)

- Yield reductions due to severe erosion
- → **8.2% mean crop yields loss**

Madagascar

Carret, J; Loyer, D. (2003).

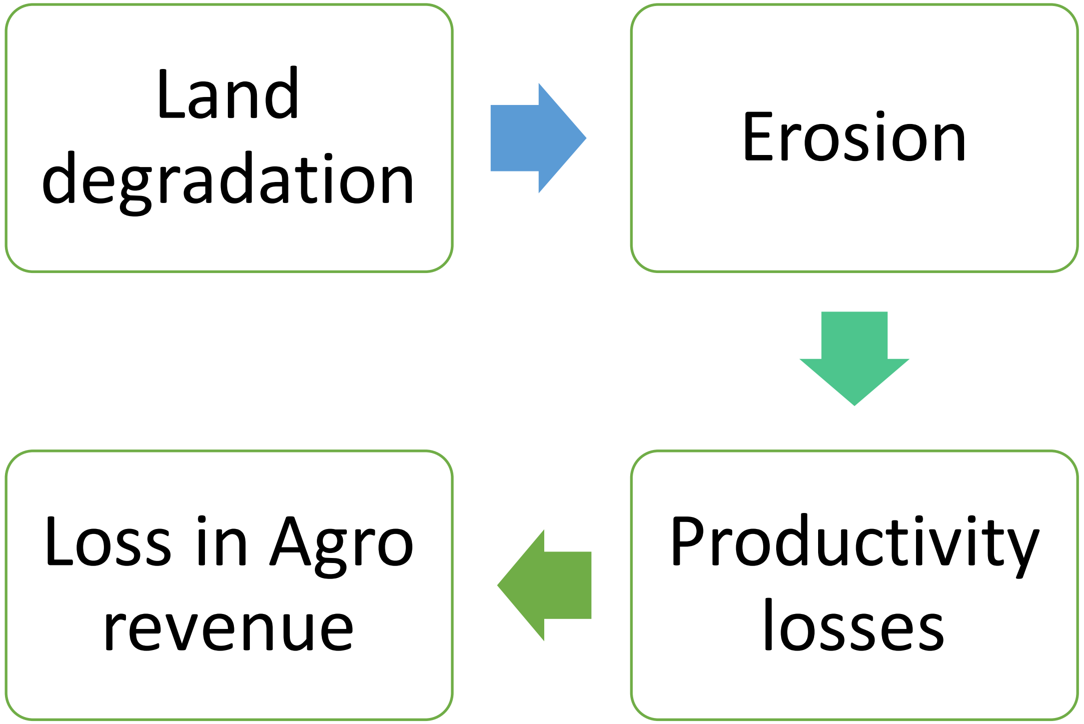
- Silted irrigation channels and suboptimal water availability
- → **10% loss of productivity in rice plots**

Randrianarisoa, J. & Minten, B. 2001.

- Cyclones on previous year
- → **7% agricultural production value loss**

Portela et al. (2012)

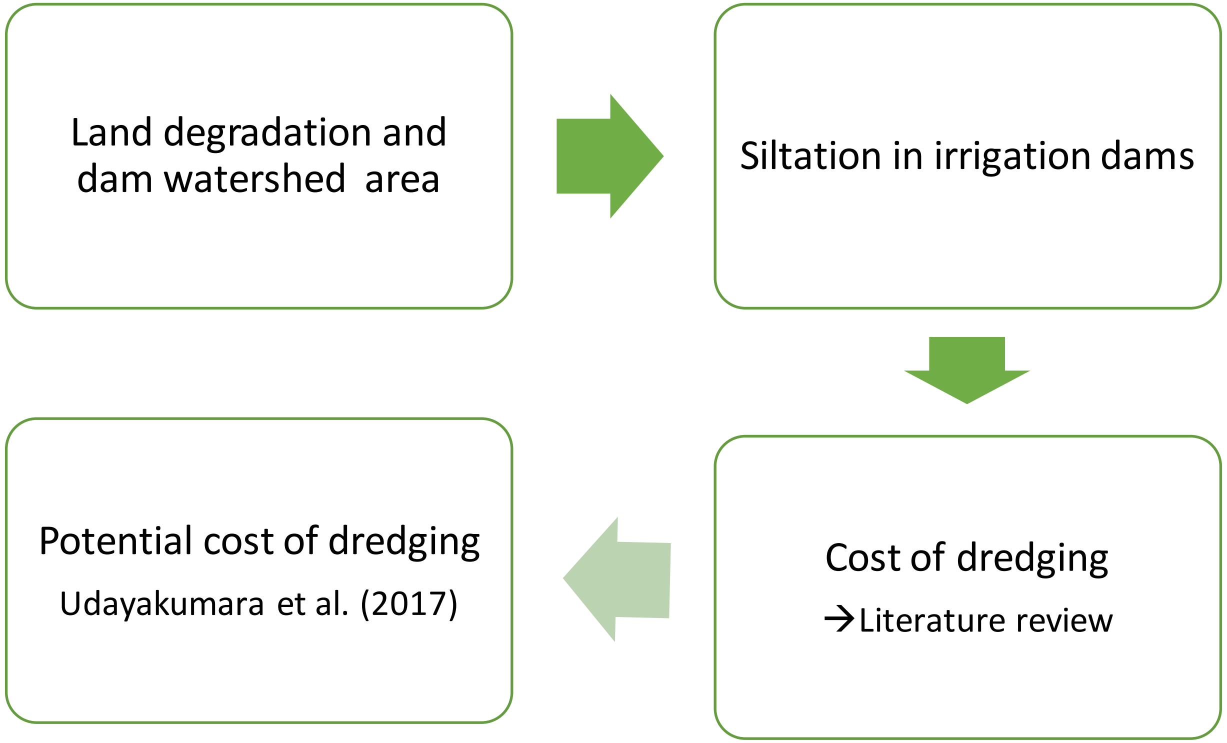
- 1% increase in the use of water (rainfall or irrigation)
- → **Rice production : +0.91%**
- → **Manioc production: +0.83%**



Productivity losses due to

$$C = \sum^{n} R_{it} \cdot L \cdot P_{it}$$

where
C: cost of agricultural losses for erosion afflicted region, measured in 2020 USD
R: Total production of crop i in period t, measured in tons
L: Production loss coefficient
P: Price of crop i in period t, measured in 2020 USD per ton of produce



Potential cost of dredging

$$C = S * D$$

where

C: Cost of dredging reservoir, measured in 2020 USD

S: Total sediment trapped in reservoirs, measured in tons

D: Cost of dredging, measured in 2020 USD per ton

Agriculture results

ss in productivity for selected crops due to erosion

Accumulated in million USD 2020		Annual average in Million USD 2020	
High	4753.48	High	163.91
Av.	4100.75	Av.	141.41
Low	3448.01	Low	118.90

Potential dredging cost of irrigation dams

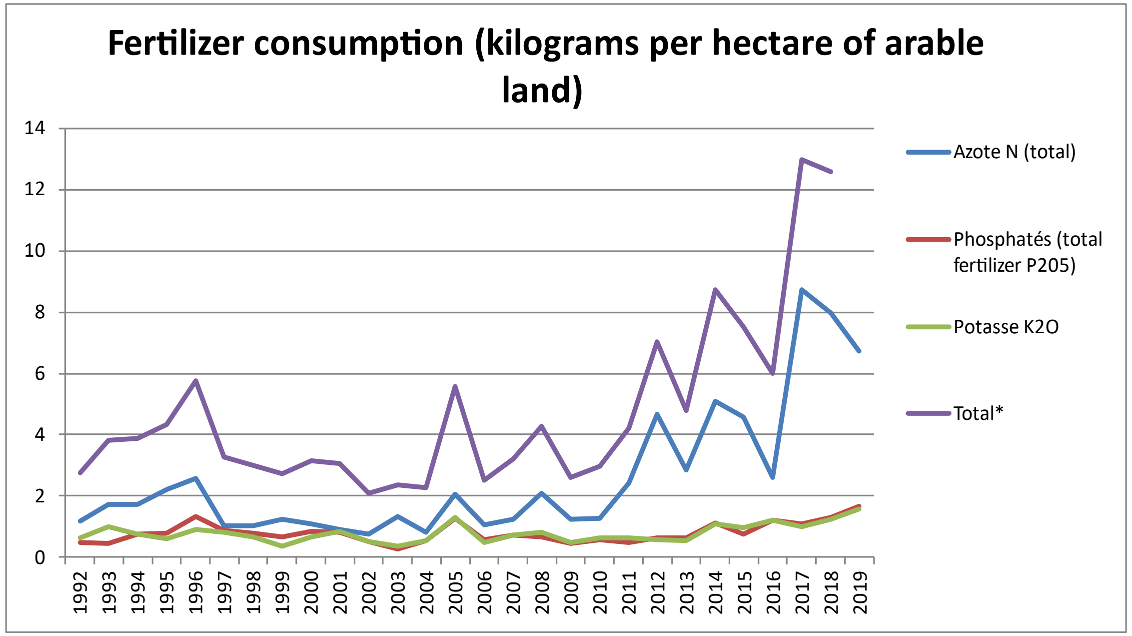
Accumulated in million USD 2020		Annual average in Million USD 2020	
High	328.47	High	11.33
Av.	239.65	Av.	8.26
Low	150.83	Low	5.20

Total Loss Agricultural Sector

	Accumulated in Million USD 2020	Annual average in Million USD 2020
Loss in productivity for selected crops due to erosion + Potential dredging cost of irrigation dams	4340.40	149.67

Maize Function Results

lnProdMaizTon	Coef.	Robust Std. Err.	z	P>|z|
lnSuperMaizHa	.6416534	.1513671	4.24	0.000
lnSedimentExport	-.107341	.119962	-0.89	0.371
lnPreciMaiz	.0265226	.0863528	0.31	0.759
lnAnimales	.0787763	.041068	1.92	0.055
lnLitFem	-.3145459	.1344624	-2.34	0.019
lnLitMen	.6510934	.1938091	3.36	0.001
lnPopula	-.3510608	.2303857	-1.52	0.128
lnErosionRm3Ha	-.454947	.2412999	-1.89	0.059
lnAWYtnha	-.1524747	.0623427	-2.45	0.014
_cons	4.267997	2.434039	1.75	0.080
sigma_u	.24352784			
sigma_e	.06175867			
rho	.93957325	(fraction of variance due to		

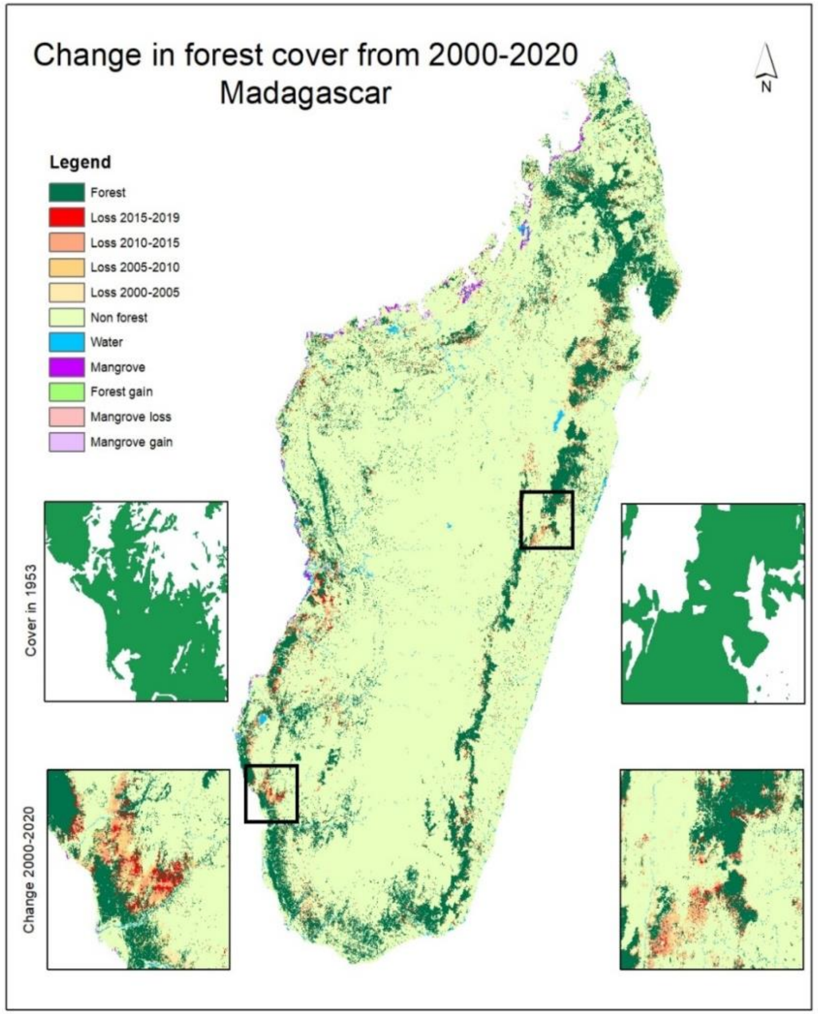


Climate

Emission Reduction Program

Atiala Atsinanana

USD $5 per ton of CO2e (FCPP 2018)



Source: World Bank Team Estimation.

Total forest loss:

3.9 M Has

Climate

- Impact of land degradation
- Carbon absorption losses
- Social cost Carbon emissions additional costs

- The impact of land use change
- Carbon stock loss
- Market price of carbon
  Direct exchange value of carbon

Potential carbon credits lost

$$C = P * (A * S)$$

where
C: Opportunity cost of lost carbon credits
P: Market price of CO2, measured in $ per ton of CO2
A: Total area of deforestation, measured in ha
S: CO2 content of forest, measured in tons of CO2 per ha

Social cost of carbon

$$C = \sum N_t \, x \, S_t$$

where
C: Global cost of carbon not absorbed
N: NPP decrease in period t, measured in tons of CO2 at the National level
S: Social cost of carbon price for period t, measured in 2020 US$ per ton of CO2

Climate results

The average amount of carbon not absorbed

1.56 M tons of CO_2 per year.

1700 M USD of potential loss revenue in carbon market

12% of Madagascar's current GDP

Humid forest cover loss	Area (thousand has)	Accumulated Value of CO_2 loss stocks (million USD)	Annual average losses (million USD)
	1 947.5	**1791.7**	**59.75**

Annual average loss

8% of forest rents in 2020

Forest loss in Protected Areas (PAS)	Area (thousand has)	Accumulated Value of CO_2 loss stocks (million USD)	Annual average losses (million USD)
	50.98	**49.91**	**1.67**

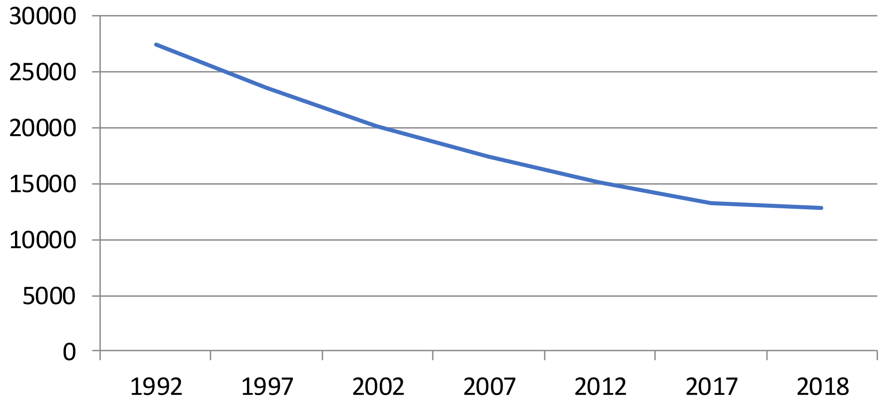
Annual average loss in Protected Areas
1 M USD

Water consumption

Access drinking water
41%

Natural sources
Wells
Public taps

Renewable internal freshwater resources per capita (cubic meters)



Source: Food and Agriculture Organization, AQUASTAT data

Water consumption

As part of the valuation exercise, a regional assessment of the economic impact on households of a reduction on water availability was also conducted:

Districts
- Antsiranana II
- Morombe
- Toliary-II

Data availability
- Local surveys

Vulnerable households
(100 000 Ar/month)
- Average water consumption

Willingness to pay
- Project outcome 50-100 Ar/ 20L
- Predatory prices 500 Ar/ 15L

Percentage of income required
- WTP Projects outcome: 3%
- Predatory prices: 47%

Conclusion and lessons for Zambia

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Author: Frank Vassen. Lavaka (erosion gully), Ankarafantsika National Park, Madagascar

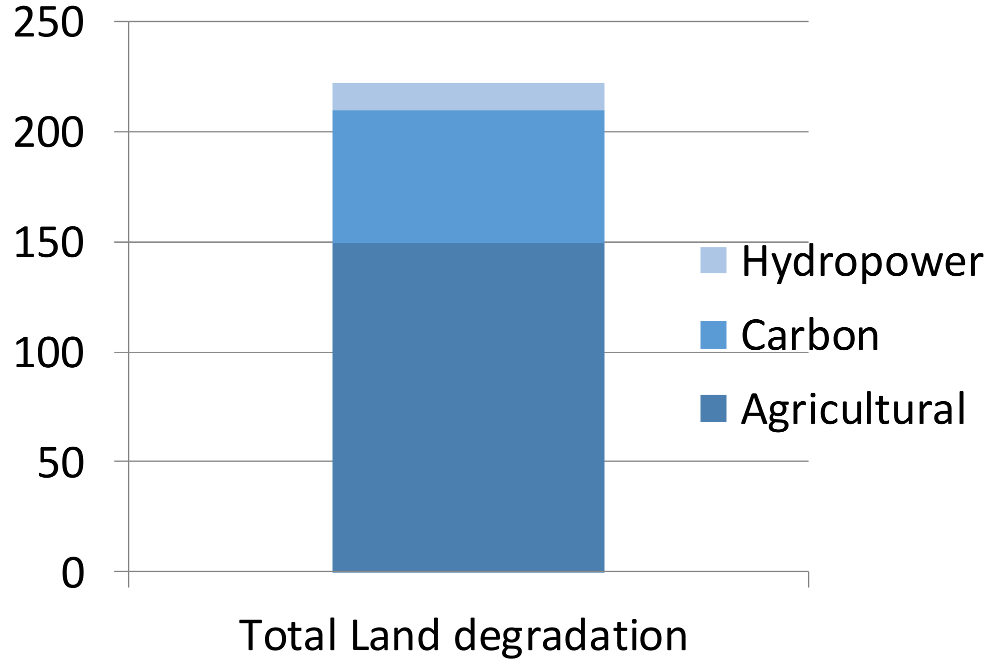
Conclusions

Land degradation Impact	
USD 6 512M	49% GDP

Annual average Impact	
USD 222.29 M	1.7% GDP.

Agricultural costs
64.67%

Annual cost of Land degradation in Million USD



Lessons for Zambia

Determine the need for economic valuation

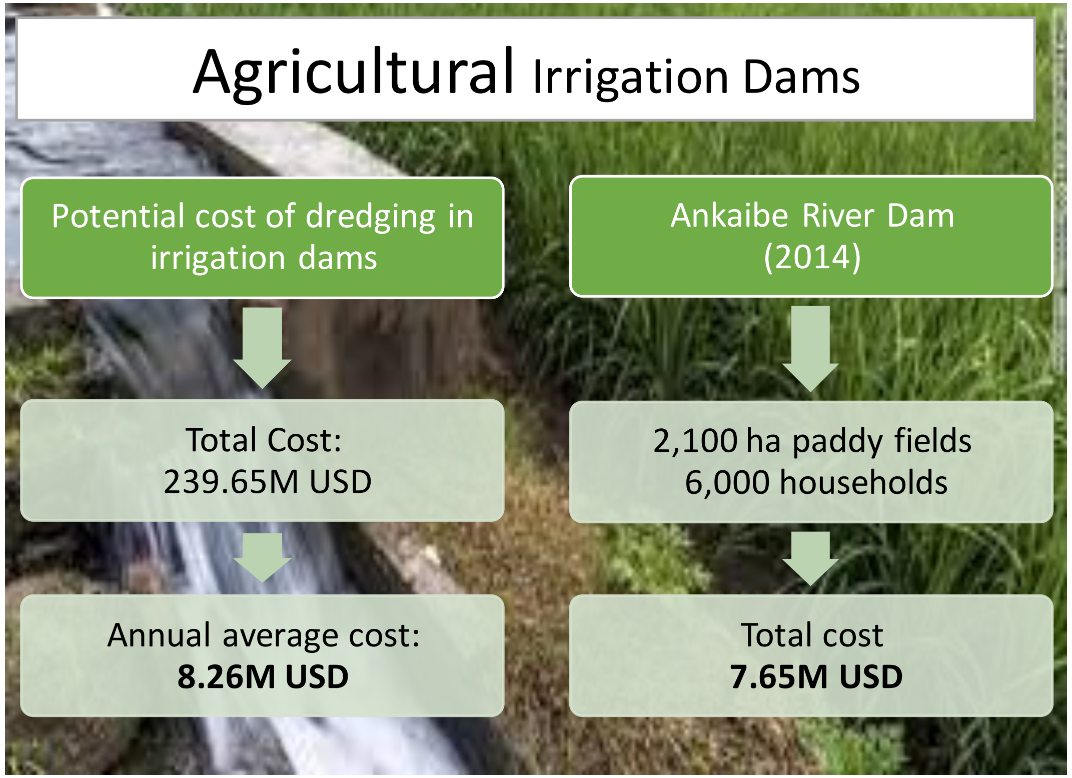
- Capacity-building assistance→ What kind of valuation

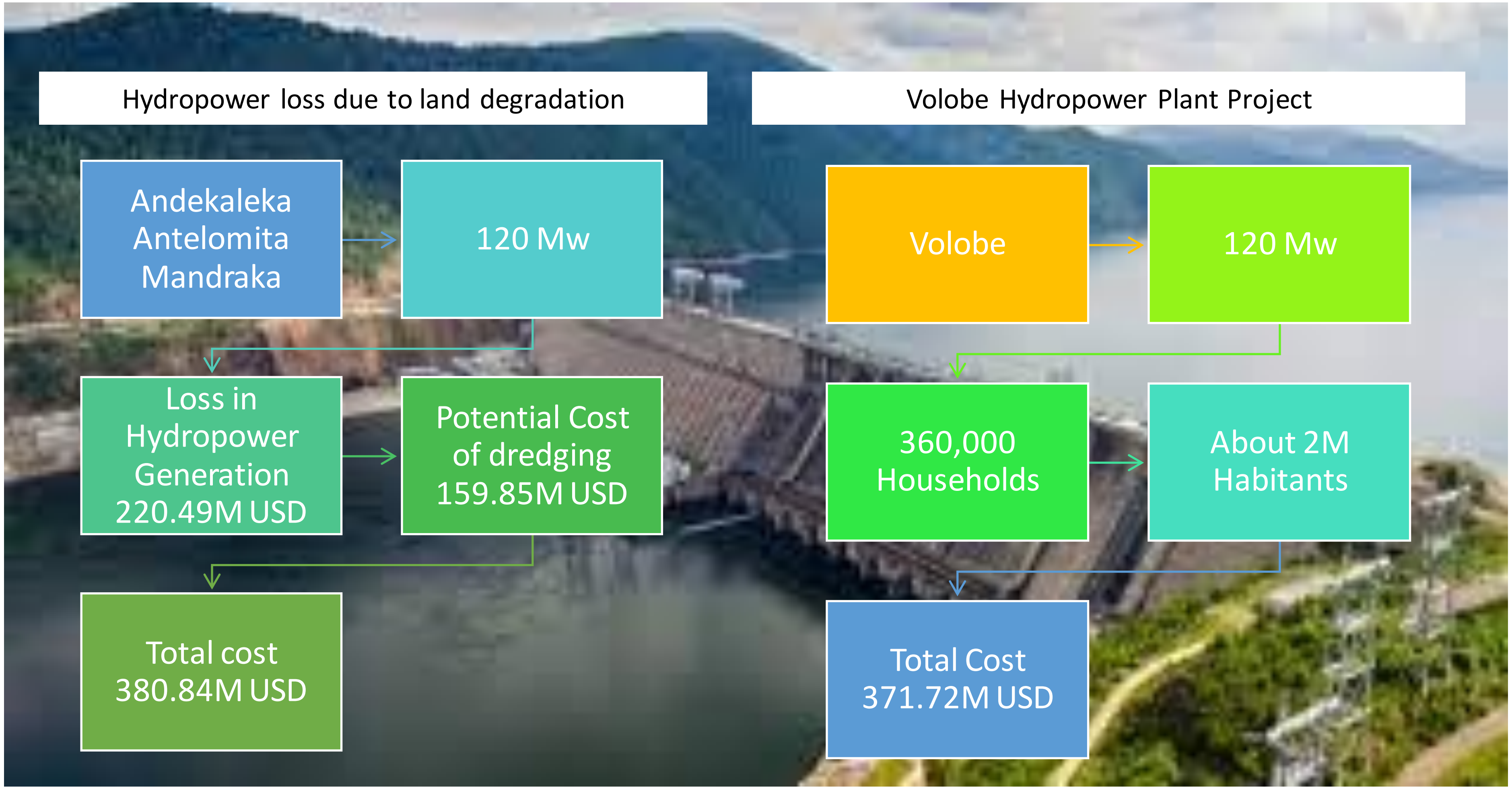
Coordinate and use spatial analysis

Understand and contextualize values

Use economic data to guide investment decisions

- Strategic environmental assessments
- ES Accounting




Hydropower loss due to land degradation
Andekaleka Antelomita Mandraka
120 Mw
Loss in Hydropower Generation 220.49M USD
Potential Cost of dredging 159.85M USD
Total cost 380.84M USD
Volobe Hydropower Plant Project
Volobe
120 Mw
360,000 Households
About 2M Habitants
Total Cost 371.72M USD


THANK YOU