Biophysical Assessment of Ecosystem Services

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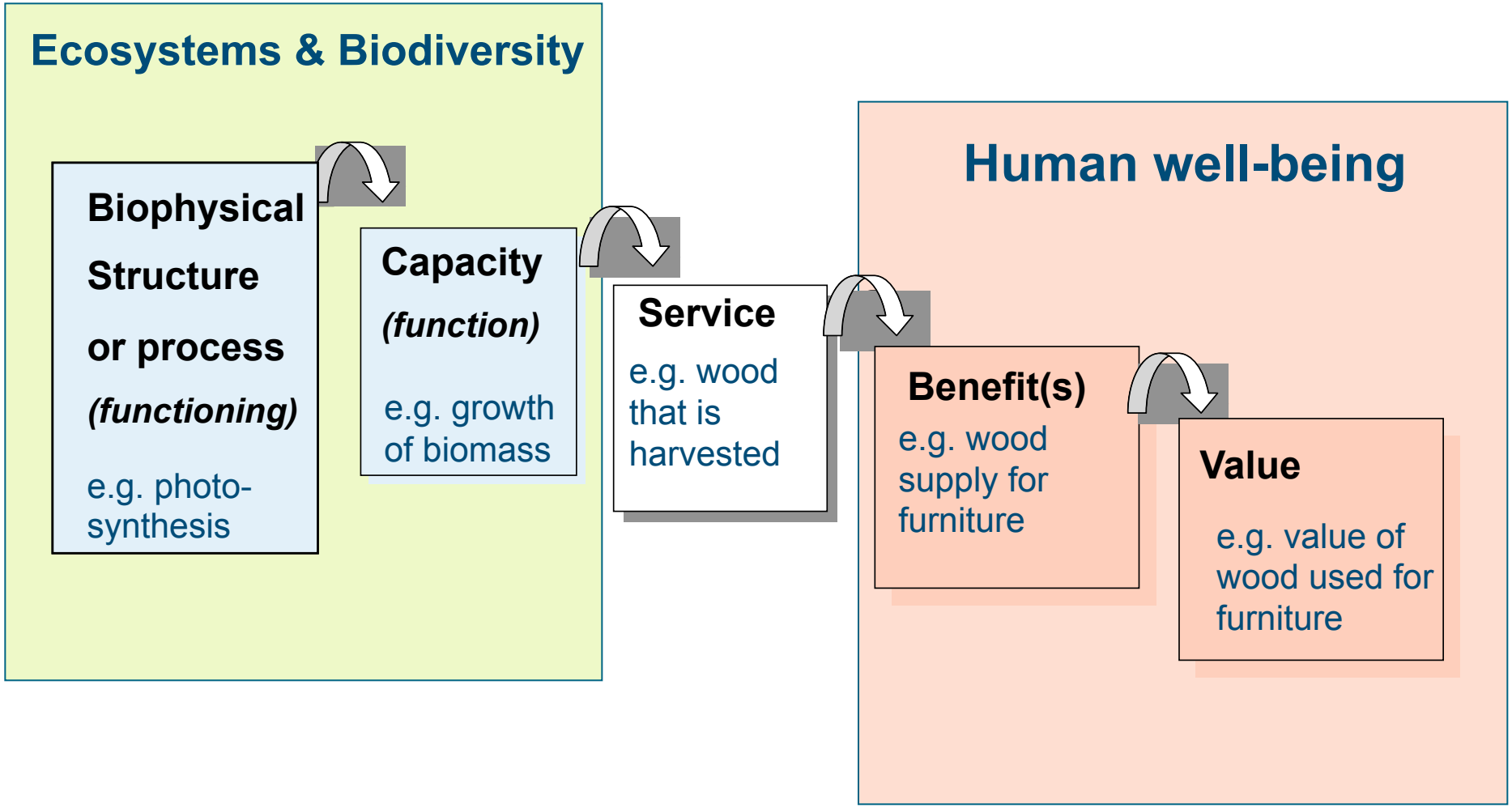
Contents

Ecosystem services

- Ecosystem services reflect the contribution of ecosystems to human benefits
  - Flow (actual, potential)
  - Depend on the supply (from the ecosystem) and the demand (from society)
  - E.g. the supply of timber that can be harvested by people as a function of forest growth and demand for timber

Ecosystem services and human well-being



Cascade Diagram, modified from Haines-Young and Potschin)

Millennium Ecosystem Assessment (MA)

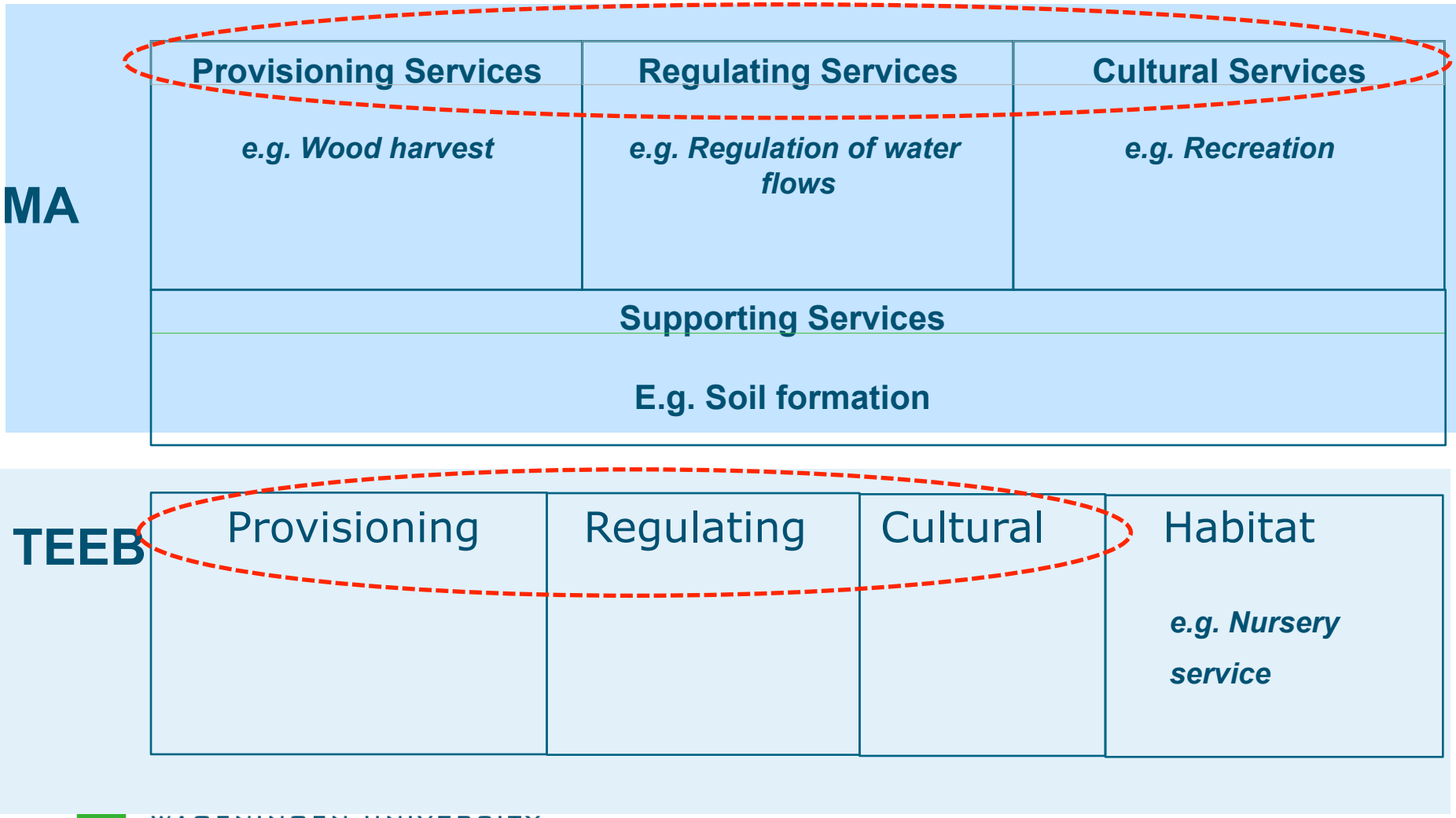
- Global assessment to investigate effects of ecosystem and biodiversity loss on human wellbeing
- Conducted from 2001-2005; 1360 scientists from 95 countries; (+33 sub-global assessments)
- + 60% of Ecosystem services lost or in decline
- All publications available at www.MAweb.org

Source: Millennium Assessment

Types of ecosystem services (this course)

- **Provisioning services**: the products that can be extracted from or harvested in ecosystems
- **Regulating Services**: the regulation of ecological, hydrological and climate processes
- **Cultural services**: the non-material benefits from ecosystems (e.g. recreation)

Types of ecosystem services (MA versus TEEB)



Supporting services

- Invented by MA (2003)
- All ecological processes supporting the supply of the other services
- Eg. Denitrification, soil formation, photosynthesis
- Very many – difficult to individually determine their impacts
- Double counting will occur if included in a valuation study
- Not further addressed in this course

CICES: Provisioning Services

Theme	Service Class	Service Group	Service Type	Sub-types	Examples and indicative benefits
Provisioning	Nutrition	Terrestrial plant and animal	Commercial cropping	eg. by crops	Cereals, vegetables, vines etc.
			Subsistence cropping	eg. by crops	Cereals, vegetables, vines etc.
			Commercial animal production	eg. by animal	Sheep, cattle for meat and dairy products
			Subsistence animal production	eg. by animal	Sheep, cattle for meat and dairy products
			Harvesting wild plants and animals for food	eg. by resource	Berries, fungi etc
		Freshwater plant and animal	Commercial fishing (wild populations)	eg. by fishery	By species
			Subsistence fishing	eg. by fishery	By species
			Aquaculture	eg. by fishery	By species
			Harvesting fresh water plants for food	eg. by resource	Water cress
		Marine plant and animal	Commercial fishing (wild populations)	eg. by fishery	Includes crustaceans
			Subsistence fishing	eg. by fishery	Includes crustaceans
			Aquaculture	eg. by fishery	Includes crustaceans
			Harvesting marine plants for food	eg. by resource	Seaweed
		Potable water	Water storage	eg. by feature	Spring, well water, river, reservoir, lake
			Water purification	eg. by habitat	Wetlands
	Materials	Biotic materials	Non-food plant fibres	eg. by resource	Timber, straw, flax
			Non-food animal fibres	eg. by resource	Skin, bone etc., guano
			Ornamental resources	eg. by resource	Bulbs, cut flowers, shells, bones and feathers etc. (Stones? Gems?)
			Genetic resources	eg. by resource	Wild species used in breeding programmes
			Medicinal resources	eg. by resource	Bio prospecting activities
		Abiotic materials	Mineral resources		Salt, aggregates, etc. (EXCLUDE subsurface assets)
	Energy	Renewable biofuels	Plant based resources	eg. by resource	Wood fuel, energy crops etc.
			Animal based resources	eg. by resource	Dung, fat, oils
		Renewable abiotic energy	Wind	eg. by resource	
			Hydro	eg. by resource	
			Solar	eg. by resource	
			Tidal	eg. by resource	
			Thermal	eg. by resource	

Source: EEA, 2011: CICES Update

CICES Regulating and Maintenance, Cultural

Theme	Service Class	Service Group	Service Type	Sub-types	Examples and indicative benefits
Regulation and Maintenance	Regulation of wastes	Bioremediation	Remediation using plants	eg. by method	Phytoaccumulation, phytodegredation, phytostabilisation, rhizodegradation,
			Remediation using micro-organisms	eg. by method	In situ (Bioremediation), ex situ (composting), bioreactors
		Dilution and sequestration	Dilution	eg. by method	Wastewater treatment
			Filtration	eg. by method	Filtration of particulates and aerosols
			Sequestration and absorption	eg. by method	Sequestration of nutrients in organic sediments, removal of odours
	Flow regulation	Air flow regulation	Windbreaks, shelter belts	eg. by process	
			Ventilation	eg. by process	
		Water flow regulation	Attenuation of runoff and discharge rates	eg. by process	Woodlands, wetlands and their impact on discharge rates
			Water storage	eg. by process	Irrigation water
			Sedimentation	eg. by process	Navigation
			Attenuation of wave energy	eg. by process	Mangroves
		Mass flow regulation	Erosion protection	eg. by process	Wetlands reducing discharge peak
			Avalanche protection	eg. by process	Stabilisation of mudflows, erosion protection [reduction]
	Regulation of physical environment	Atmospheric regulation	Global climate regulation (incl. C-sequestration)	eg. by process	Atmospheric composition, hydrological cycle
			Local & Regional climate regulation	eg. by process	Modifying temperature, humidity etc.; maintenance of regional precipitation
		Water quality regulation	Water purification and oxygenation	eg. by process	Nutrient retention in buffer strips etc. and translocation of nutrients
			Cooling water	eg. by process	For power production
		Pedogenesis and soil quality regulation	Maintenance of soil fertility	eg. by process	Green mulches; n-fixing plants
			Maintenance of soil structure	eg. by process	Soil organism activity
	Regulation of biotic environment	Lifecycle maintenance & habitat protection	Pollination	eg. by process	By plants and animals
			Seed dispersal	eg. by process	By plants and animals
		Pest and disease control	Biological control mechanisms	eg. by process	By plants and animals, control of pathogens
		Gene pool protection	Maintaining nursery populations	eg. by process	Habitat refuges
Cultural	Symbolic	Aesthetic, Heritage	Landscape character	eg. by resource	Areas of outstanding natural beauty
			Cultural landscapes	eg. by resource	Sense of place
		Spiritual	Wilderness, naturalness	eg. by resource	Tranquillity, isolation
			Sacred places or species	eg. by resource	Woodland cemeteries, sky burials
	Intellectual and Experiential	Recreation and community activities	Charismatic or iconic wildlife or habitats	eg. by resource	Bird or whale watching, conservation activities, volunteering
			Prey for hunting or collecting	eg. by resource	Angling, shooting, membership of environmental groups and organisations
		Information & knowledge	Scientific	eg. by resource	Pollen record, tree ring record, genetic patterns
			Educational	eg. by resource	Subject matter for wildlife programmes and books etc.

Source: EEA, 2011: CICES Update

Biodiversity / Nature conservation

Is biodiversity / nature conservation an ecosystem service ?

How can biodiversity be included in Ecosystem Accounts ?

http://ec.europa.eu/environment/nature/knowledge/ecosystem_assessment/pdf/MAESWorkingPaper2013.pdf

See also: Mace, 2012.

Ecosystem services: Policy Applications.

A. Awareness raising

B. Revealing stakeholder interests

C. Analysing the costs and benefits of ecosystem management options

D. Payments for ecosystem services (PES)

E. Land use planning

F. Ecosystem Accounting

"Society must urgently replace its defective economic compass so that it does not jeopardize human well-being and planetary health through the under-valuation and consequent loss of ecosystems and biodiversity."

Pavan Sukhdev, TEEB Study Leader

29.5.2008, CBD COP9

C. CBA of management options: Timber logging versus sustainable forest management in Palawan, the Philippines

- At stake: logging uphill from Bacuit Bay in Palawan (some 120 km^2; 15-20 km^2 of coral reefs) (Source: Hodgson and Dixon, 1988).
- Logging and loss of forest cover would lead to increased sedimentation in the Bay, leading to a loss of coral reefs.
- Coral reefs are important for

  fisheries and tourism

Timber logging versus sustainable forest management in Palawan

- Impacts of logging: most of the eroded soil would end up in Bacuit Bay
- This would lead to a gradual loss of around 50% of the coral reefs
- Loss of coral reefs would cause a loss of 50% of local fisheries, and
- As the attractiveness for divers would gradually decrease, leading to a loss of 83% of local tourism revenues

Timber logging versus sustainable forest management in Palawan (NPV)

	Logging Ban (US$ million)	Continued logging (US$ million)
Tourism	25.5	6.3
Fisheries	17.2	9.1
Logging	0	9.8
Total	42.7	25.2

Source: Hodgson and Dixon, 1988

D. Payments for Ecosystem Services

Market-related sources	Volume (US$ billion/ year)
PES for watershed services	~ 6
REDD+ market	0.1
Voluntary biodiversity markets	<0.1
Green commodities	2.6
Ecotourism	0.7 – 1.3 for park management
US and Australian offset markets	~ 2 - 2.5
Other (e.g. bio-prospecting, direct ecosystem service and biodiversity fees)	0.2 – 0.3

Source: adapted from Hein et al., 2012

Part 2. Analysing and modelling

- ...Of Ecosystem services and Ecosystem capacity to generate services

(note modelling techniques and mapping techniques to be continued tomorrow)

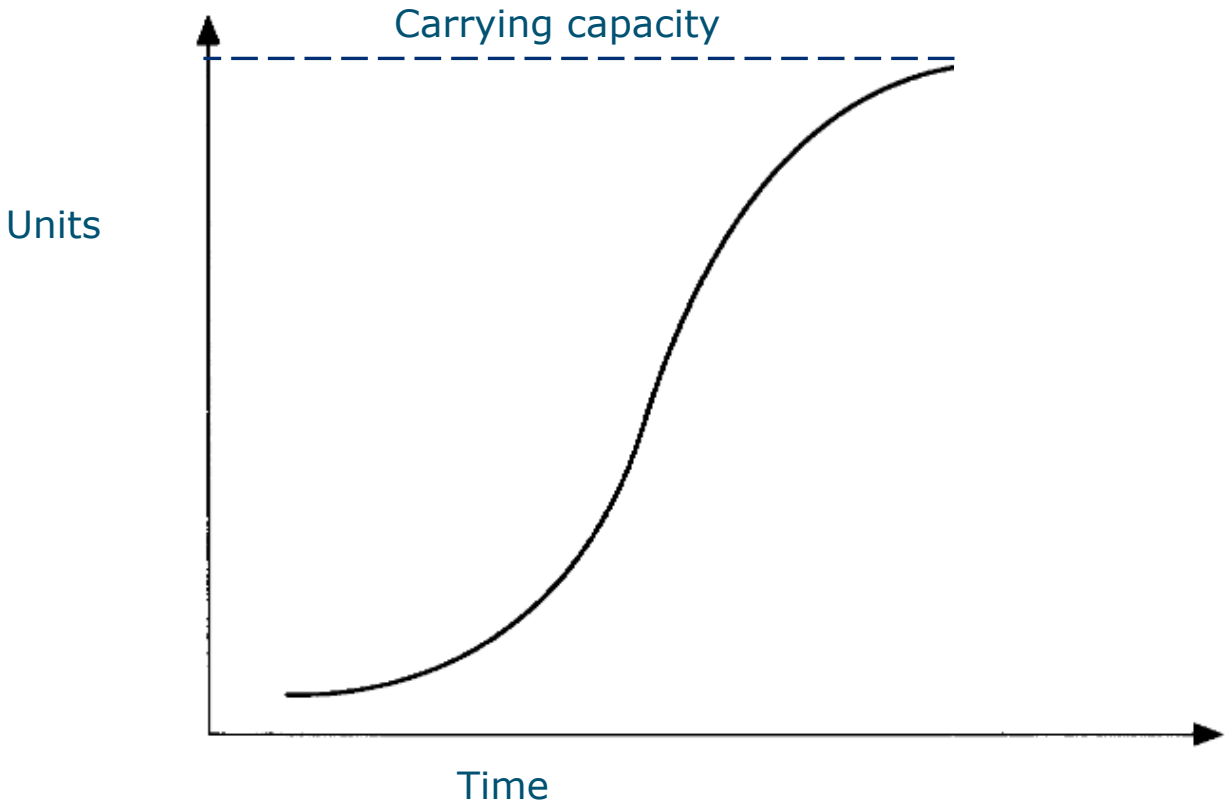
	Ecosystem service capacity	Ecosystem service flows
Provisioning services	Capacity to provide the products (overharvesting may occur)	Amount of products extracted / harvested
Regulating services	Regulating impact of ecosystems on physical environment	Regulating impacts on people
Cultural services	Depend on service	Depend on service

Basic methodologies - provisioning services

- Flows of provisioning services:
  - Data: Recording outputs of the ecosystem: production statistics, surveys, production models.
  - Mapping: Interpolation (spatial tools), allocation (allocation models)
  - Cross validation

- Analysis of capacity to generate provisioning services
  - Analyse current stock of the service involved (e.g. standing stock of timber)
  - Analyse regrowth (varies as a function of stock, carrying capacity and management; assumption: under current management)

Simplified growth curve biological resource



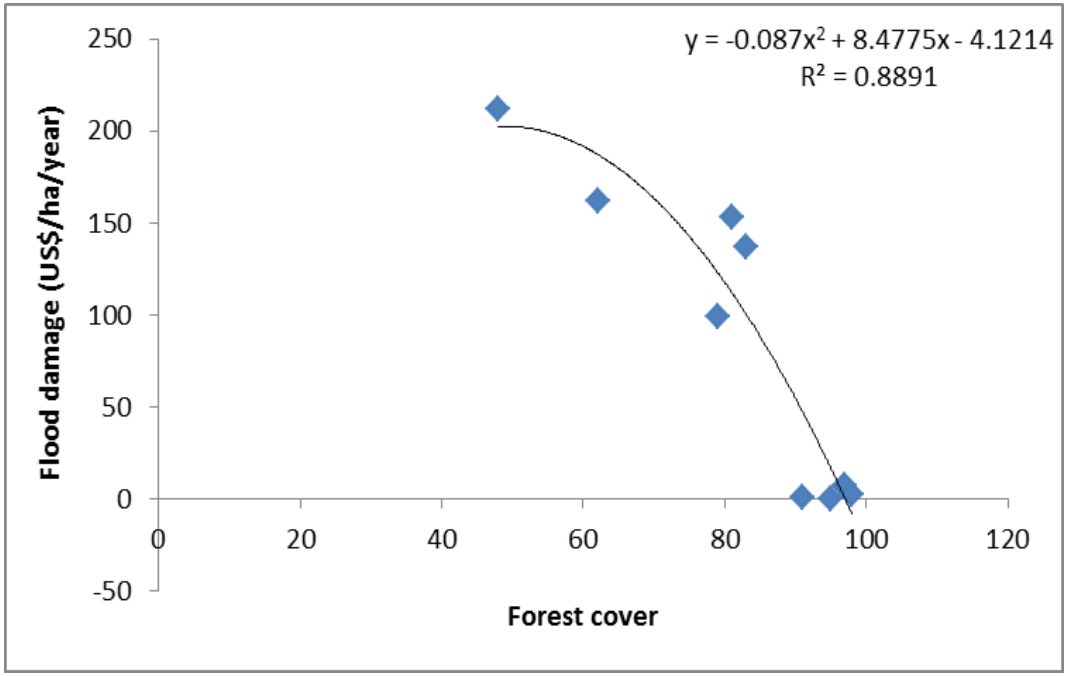
$$\frac{dP}{dt} = rP\left(1 - \frac{P}{K}\right)$$

Logistic growth curve

- The capacity to generate a provisioning service can be estimated for a given year, and may vary over time as a function of management and ecological processes

Basic methodologies - regulating services

- Hydrological services:
  - Define service, identify indicators
  - Spatial modelling of effects of vegetation on water flows / Comparison of watersheds
  - Cross validation



Trinidad: Relation between forest cover in catchments and flood damage costs. The value of the flood control service varies from US$ 60 to US$ 460 per ha forest/ year.

Source: Brookhuis and Hein, in preparation

Basic methodologies - cultural services

- Recreation and tourism:
  - Flow: number of tourists per area per year
  - Capacity: maximum number of tourists that can be sustained and can be expected (given access to an area, facilities, etc.)
- Biodiversity (Biodiversity account)
  - Flow: presence of species (# red list, functional species, species in groups, species abundance)
  - Capacity: potential presence (may be higher or lower)

Exercise (15 minutes)

- Imagine the case of Laguna Bay, Philippines
- Reflect on the key ecosystem services supplied by the ecosystems in this area
- Link every service to the main beneficiaries (stakeholders)
- Propose an indicator that can be used to measure the:
    - Flow of the ecosystem service
    - Capacity of the ecosystem service
- Note: the indicator must be measurable (specify the unit)

Ecosystem Services

Focus: biophysical assessment: practical

Practical

- Exercise: model the flow of wood (and the capacity of the ecosystem to supply wood), using Excel.