Restoration Economic Valuation & Restoration Carbon ACCRUAL

Assessing the net economic benefits and carbon mitigation potential of Forest Landscape Restoration

Economic analysis can be a key step in restoration

It allows you to:

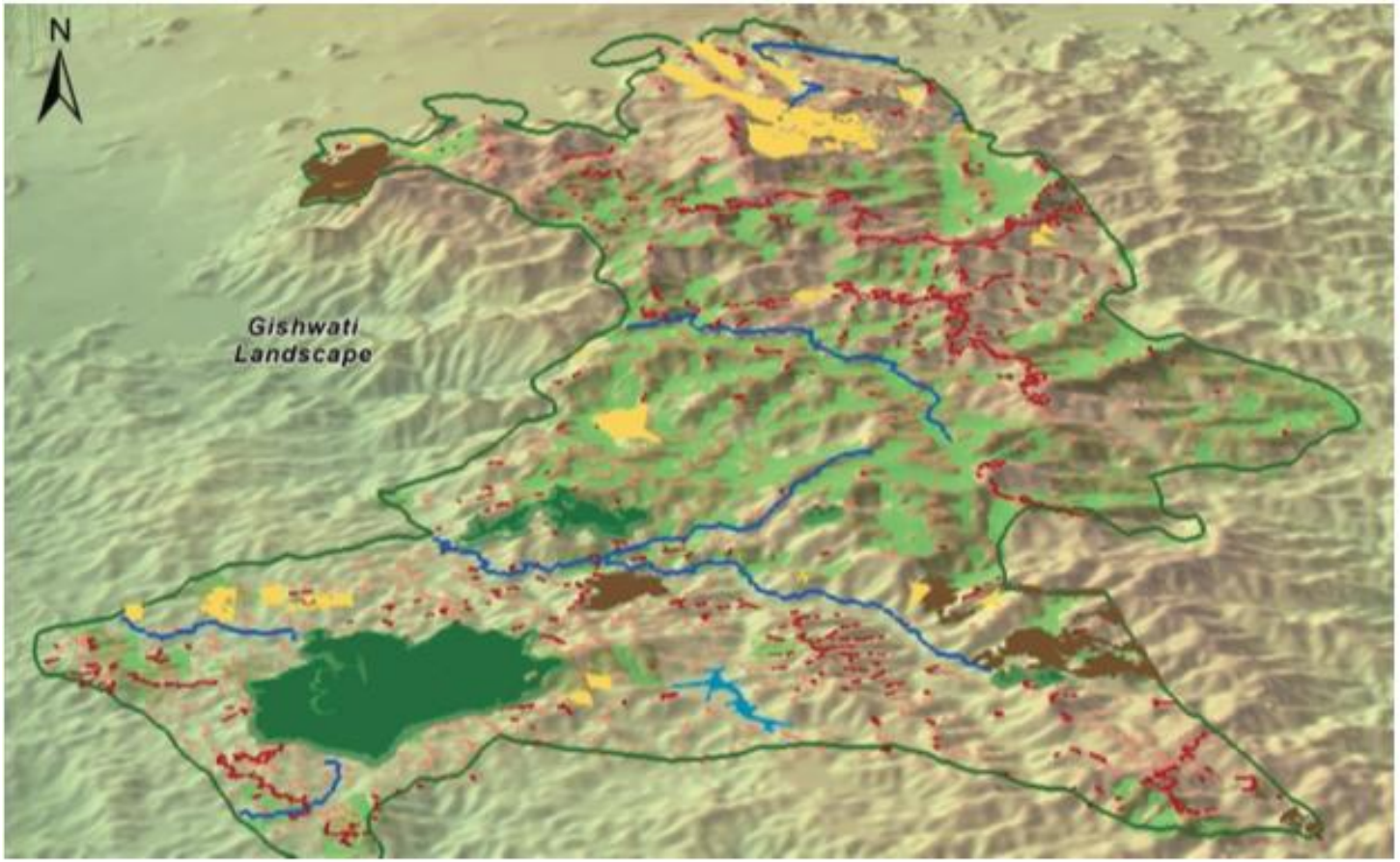
- Anticipate costs of interventions
- Understand net benefits – “what, when and to whom”
- Pick high priority / value landscapes – “where”

Restoration Economic Valuation

- This valuation tool lets you model the costs, revenue, and ecological benefits of restoration transitions (e.g., transition from agriculture to agroforestry land use)
  - Costs = annual budget needed for management activities and inputs;
  - Revenue = monetary value generated by the sale of fuelwood, timber, crops, carbon;
  - Also considered: the amount of erosion associated with each land use / other values (like water supply);
- Final models are based on data representing a range of ecological outcomes reflecting real-world variation (derived from repeated random in-country sampling).

What is the analysis process?

1. Conducting digital spatial analysis



- Deforested area in riparian corridors
- Existing natural forest
- Area for buffers around natural forest
- Degraded natural forest
- Deforested area surrounding wetlands
- Deforested area on steeply sloped ridges (>55%)
- Deforested area on moderately sloped ridges (20% < slope < 55%)
- Degraded agricultural land
- Silvopastoral areas
- Gishwati landscape

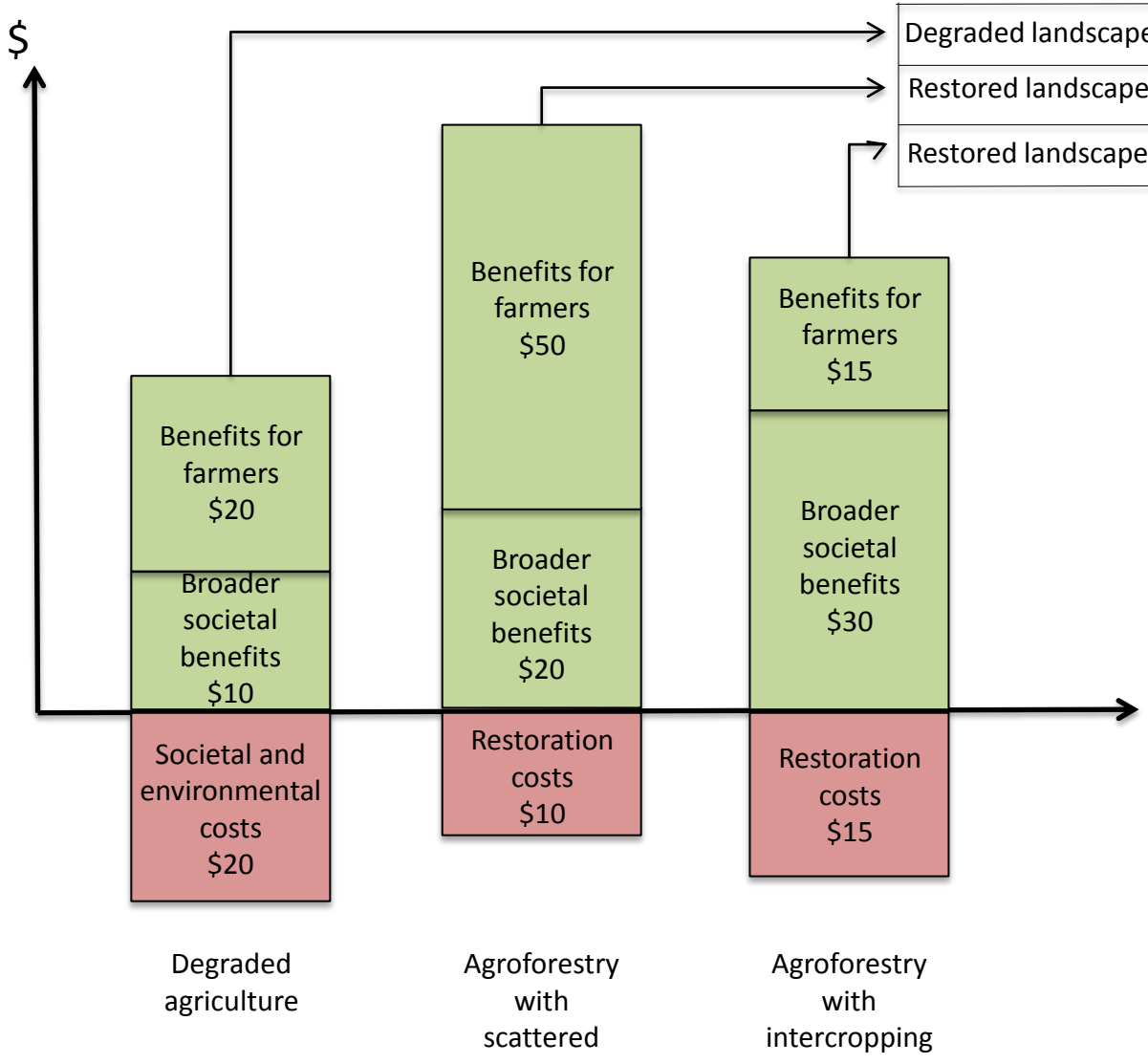
2. Considering Restoration Transitions

- We consider degraded land uses in the project area:
  - E.g., degraded agriculture, poorly managed woodlots and plantations, deforested land, etc.
- And identify transitions to restored landscapes. E.g.:

  - Degraded Agriculture into: Agroforestry
  - Poorly Managed woodlots and plantations into: Well Managed
  - Degraded forest into: Naturally regenerated secondary forest
  - Deforested land into: Protective forests (buffers and ridgetops)

3. Clarifying societal and individual costs and benefits of transitions

	Benefits - costs	Net benefit	Marginal benefit
Degraded landscape	$30 - $20	$10	-
Restored landscape I	$70 - $10	$60	$50
Restored landscape II	$45 - $15	$30	$20



This involves modeling of many values

- Ecosystems services such as:
  - Timber produced
  - Carbon sequestered
  - Erosion controlled
  - Crop yields improved or sustained
  - Other context dependent services, like water supply (varies by country)

- Revenues and costs estimated with market data and budgeting approach
- With repeated random sampling accounting for uncertainty

Modeling timber value

- Each land use is assigned a stocking density (trees per hectare) and management actions are defined:
  - Rotation interval
  - Thinning schedule
  - Seedling survival
- Stocking density is multiplied by growth predictions for each species to estimate above-ground biomass

Species	Mean annual increment (Cubic meters)				
	Single tree	300 trees per hectare	1100 trees per hectare	1600 trees per hectare	Source
Gevillea robusta	0.0048 (0.002)	1.44 (0.6)			Kalinganire, 1996
Eucalyptus tereticornis	0.0065 (0.001)		7.15 (1.1)	10.4 (1.6)	Belgian Development Agency , 2012
Pinus petula	0.003 (0.0005)			4.8 (0.8)	Africa Forest Forum, 2011

Notes: Standard errors are in parenthesis. Grevillea robusta was only considered in an agroforestry context with a density of 300 trees per hectare. Pinus petula was only considered for planting densities of 1600 trees per hectare.

Modeling carbon

- IPCC Tier 1 methodology is used to estimate carbon sequestration considering carbon stocks in:
  - Above ground biomass
  - Below ground biomass
- Carbon sequestration is calculated as follows:

$$\text{Above ground biomass}_i(ABG) = M3 * BCEF_{si} \quad [1]$$

Below-ground biomass (RBDM) $= e(-1.805 + 0.9256 * \ln(AGB_i))$ [2]

$$C(\text{tonnes}) = [AGB + RBDM] * 0.49 \quad [3]$$

Modeling erosion

We model erosion benefits by estimating reduced erosion

- Using the Universal Soil Loss Equation (USLE):
  - Erosion = R*K*LS*C

Land Use	Universal Soil Loss Equation Variable				Average annual erosion (t/ha)
	R	K	LS	C	
AG	332	0.12	1.5	0.3	17.928
AF	332	0.12	1.5	0.1	5.98
PME	431	0.15	1.5	0.15	14.55
IME	431	0.15	1.5	0.1	9.70
DF	428	0.16	1.5	0.1	10.27
NR	428	0.16	1.5	0.01	1.03
PF	428	0.16	1.5	0.01	1.03

Modeling crop yields

- We use data on baseline crop production

Crop yield regression data means		
Variable	**Maize**	**Beans**
Average yield (t/ha)	3.63 (8.22)	0.91 (0.22)
Land area (ha's)	2,669 (1681)	590 (175)
Precipitation (mm)	591 (175)	590 (175)
Observations	115	114
Notes: Standard errors in parenthesis.		

- And estimate the crop increase/decrease of agroforestry using estimates from literature and data from our partners (e.g. ICRAF).

Estimating costs

- Model the costs of management actions and inputs
- Costs can include planting, monitoring, thinning, seeds, fertilizer, etc…

Annual Legume budget for Rwanda

ITEMS	UNIT	QUANTITY	UNIT PRICE	MONETARY VALUE (Frw)
PRODUCTION				
-Legume	Kg	1,080	93	100440
(1)Gross revenue				100440
Monetary variable input costs				
Hired labor	M.D	22	300	6600
(2) Total M.V.I.C				6600
Non-monet. variable input costs				
Seeds	Kg	40	93	3720
Organic fertilizer	Kg	3,000	2	6000
Household labor	M.D	199	240	47760
Capital cost				660
(3) Total N.V.I.C				58140
Fixed costs				
Small agr. equipment	-			1317
(4) Total F.C				1317
(5)Total variable input cost (2+3)				64740
(6)Total costs (2 + 3 + 4)				66057
(7)Gross Margin[Monetary] (1- 2)				93840
(8)Total Gross Margin (1 – 5)				35700
(9)Net Margin (1– 6)				34383
Returns to family labor per day[(a)]				413
Remuneration rate (8/5 * 100)				55%

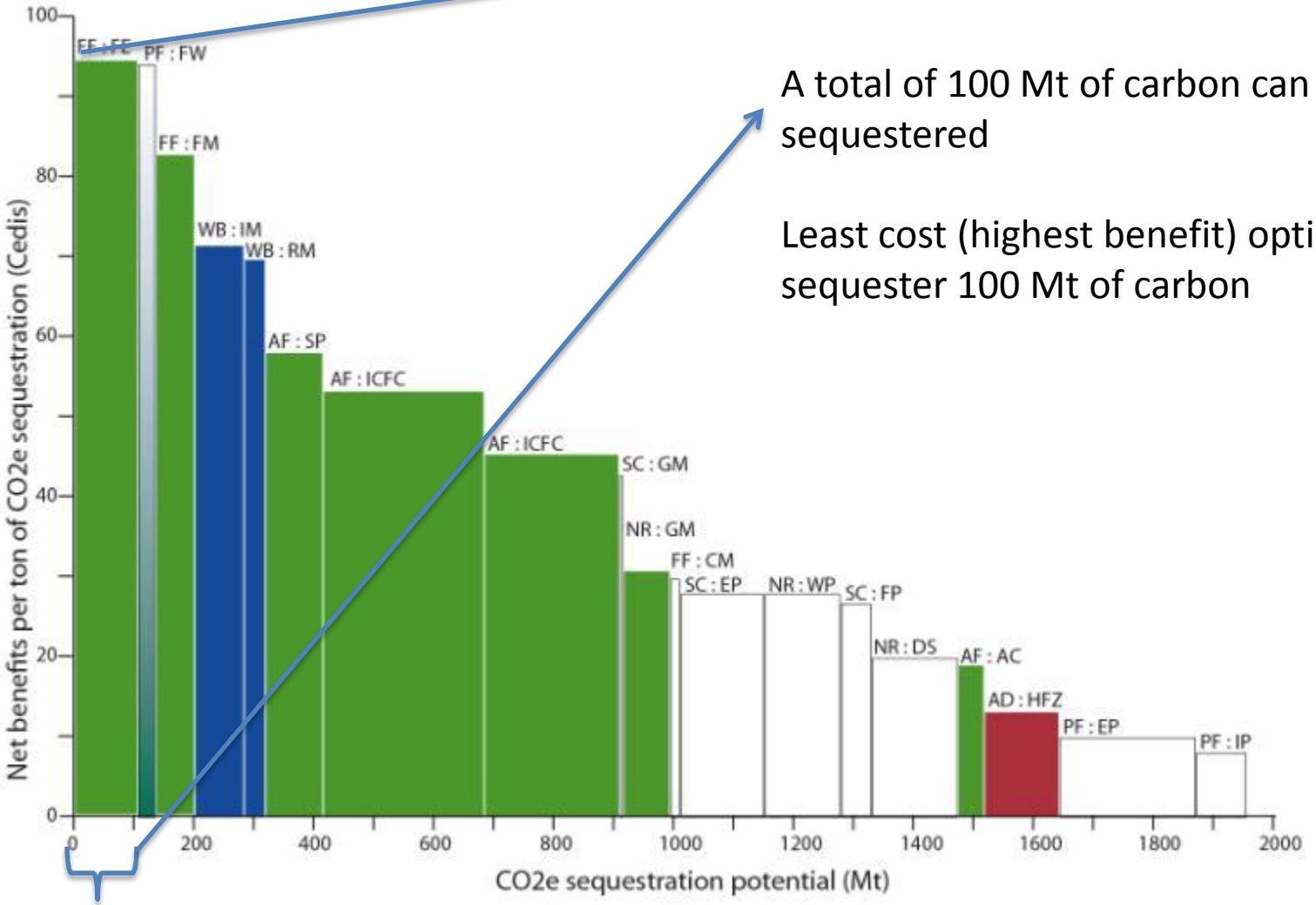
Outputs of the economic analysis and carbon assessment

Analysis of carbon abatement potential

Each ton of carbon sequestered generates 95 GHC of economic benefits

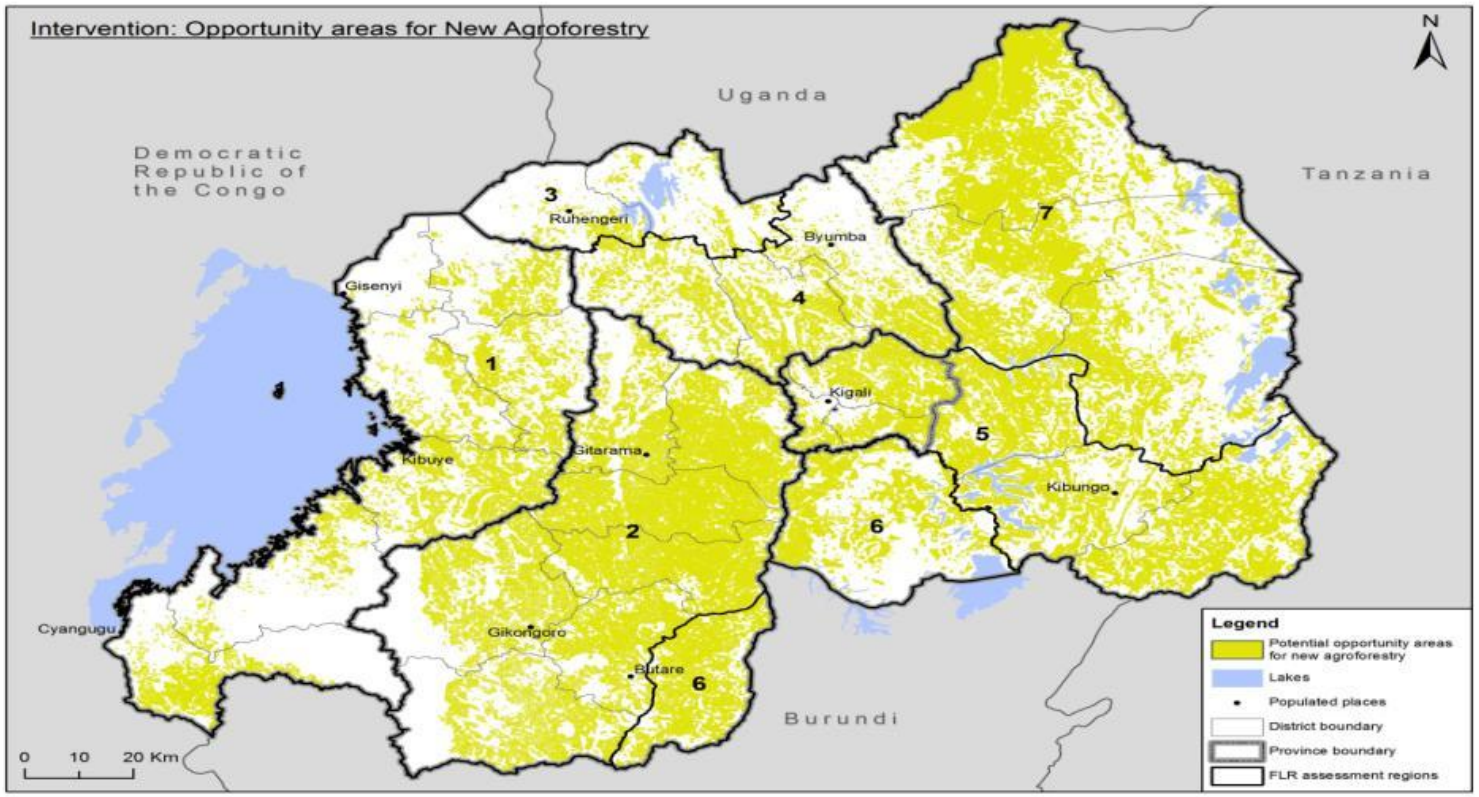
A total of 100 Mt of carbon can be sequestered

Least cost (highest benefit) option to sequester 100 Mt of carbon



A "Carbon Cost Abatement" curve of sequestration potential by land use intervention

Identification of benefits from different restoration interventions

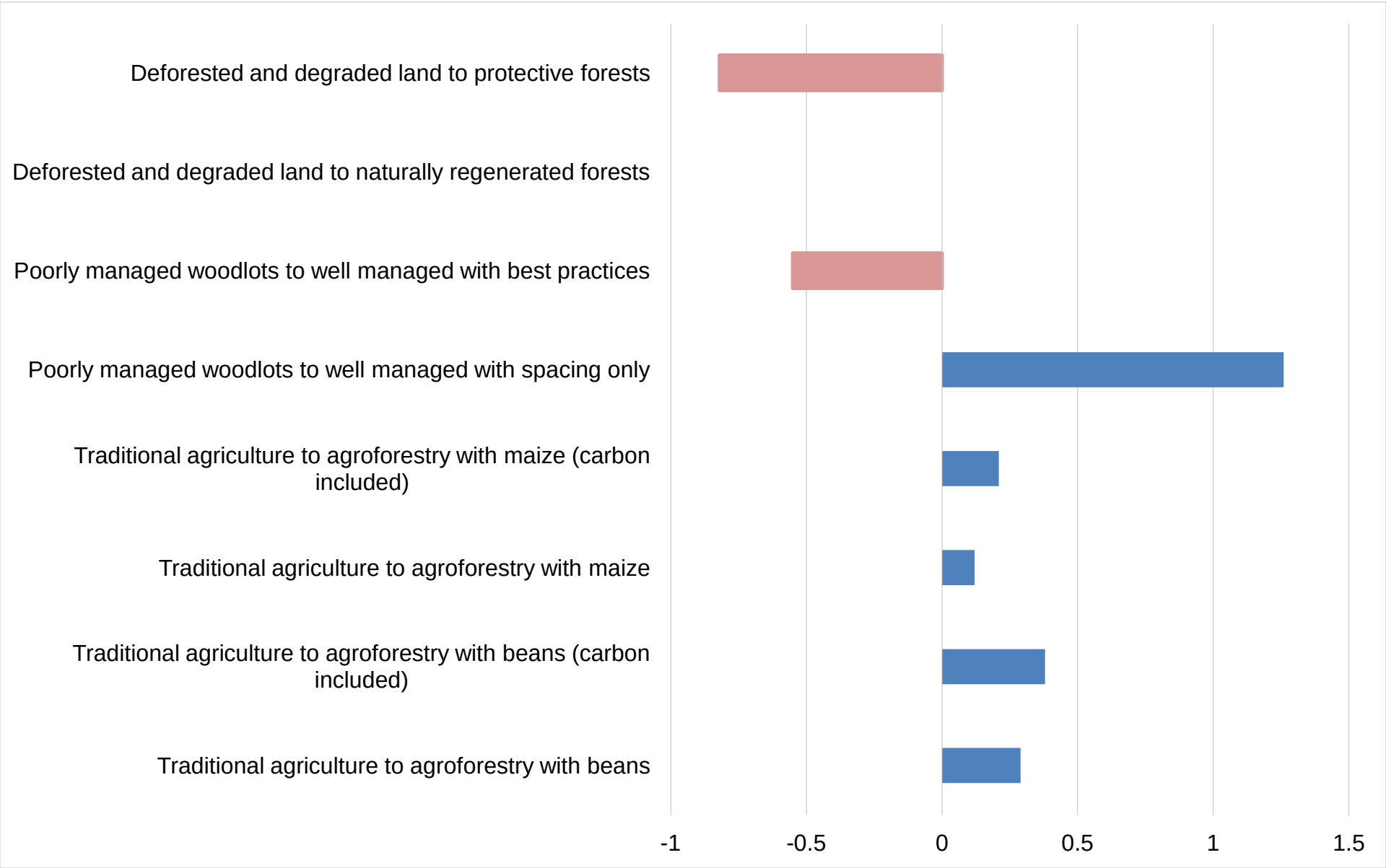


Benefits to society

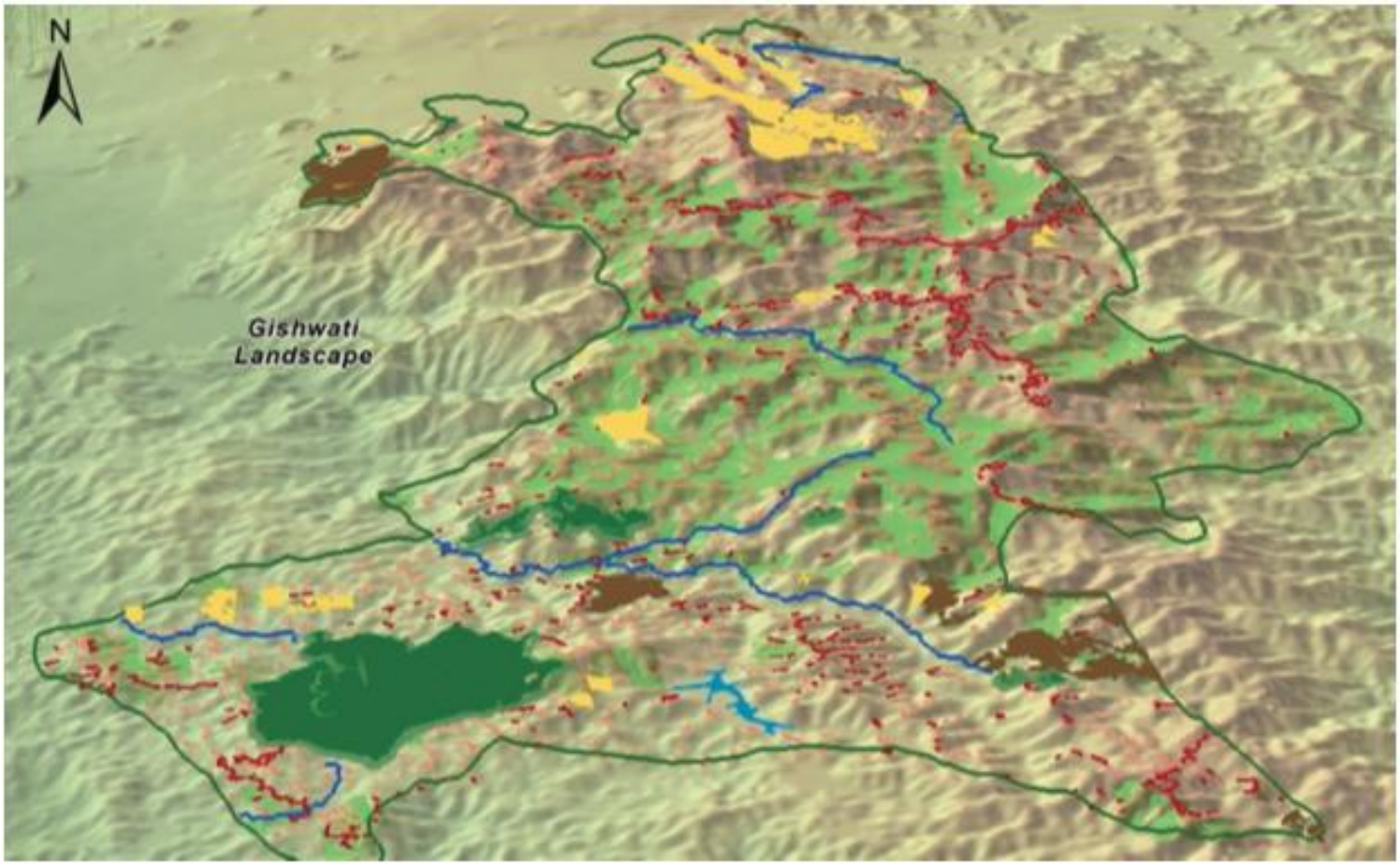
Benefits to farmers

Annual crop value (Rwf/ha)	Annual woody biomass value (Rwf/ha)	Annual reduced erosion (t/ha)	Additional carbon (t/ha)	Average Return on Investment
-99,000 to 189,000	75,665 to 132,980	22 to 27	251 to 449	28%

Calculation of Return On Investments



Derived maps of potential priority areas



20 m buffer of riparian areas

Existing closed natural forest

100 m buffer of existing closed natural forest

Existing degraded natural forest

50 m buffer of wetland areas

Ridge tops with very steep slopes (>55%)

Ridge tops with very steep slopes (20% - 55%)

Agroforestry opportunityareas

Silvopasture opportunity areas

Gishwati landscape

Contact Us To Learn More

We are producing Digital Restoration Economic Valuation tools to allow anyone to use the economic valuation framework for forest landscape restoration quickly and easily.

For updates on the software, or to learn more about the economic framework:

Contact us at
flr@iucn.org

THE GLOBAL PARTNERSHIP ON FOREST LANDSCAPE RESTORATION

WORLD RESOURCES INSTITUTE