Valuation of biodiversity and ecosystem services

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Subregional workshop for Eastern Europe and Central Asia on Valuation and Incentive measures

Tbilisi, Georgia, 29-31 May, 2012

Secretariat of the Convention on Biological Diversity

CBD Technical Series No. 28

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AN EXPLORATION OF TOOLS AND METHODOLOGIES FOR VALUATION OF BIODIVERSITY AND BIODIVERSITY RESOURCES AND FUNCTIONS

Options for the Application of

TOOLS FOR VALUATION OF BIODIVERSITY

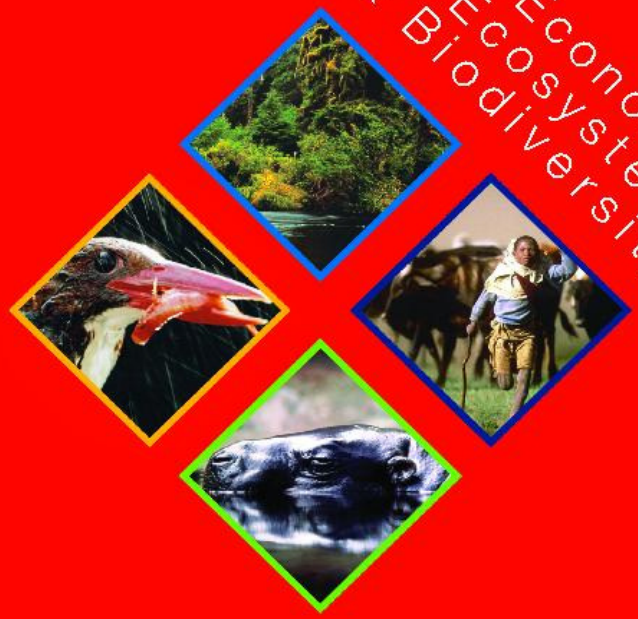
and Biodiversity Resources and Functions

Biodiversity and its resources and functions generate substantial ecosystem services many of which are not traded on markets and whose value is therefore not reflected in market prices. Consequently, private and public decision-making and the allocation of funds will be distorted if the repercussions of activities on biodiversity resources and functions, and the associated ecosystem services, are not adequately taken into account. This distortion is an important underlying cause of biodiversity decline. Undertaking valuation of biodiversity resources and functions and the associated non-marketed ecosystem services has the potential of improving private and public decision-making, thereby contributing to the target of the Convention to significantly reduce by 2010 the current rate of biodiversity loss.

TOTAL ECONOMIC VALUE (TEV) Most public and private resource management and investment decisions are strongly influenced by considerations of the monetary costs and benefits of alternative policy choices. Undertaking valuation should seek to address the relevant components of the Total Economic Value of non-marketed ecosystem services, bearing in mind that the concept of Total Economic Value includes both the direct and indirect use value as well as non-use value of ecosystem services and hence goes beyond the immediate benefits of commercial exploitations of biodiversity resources. Decisions can be improved if they are informed by the economic value of alternative management options and involve mechanisms that bring to bear non-economic considerations as well.

The options of valuation tools provided in the accompanying table should not be taken as a closed set of tools, considering the evolutionary character of this field.

The Economics of Ecosystems & Biodiversity



TEEB FOR LOCAL AND REGIONAL POLICY MAKERS

Aichi target 2 of the Strategic Plan

People value biodiversity in many ways…

"…the intrinsic value, ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic values of biological diversity and its components;" (decision X/3, paragraph 9 (b) (ii))

Need to mainstream biodiversity values

"By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems."

Aichi target 2 of the Strategic Plan

Different types of biodiversity values…

"…the intrinsic value, ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic values of biological diversity and its components;" (decision X/3, paragraph 9 (b) (ii))

Need to mainstream biodiversity values

"By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems."

→ integrate economic values into decision-making

Limits to (economic) valuation…

Economic valuation places biodiversity values 'on an equal footing' with other economic benefits and costs, BUT:

Some values cannot be measured…

(e.g., intrinsic, religious values)

…but need to be **recognized** nevertheless.

Others can be measured but are difficult to monetize…

…their values need to be **demonstrated** (by other tools).

Still others can be measured and monetized…

…their value can be **captured** by applying economic valuation tools

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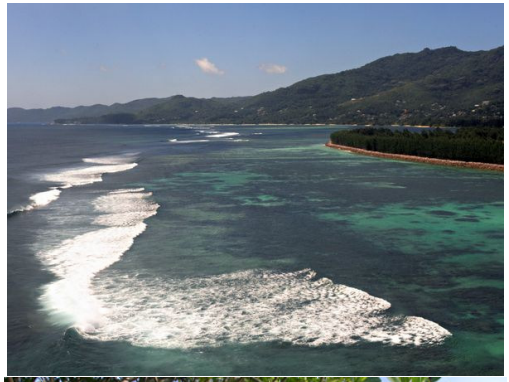
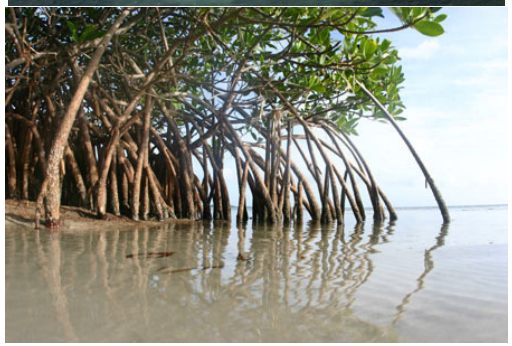
What is this?





A water purification plant

A flood control mechanism

A paradise for flyfishing

Food

Beauty

A place of worship

Leisure

A pollinator

A cure

A way of life

One ecosystem

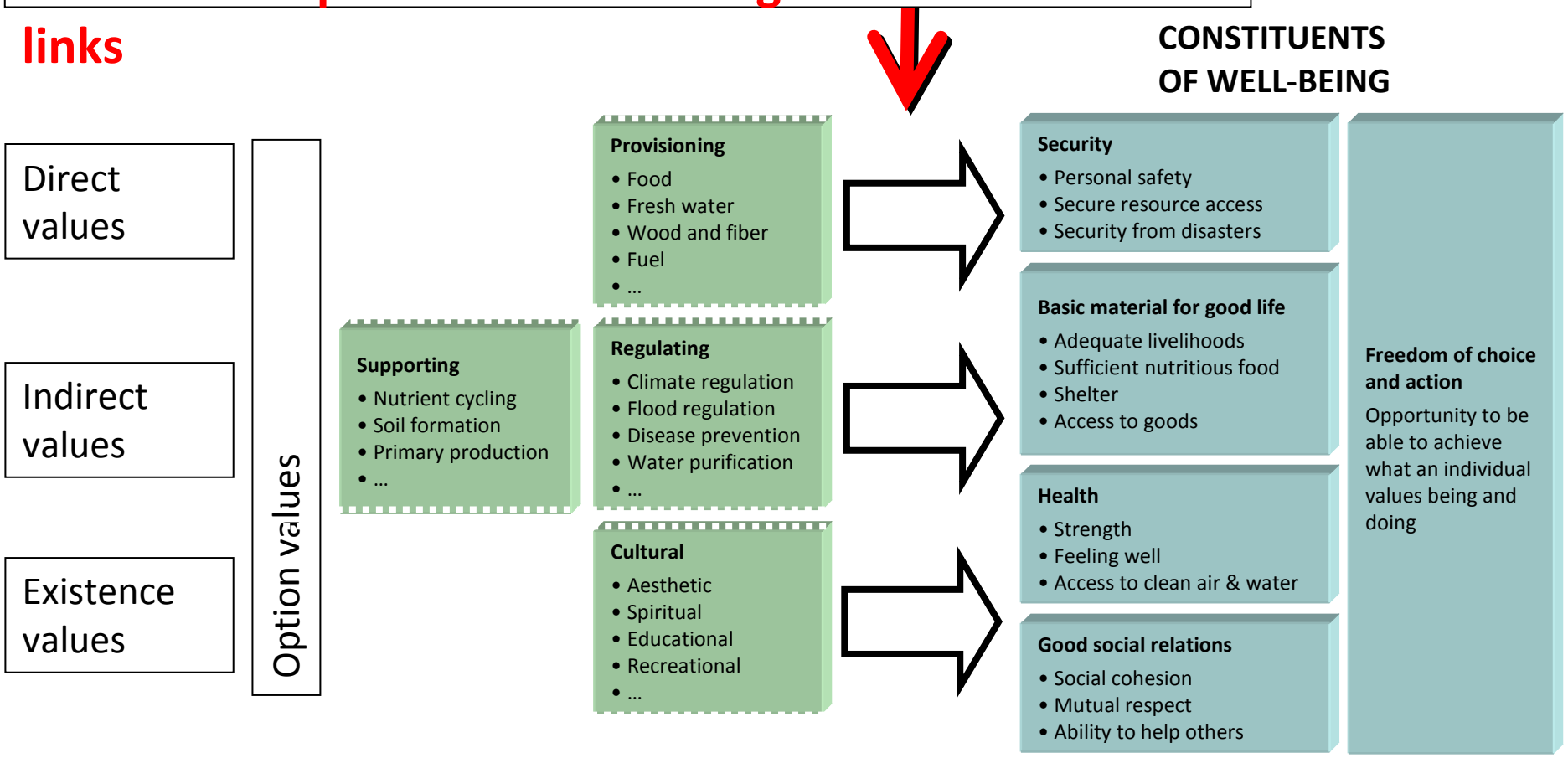
→many <u>different</u> services

and benefits

→require different approaches/tools to valuation

Valuing ecosystems

Valuation: expresses economic significance of the links



Source: Millennium Ecosystem Assessment 2005

Why undertake economic valuation?

Some ecosystem services are traded and valued in markets…

e.g. many (but not all) provisioning services

…but many ecosystem services are not:

Public goods: nobody can be excluded from their use, non-rival

➔Weak price signals/ incentives for individual conservation/ sustainable use efforts

Economic valuation provides missing information about ecosystem services so that we can measure benefits to people and manage them better

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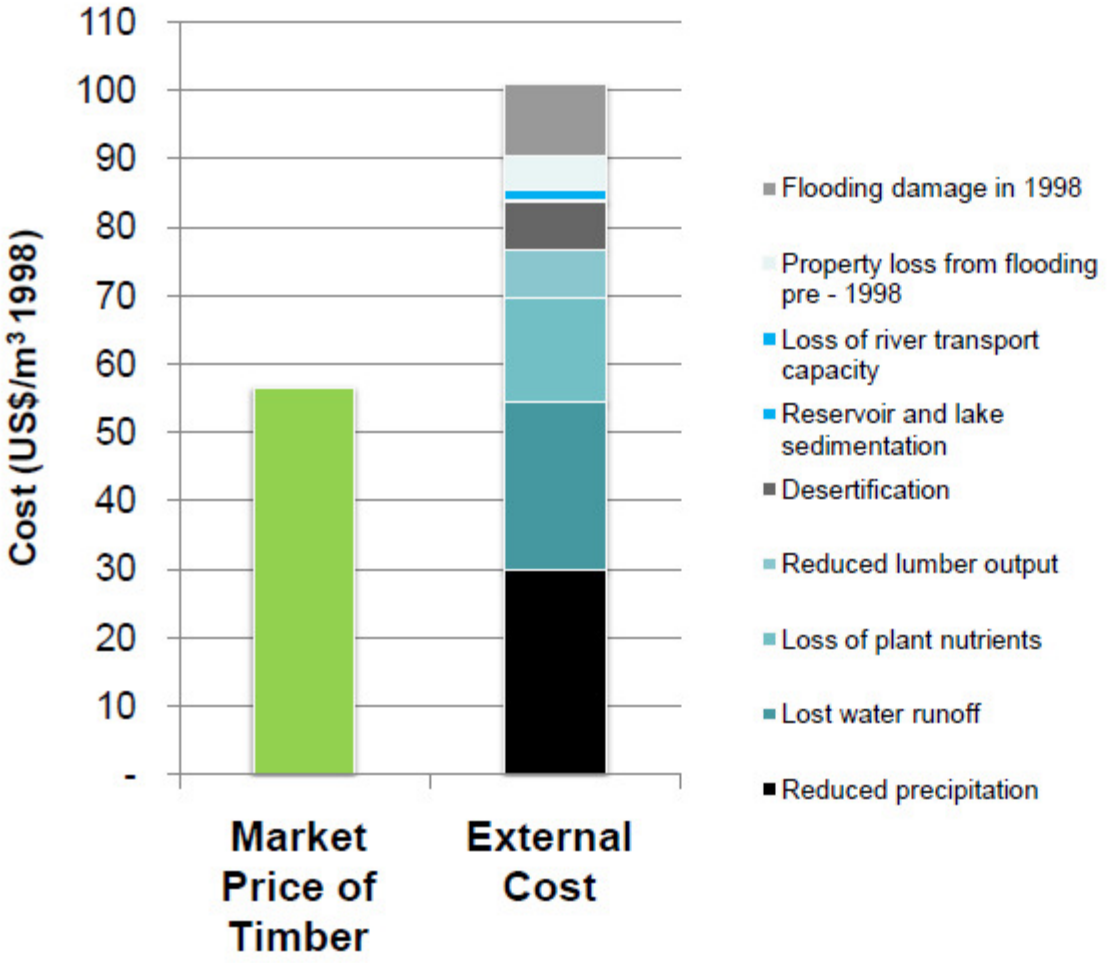
Business impacts at sector & country-level



- US$12.2 billion estimated ecological cost of deforestation in China (1950-88)
- 60% of this cost is attributed to logging
- 64% of logging was for construction and materials sectors
- External costs = 178% of the market price of timber (1998)

Source: TEEB for Business, 2010 (Annex 2.1).

Valuing biodiversity, ecosystems, or ecosystem services?

Valuing ecosystem services is easier than valuing biodiversity

- Role of biodiversity in ecosystem functions, and role of ecosystem functions in providing ecosystem services

Valuing individual ecosystem services is easier than valuing whole ecosystems

- Stock versus flows
- Being comprehensive while avoiding double-counting
- Net present value and the role of discount rates

Valuation is situation specific

- You must know what you want to do with the information in order to decide whether and how to use valuation....

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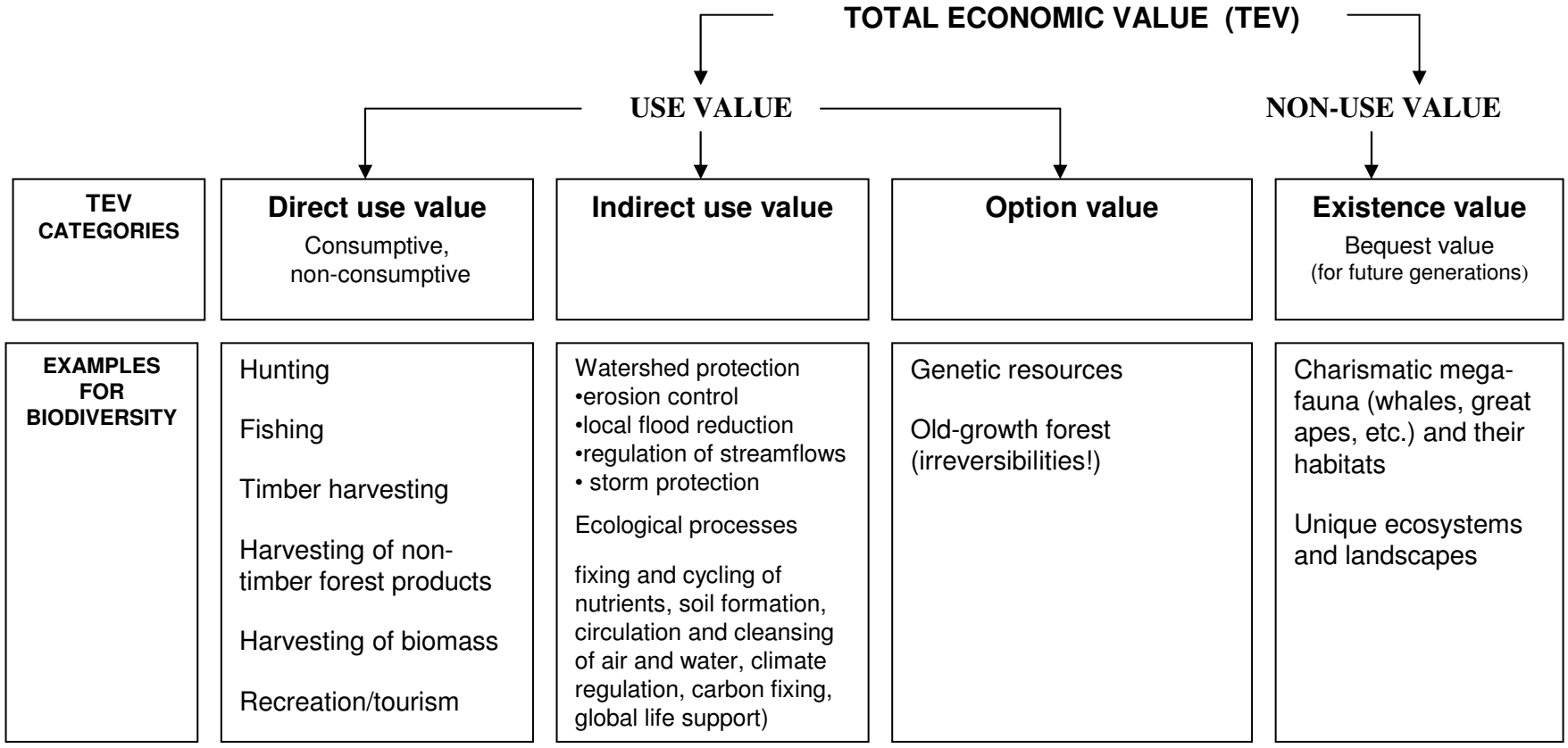
Applications

1. To determine the value of the total flow of benefits from ecosystems
   - Used in nationals account context and to estimate role of ESS in economy
2. To determine the net benefits of interventions that alter ecosystem conditions
   - Focuses on changes in flows of costs and benefits (not sum total value)
   - Applies in project and policy context for specific investments, incentives and asks whether they are worth the expenditure
3. Identify the distribution of costs of benefits from ecosystems
   - Impact on stakeholders important to know to avoid resistance and equity issues
4. To identify potential financing sources for conservation
   - Knowing the value of ecosystems is not enough in itself – it has to lead to real investments
   - Identify who benefits from conservation and how much – helps to design mechanisms to capture benefits

Total Economic Value (TEV)



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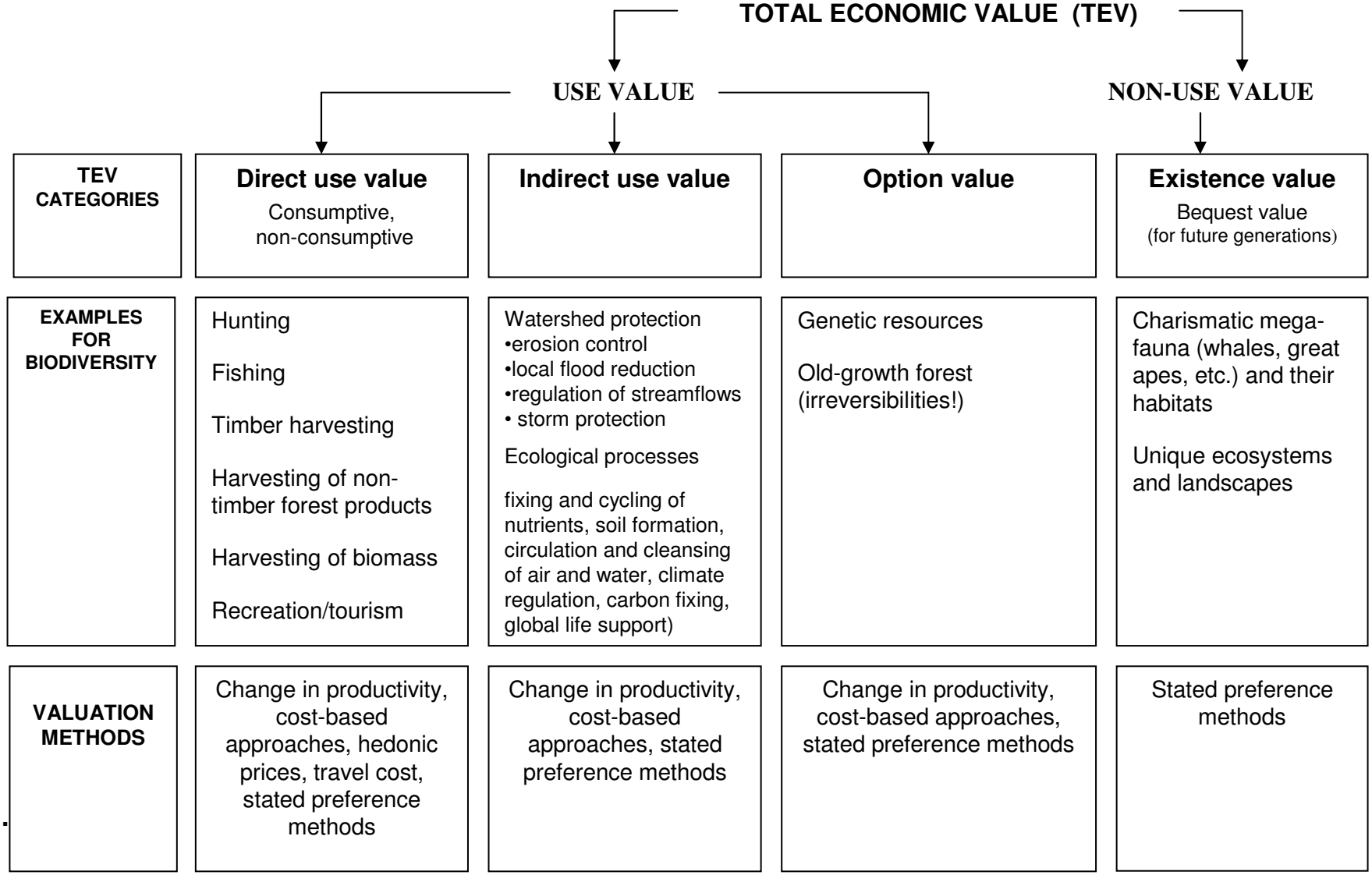
Total Economic Value (TEV)



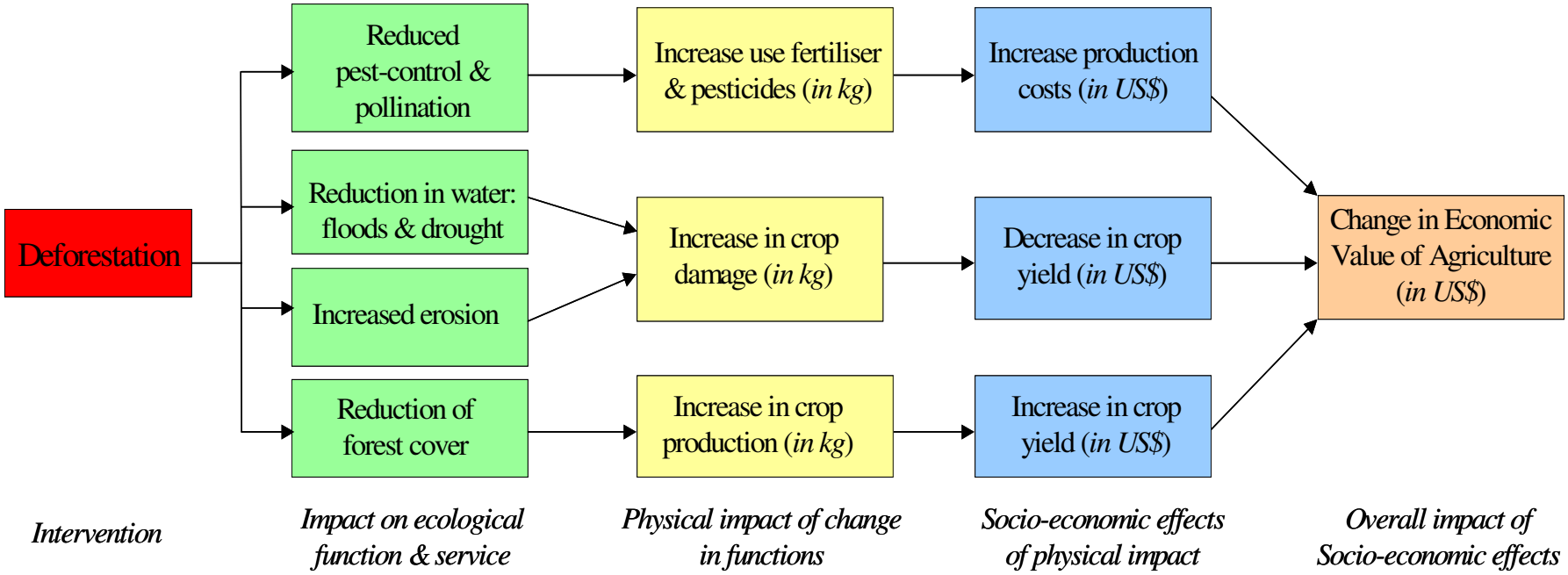
TEV CATEGORIES	Direct use value Consumptive, non-consumptive	Indirect use value	Option value	Existence value Bequest value (for future generations)
EXAMPLES FOR BIODIVERSITY	Hunting Fishing Timber harvesting Harvesting of non-timber forest products Harvesting of biomass Recreation/tourism	Watershed protection •erosion control •local flood reduction •regulation of streamflows • storm protection Ecological processes fixing and cycling of nutrients, soil formation, circulation and cleansing of air and water, climate regulation, carbon fixing, global life support)	Genetic resources Old-growth forest (irreversibilities!)	Charismatic mega-fauna (whales, great apes, etc.) and their habitats Unique ecosystems and landscapes
VALUATION METHODS	Change in productivity, cost-based approaches, hedonic prices, travel cost, stated preference methods	Change in productivity, cost-based approaches, stated preference methods	Change in productivity, cost-based approaches, stated preference methods	Stated preference methods

Tools – Direct market valuation approaches

1. Market price based approaches
   - when market information is available, provisioning services
2. Cost based approaches
   - Look at costs of replacing or restoring services provided by ES
   - E.g. costs of building water filtration plant if water quality standards fall due to wetland degradation
   - Estimates are minimum estimates and do not reflect value
3. Production function approaches
   - Widely applied, based on scientific knowledge of rship between ESS and a marketed output, e.g. pollination and fruit production
   - ESS are inputs into production function of a marketed good
   - Step 1 – identify physical effects of change in ESS on good
   - Step 2 – impact of change valued using quantity and price of marketed good

Used for regulating services

Valuing change in economic output
(dose-response functions)



Tools – revealed preference methods

- when price information is not available, individuals reveal their willingness-to-pay in actual behavior in "surrogate" markets

1. Travel cost methods
   - Uses individuals expenditures (transport cost and time) to reach a site to estimate WTP for site
   - Usually survey based to collect large amounts of data
   - Used to value national parks, PAs, beaches, useful to set user fees
   - E.g. viewing value of elephants in Africa, PAs in Europe

2. Hedonic methods
   - Uses market prices to estimate value of environmental attributes which is embedded in the price of a marketed good
   - look at differential prices of houses with bundles of characteristics
   - can estimate the value of proximity to green or forest areas, air quality

Tools – stated preference methods

- When no markets exist with information about people's preferences for ES goods and services

1. Contingent valuation method (CVM)
   - Survey based to directly ask people their WTP (or WTAC) for a change in ecosystem service
   - Can be used to estimate value of any type of ESS (incl. non-use)
   - Costly and time intensive, requires survey pre-testing and much time spent for respondent's to understand changes
   - Results affected by survey method, payment vehicle, hypothetical nature of questions
   - E.g. Exxon Valdes oil spill, what is a possum worth?
2. Choice modeling
   - Similar to CVM, but people are asked to choose between sets of environmental goods and services with different prices
   - Focuses on trade-offs among scenarios
   - E.g. improved water quality in a lake will affect a number of service – can rank importance of drinking water, fishing, swimming, BD

Example: Mangrove forests in Thailand

- Policy question: mangrove conservation or conversion to shrimp farms?
- Study covers direct and indirect use value of mangrove forests
  - Direct use values: fish/seafood, honey, timber (boat repairs)
  - Indirect use values: fish breeding ground (for offshore fisheries); coastal protection; [carbon storage – not considered in trade-off analysis]
- Change-in-productivity approach; replacement cost

Source: Sathratai and Barbier 2001 and updates, TEEB

Example: Mangrove forests in Thailand

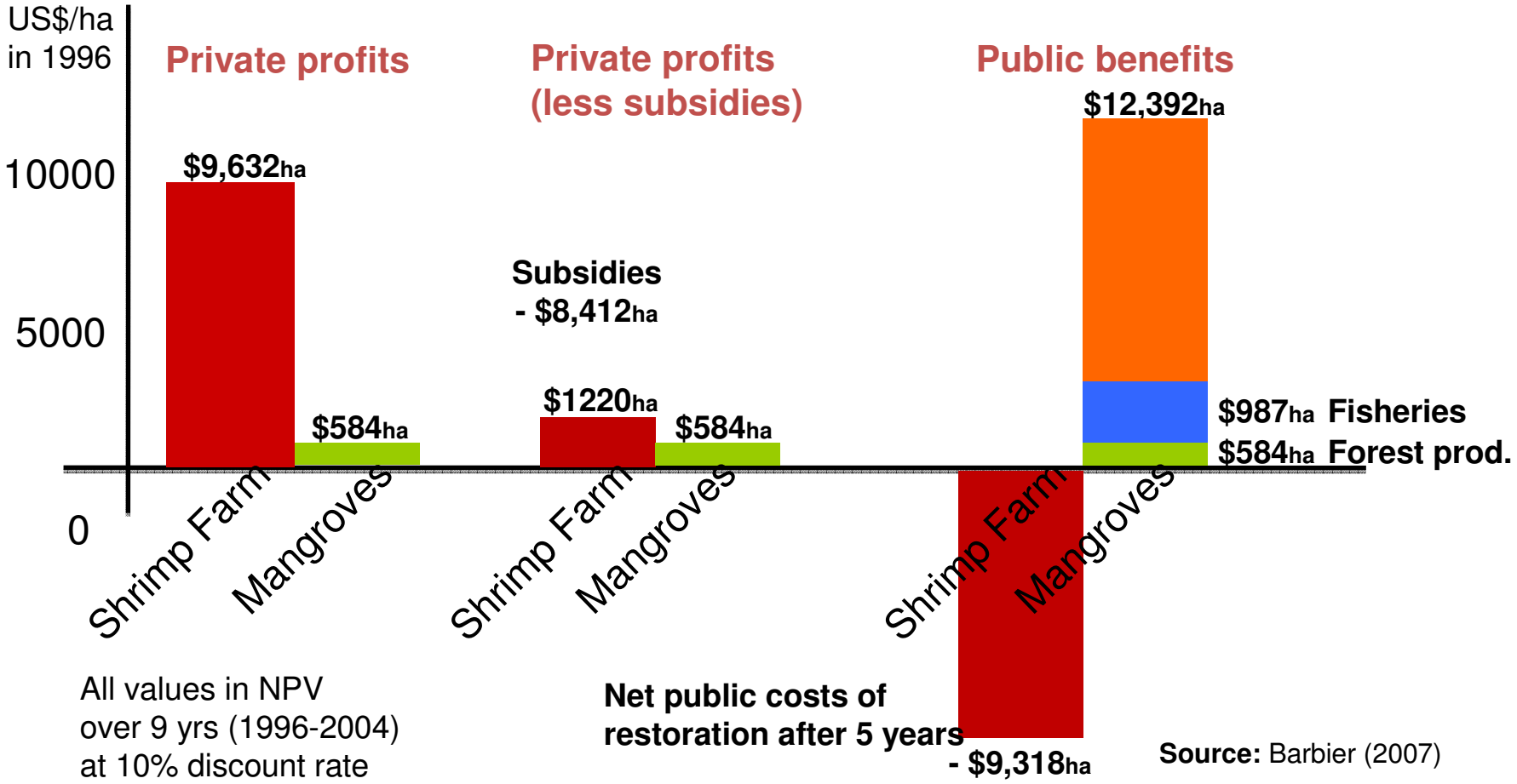
NET PRESENT VALUE OF MANGROVE FOREST BENEFITS*	
BENEFIT	**Value (US$) per ha**
DIRECT USE VALUE:	
Net income from timber and non-timber products	87.84
INDIRECT USE VALUE:	
Offshore fishery linkages	20.82–68.90
Coastline protection	3,678.96
TOTAL DIRECT AND INDIRECT USE VALUE	3,787.62–3,835.70
DIRECT USE VALUE ONLY:	
Net present value (10% discount rate)	822.59
Net present value (12% discount rate)	734.83
Net present value (15% discount rate)	632.27
DIRECT AND INDIRECT USE VALUES:	
Net present value (10% discount rate)	35,470.72–35,920.98
Net present value (12% discount rate)	31,686.34–32,088.57
Net present value (15% discount rate)	27,264.13–27,610.22

* All net present value calculations are based on a 20-year time line.

Source: CBD TS 28, p.46, Sathratai and Barbier 2001

Example: Mangrove forests in Thailand

Shrimp farms vs mangroves



All values in NPV
over 9 yrs (1996-2004)
at 10% discount rate

Net public costs of restoration after 5 years

Source: Barbier (2007)

Example – Contingent Valuation in US

- tanker ran into reef off coast of Alaska producing worst oil spill in US history killing hundreds and thousands of sea birds and other wildlife
- First case of compensation sought for existence values
- Survey took 18 months to prepare, interviews took 40 min to ensure understanding of damages caused, 1600 US households
- Survey asked WTP for programme of escort ships to guide tankers through PW Sound to avoid further incidents
- Statistical techniques calculated aggregate WTP as USD 2.8 billion
- Case was settled out of court for USD 1 billion, Exxon spent another USD 2 billion on clean up activities

Valuing pollination services in Costa Rica

- Production functions approach
- Wild forest-based pollinators increased coffee yields by 20% on farms located within 1 km of forest in Costa Rica
- Improved quality by reducing “peaberries” (misshapen seeds) by 27%
- In 2002-03, pollination services from two forest fragments (46 and 111 ha) were estimated to be worth US$60,000 per year for one study farm
- **How to turn this value into cash flow for conservation?**

Source: Ricketts, T.H., Daily, G.C., Ehrlich, P.R. and Michener, C.D. 2004. ‘Economic value of tropical forest to coffee production,’ *Proc. Natl. Acad. Sci.* USA, 10.1073/ pnas. 0405147101.

Valuation and financing to save elephants in Sri Lanka

- elephants consume 150kg of food every day: crop raiding is a big problem in densely inhabited areas and causes injuries
- a survey of impacts on 480 local households and their willingness to accept compensation
- a second survey among Colombo city residents: willingness to pay for the conservation of elephants exceeds the funding needed for compensating rural elephant damage
- Ceylinco Insurance presented a new scheme, partly CSR and partly profit driven: proposed small charge on top og premium payments of life/ vehicle policy holders to finance a trust for compensations payments

Source: H. Gundimeda TEEB D0

Valuation of tropical forests

- Assess value of a natural asset based on flow of ecosystem services – changes in BES
- Establishing the environmental baseline
  - BAU is continued deforestation at 1% => loss of BES
  - 88% of conversion is primary forest
- Cost-benefit framework
  - Compare scenario of continued deforestation with conservation
- Desk study – reviewed literature and borrowed value estimates from contingent valuation and production function methods studies (bio-physical and ES changes) and market prices
- Monetise expected changes to BES….

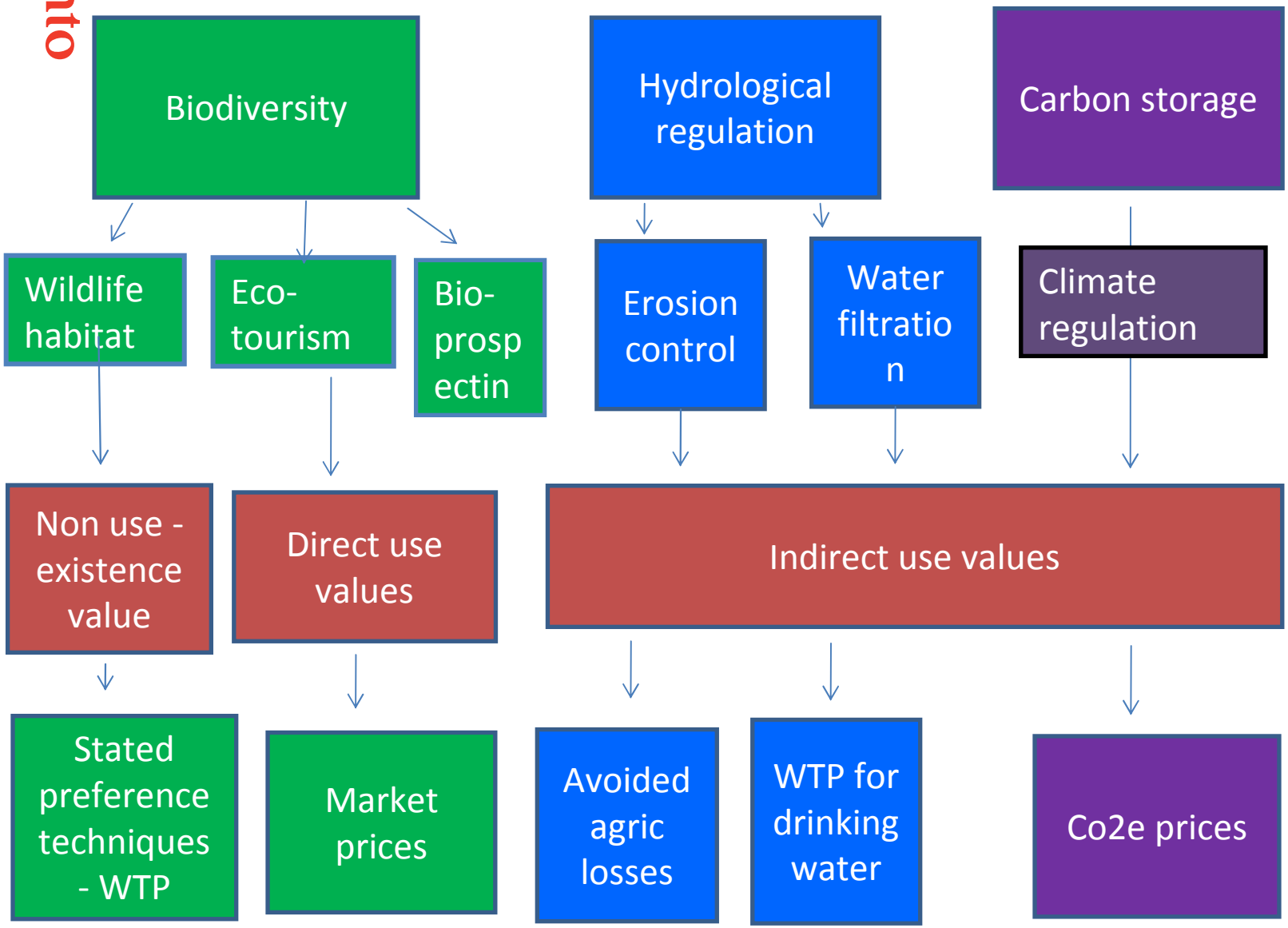
Estimating costs of conservation

Costs of conserving TGK (per hectare)

- Establishment and management costs of TGK as PA
  - Costs of managing network of PAs in Madagascar
  - Estimated at USD2.7/ha/year
- Opportunity cost of giving up swidden agriculture
  - Net income per hectare per year or NPV that is sacrificed as a result of not converting land to alternative uses (weighted avg)
  - 90% due to shifting agriculture (USD 88/ha/yr)
    - Based on annual net revenue on forest land under tavy expressed in paddy
  - 5% due to unsustainable harvest of NTFPs (USD 17/ha/yr)
    - Based on revenue from collection of fruit, animals, medicinal plants from hh survey
  - 5% due to illegal logging (USD 153/ha/yr)
    - Based on USAID estimates of revenue from sustainable logging, adjusted to reflect higher revenue of unsustainable

Rio Tinto

Estimating the benefits of forest ecosystem services



Estimating the value biodiversity

Wildlife habitat

- Contingent valuation studies estimate the existence value of populations for conservation
- Household WTP estimated using survey (USD21-31/hh)
- Transform into per hectare estimate (USD4/ha/yr)
- Aggregated over larger population (hhs in OECD)

Eco-tourism

- Little access and facilities
- Benefits up to USD4/ha/yr based on visitation rates and expenditure (USD 40/day for 7 days)
- 10% growth in visits per year
- Local versus national benefits

Bio-prospecting

- Value of genetic material
- Wide range of values based on WTP of users and on value in production of products

Estimating the value of hydrological regulation

Avoided erosion

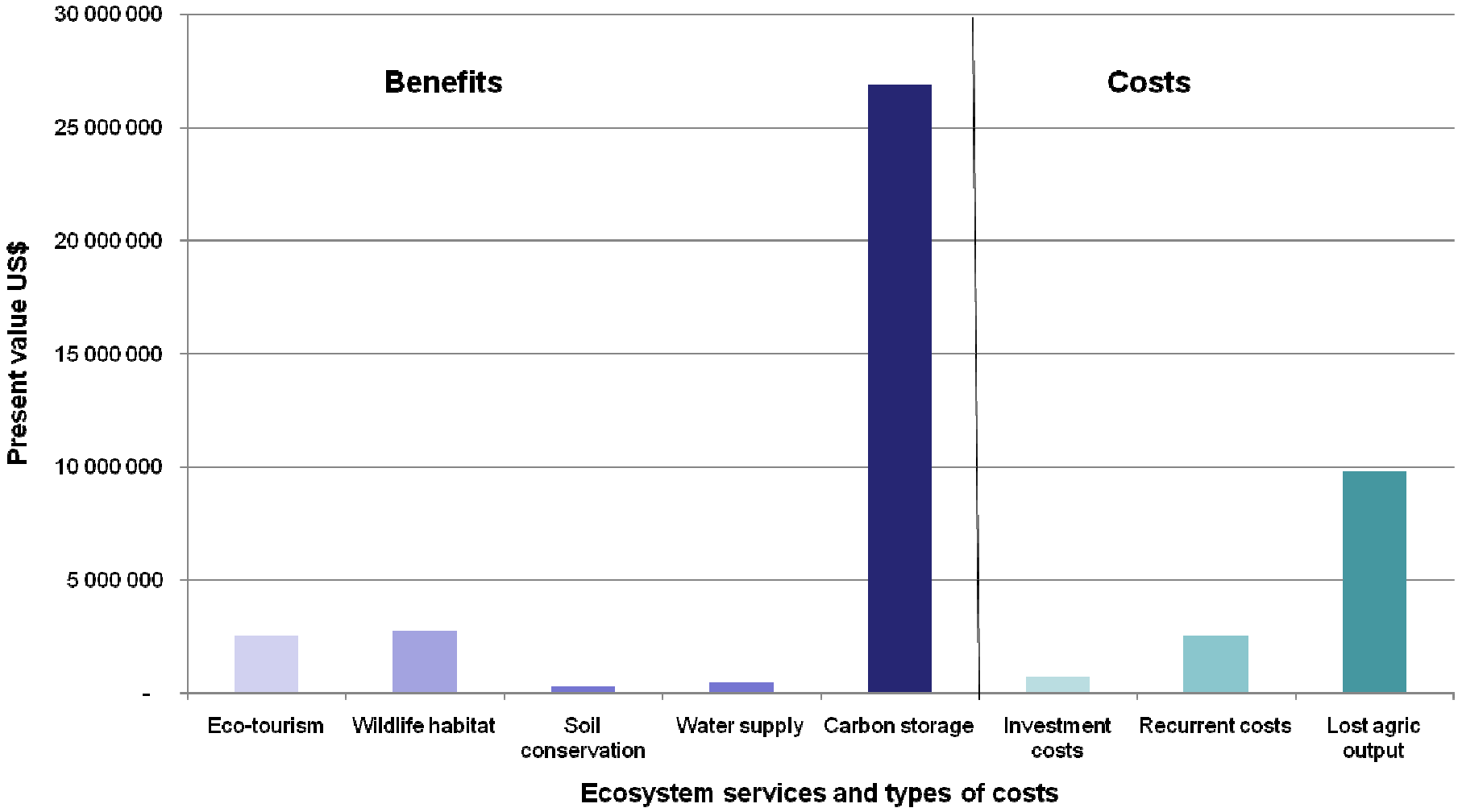
- Forests reduce erosion and siltation of land and irrigation infrastructure in downstream paddy production
- Production function estimate of value of lost rice production (USD44/ha/yr)
- Applied to area of rice paddy field to be affected by deforestn
- 1% rate of deforestation will reduce rice yields by 1% each year

Water supply

- ½ of PAs in Madagascar provide hydrological services to 17 towns
- Survey of hhs in Fianarantsoa estimated additional WTP for clear water (USD 0.30/m^3)
- Per m^3 estimate converted to USD1.7/ha/year based on area of watersheds in Madagascar and volume of provision of water

				Unit	Value
(a)Carbon content primary forest				Ton C/ha	286
(b)Carbon content of land converted to *tavy*				Ton C/ha	79
(c)Net loss of carbon from conversion=a-b				Ton C/ha	204
(d)Conversion factor carbon to CO_2e					3.67
(e)Net loss of CO2e from def =c*d					749
(f) Price of carbon	Market prices	Avg. price for REDD credits 2008		US$/tCO2e	6.3
		ETS 2008	low	US$/tCO2e	16
			high		32
	Social cost of carbon	low		US$/tCO2e	4.1
		high			12.7
(g) Value of avoided CO2e emissions per hectare		**Low estimate of social cost (US$4.1/tCO2e)**		US$/ha	**3,070**
		Avg. market price for REDD credits (US$6.3/tCO2e)		US$/ha	4,719
		Average ETS 2008 price (US$24/tCO2e)		US$/ha	17,976
(h) Annual value of avoided CO2e emissions for TGK at 1% deforestation rate (loss of 569ha/yr**) and carbon at US$4.1/tCO2e =g*569ha				US$/TGK	1.75 million

Costs and benefits of conservation



Tools - General assessment

- Valuation tools can generally provide useful and reliable information when applied carefully and according to best practice
- Choice of tools is situation-dependent
  - Ecosystem good or service to be valued
  - Cost vs accuracy
  - Total vs relative; accounting vs policy; awareness vs investment decisions
- Economic valuation requires technical expertise
- Economic valuation can provide information needed to make better decisions
  - Needs to be put into context and to be part of a broader deliberative and participatory process in order to be useful