EXPLORATION ON MARINE RESOURCES: ECOSYSTEM SERVICES

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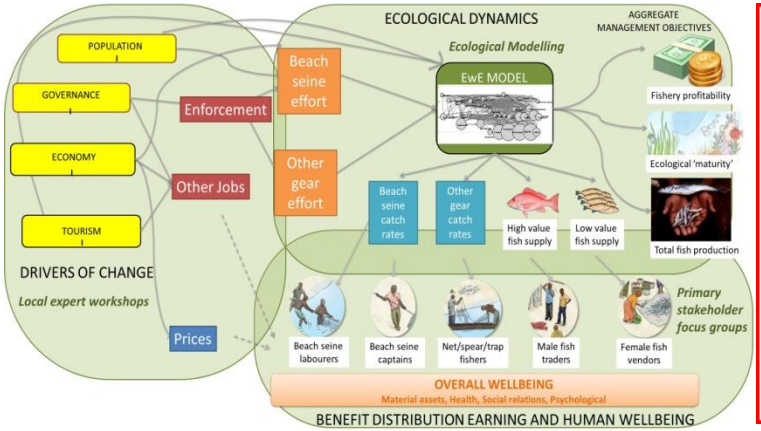

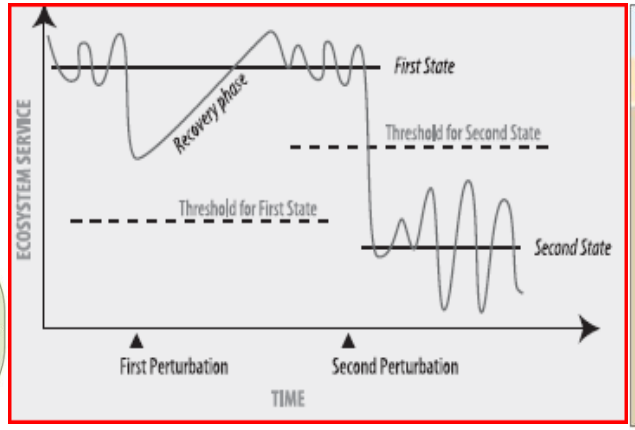

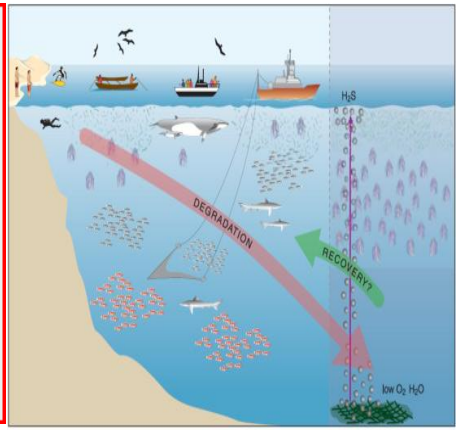

Fakultas Perikanan dan Ilmu Kelautan
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Tujuan Instruksional Khusus

- Mahasiswa yang mengikuti kuliah ini akan mampu mendefinisikan layanan ekosistem air laut terhadap manusia
- Mengetahui hal-hal (aktivitas manusia) yang dapat mempengaruhi perubahan atas layanan ekosistem
- Mengeksplorasi layanan-layanan yang dapat dilakukan ekosistem
- Melakukan penilaian atas layanan ekosistem sehingga nantinya mampu mengelola layanan tersebut secara berkelanjutan

What is..

- **Ecosystem ??**

  Interaction of living and non-living organisms as a functional unit. Human are an integral part of ecosystems

- **A well-defined ecosystem** → strong interactions among its & weak interactions across its boundaries.

- **Ecosystem services ??**

  The benefits people obtain from ecosystems → for maintaining the conditions for life on earth

  - Provisioning services: food, water
  - Regulating services: flood and disease control
  - Cultural services: spiritual, recreational, cultural benefits
  - Supporting services: nutrient cycling

The ecosystem approach: A bridge between the environment

The concept of an ecosystem provides:

a valuable framework for analyzing and acting on the *linkage between people and their environment*

Ecosystem approach

→Strategy for the integrated management of land, water, and living resources that promotes conservation and sustainable use in a equitable way.

→This approach can not be assessed if we don't take in to account all parts of the systems including their interactions.

→**Problems:** a not well-defined ecosystem boundaries → ecosystem categories.

Millennium Ecosystem Assessment Reporting Categories

Category	Central Concept	Boundary Limits for Mapping
Marine	Ocean, with fishing typically a major driver of change	Marine areas where the sea is deeper than 50 meters.
Coastal	Interface between ocean and land, extending seawards to about the middle of the continental shelf and inland to include all areas strongly influenced by the proximity to the ocean	Area between 50 meters below mean sea level and 50 meters above the high tide level or extending landward to a distance 100 kilometers from shore. Includes coral reefs, intertidal zones, estuaries, coastal aquaculture, and seagrass communities.
Inland water	Permanent water bodies inland from the coastal zone, and areas whose ecology and use are dominated by the permanent, seasonal, or intermittent occurrence of flooded conditions	Rivers, lakes, floodplains, reservoirs, and wetlands; includes inland saline systems. Note that the Ramsar Convention considers "wetlands" to include both inland water and coastal categories.
Forest	Lands dominated by trees; often used for timber, fuelwood, and non-timber forest products	A canopy cover of at least 40 percent by woody plants taller than 5 meters. The existence of many other definitions is acknowledged, and other limits (such as crown cover greater than 10 percent, as used by the Food and Agriculture Organization of the United Nations) will also be reported. Includes temporarily cut-over forests and plantations; excludes orchards and agroforests where the main products are food crops.

Millennium Ecosystem Assessment Reporting Categories

Category	Central Concept	Boundary Limits for Mapping
Dryland	Lands where plant production is limited by water availability; the dominant uses are large mammal herbivory, including livestock grazing, and cultivation	Drylands as defined by the Convention to Combat Desertification, namely lands where annual precipitation is less than two thirds of potential evaporation, from dry subhumid areas (ratio ranges 0.50–0.65), through semiarid, arid, and hyper-arid (ratio <0.05), but excluding polar areas; drylands include cultivated lands, scrublands, shrublands, grasslands, semi-deserts, and true deserts.
Island	Lands isolated by surrounding water, with a high proportion of coast to hinterland	As defined by the Alliance of Small Island States
Mountain	Steep and high lands	As defined by Mountain Watch using criteria based on elevation alone, and at lower elevation, on a combination of elevation, slope, and local elevation range. Specifically, elevation >2,500 meters, elevation 1,500–2,500 meters and slope >2 degrees, elevation 1,000–1,500 meters and slope >5 degrees or local elevation range (7 kilometers radius) >300 meters, elevation 300–1,000 meters and local elevation range (7 kilometers radius) >300 meters, isolated inner basins and plateaus less than 25 square kilometers extent that are surrounded by mountains.

Millennium Ecosystem Assessment Reporting Categories

Category	Central Concept	Boundary Limits for Mapping
Polar	High-latitude systems frozen for most of the year	Includes ice caps, areas underlain by permafrost, tundra, polar deserts, and polar coastal areas. Excludes high-altitude cold systems in low latitudes.
Cultivated	Lands dominated by domesticated plant species, used for and substantially changed by crop, agroforestry, or aquaculture production	Areas in which at least 30 percent of the landscape comes under cultivation in any particular year. Includes orchards, agroforestry, and integrated agriculture-aquaculture systems.
Urban	Built environments with a high human density	Known human settlements with a population of 5,000 or more, with boundaries delineated by observing persistent night-time lights or by inferring areal extent in the cases where such observations are absent.

Tropical Coastal Ecosystem

Land to ocean

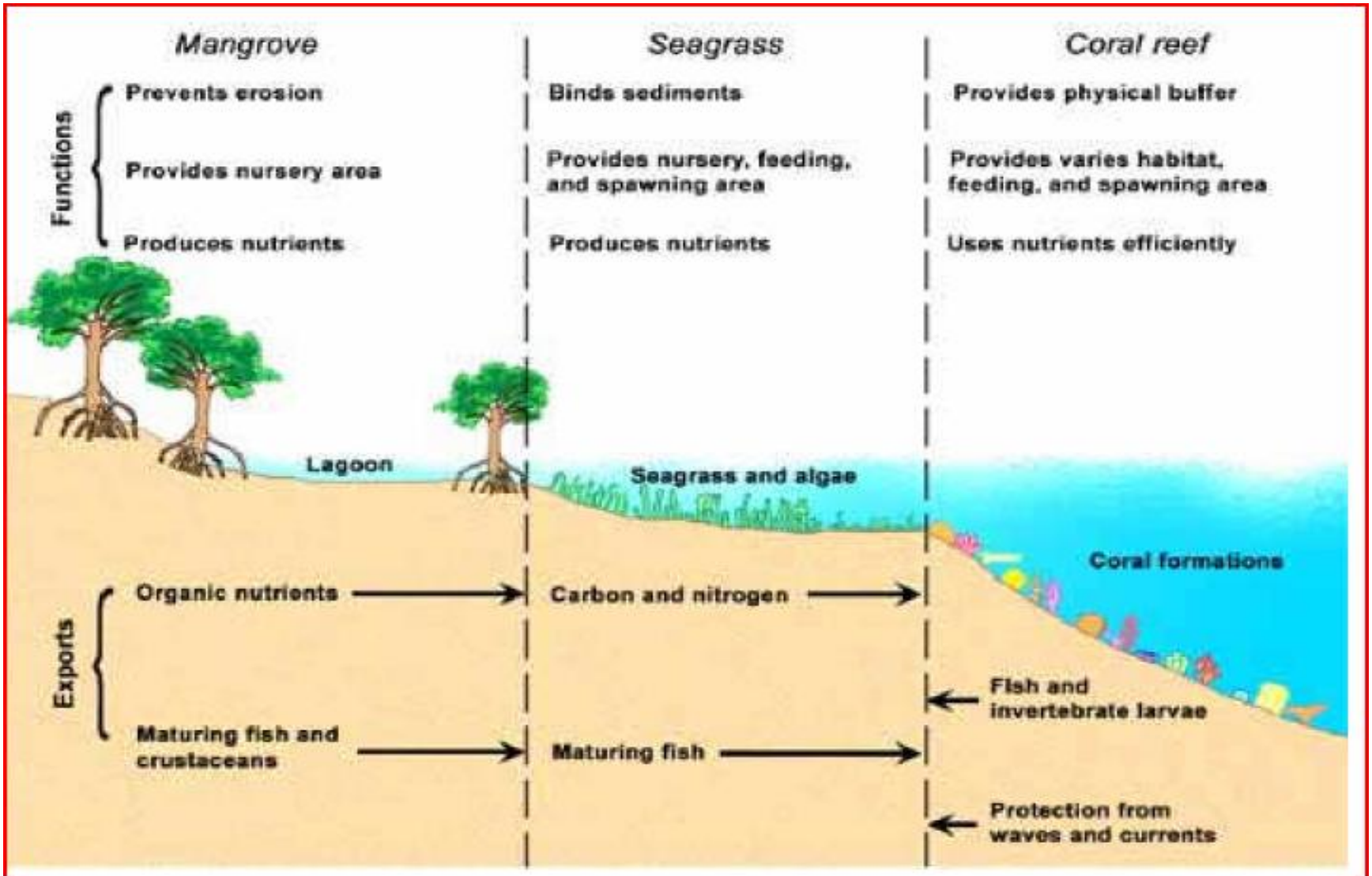
Mangroves → reefs → sea grasses → open sea

- Mangrove → filtering anthropogenic material (organic and/or inorganic) → trapped in sea grasses → low nutrient in reefs and open sea

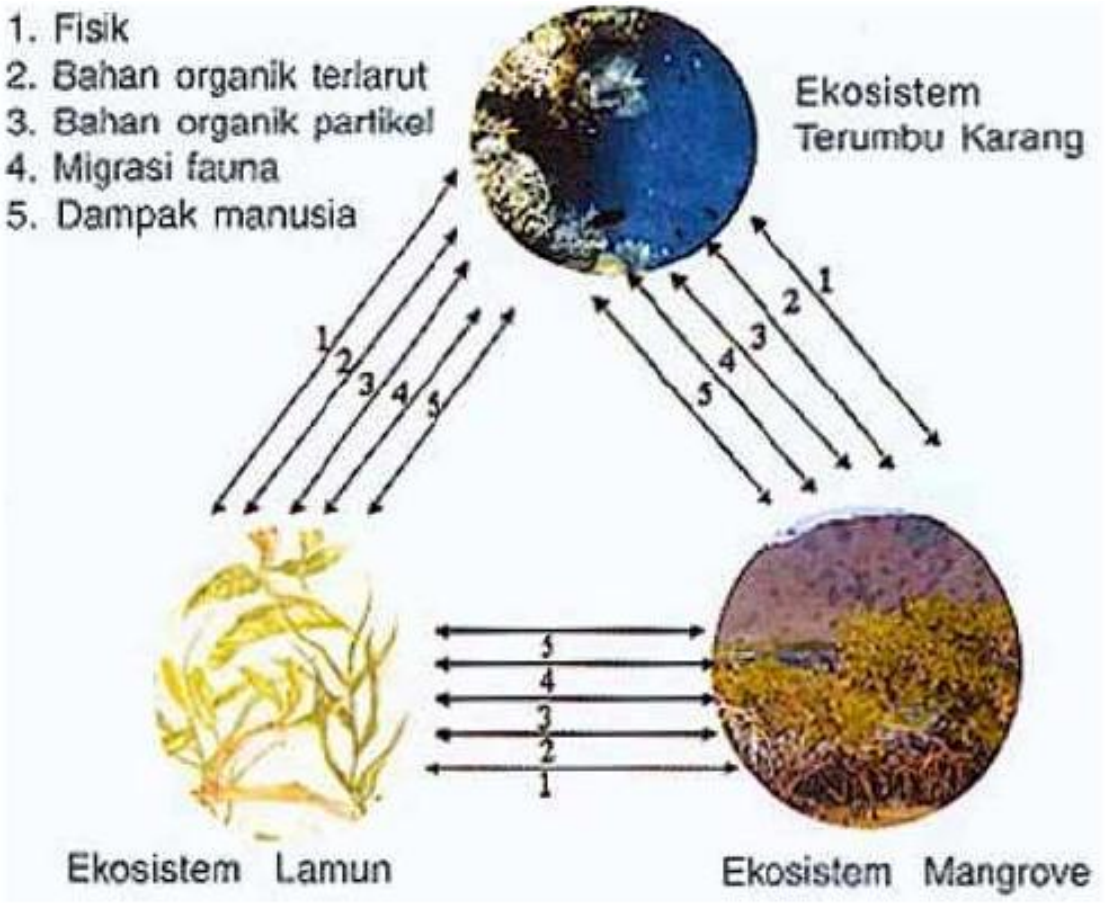
Ocean to land

- Reefs reduces hydrodynamics from open sea (currents, waves) → the coral fragments processed by fish, sea urchins, and sponges to be sand (as a substrate of sea grasses and mangroves

Interactions among ecosystems



Interactions among ecosystems



Interactions: biota migration

1. **Short term migration (feeding)**
2. **Life history migration (breeding, larvae growing)**

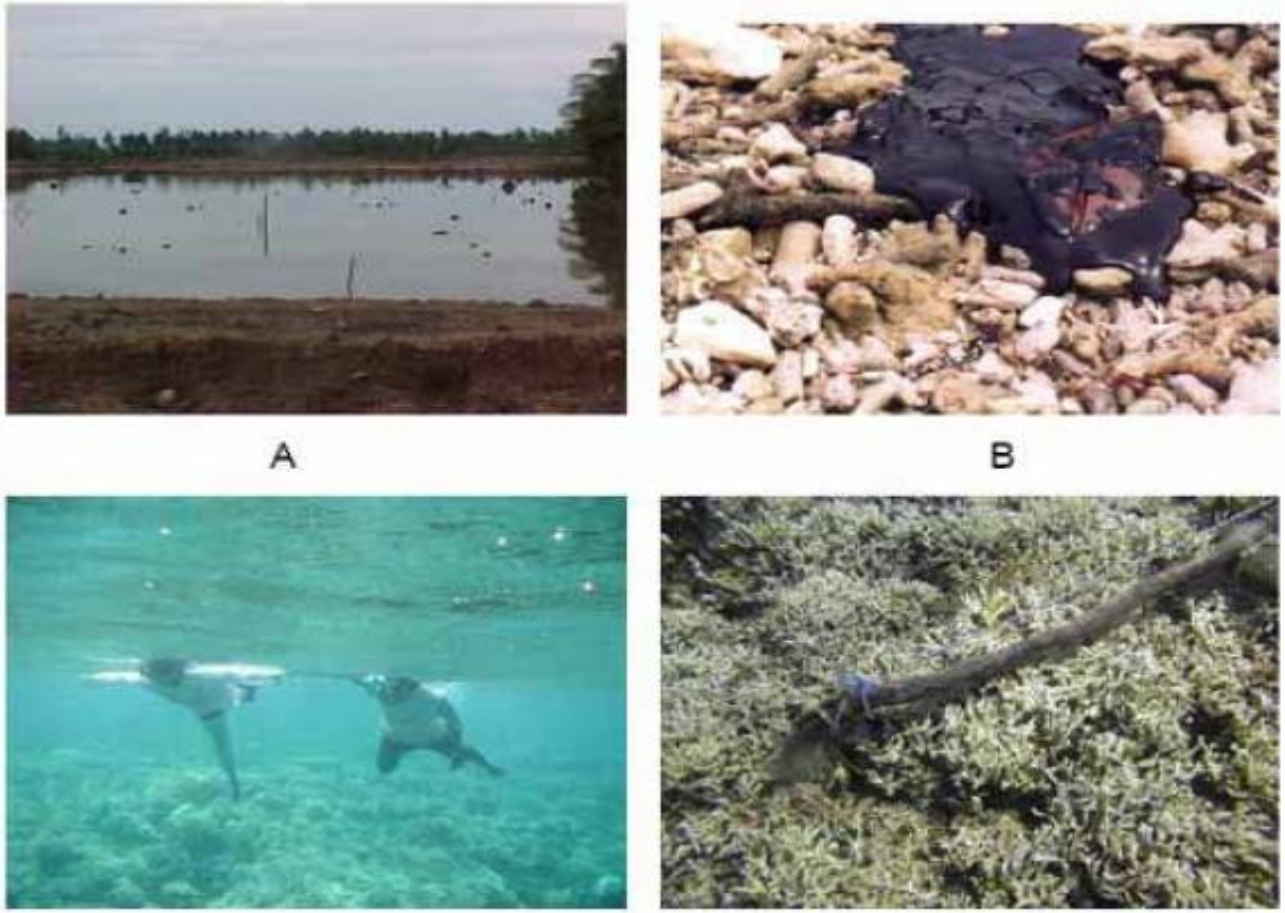
Interactions: human impacts

1. **Temporal effects**
2. **Permanent effects**

Mangrove and sea grass → destruction to go extinct
Habitat conversion (ex: hard coral to soft coral)

Source: Bengen (2004)

Interaction: human impact



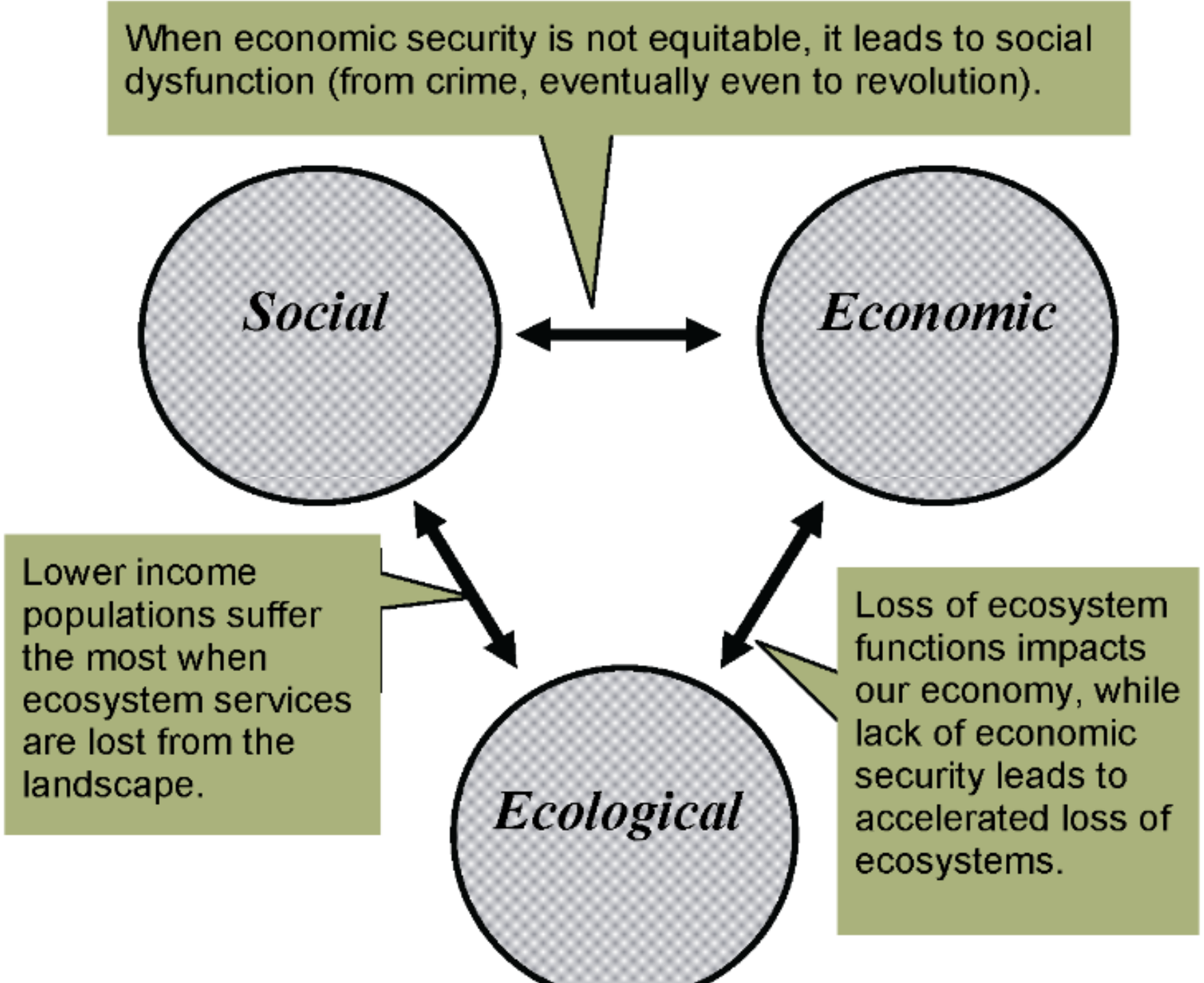
Berbagai kegiatan manusia yang merusak dan mengganggu keberlangsungan ekosistem laut tropis: (A) konversi hutan mangrove untuk tambak, (B) pencemaran minyak, (C) kegiatan wisata yang kurang berhati-hati, (D) pemasangan jangkar perahu yang merusak koloni karang.

WHAT NATURE CAN DO FOR YOU??

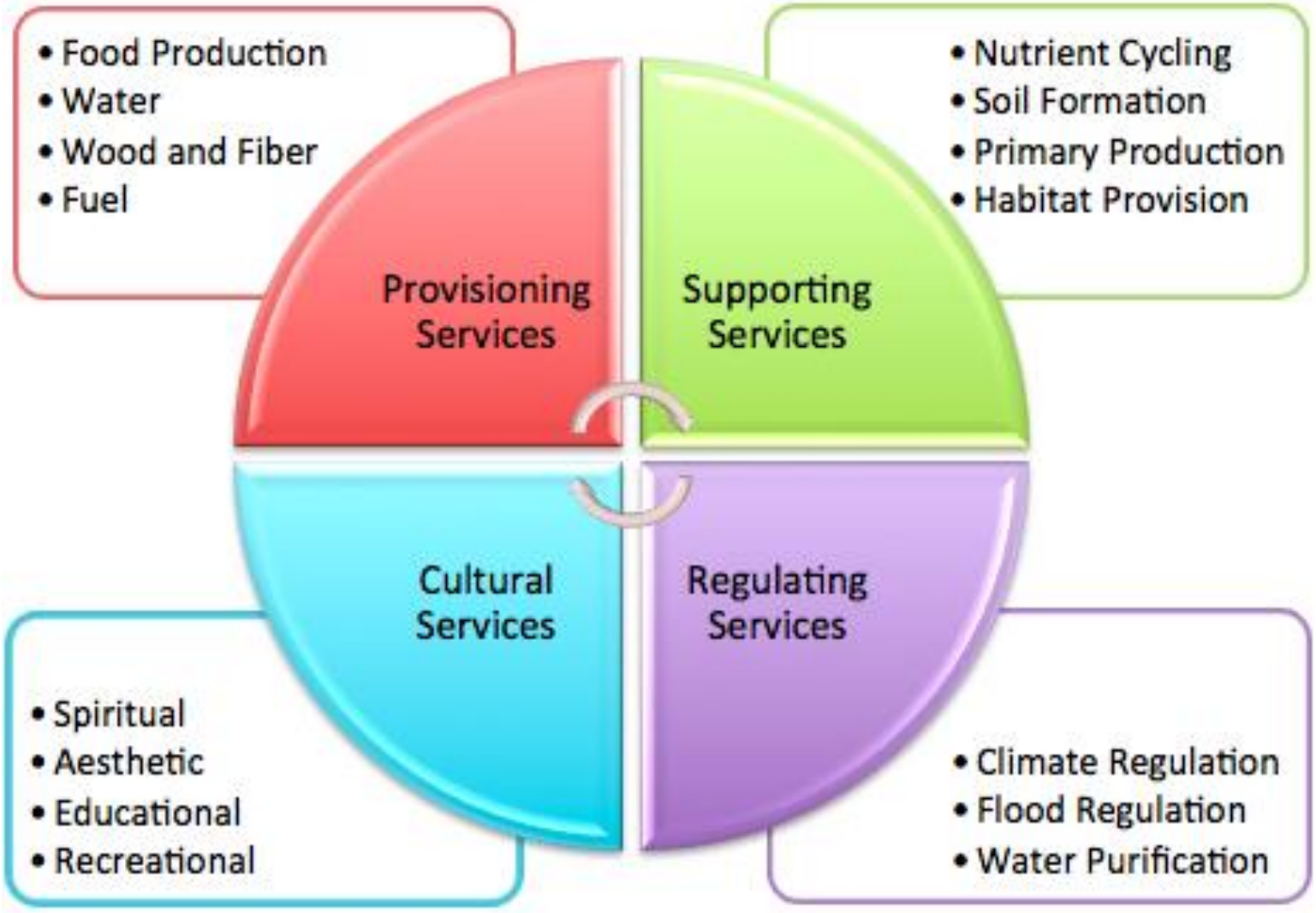
Ecosystem services

is...The conditions and processes through which natural ecosystem, and the species that make them up, sustain and fulfill human life (maintaining biodiversity & the production of ecosystem goods)

- Both ecosystem goods (ex: food) and services (ex: waste assimilation) represent the benefits human population derive, directly or indirectly, from ecosystem functions


When economic security is not equitable, it leads to social dysfunction (from crime, eventually even to revolution).
Social
Economic
Ecological
Lower income populations suffer the most when ecosystem services are lost from the landscape.
Loss of ecosystem functions impacts our economy, while lack of economic security leads to accelerated loss of ecosystems.

Categorization of ecosystem services



Source: Millenium Ecosystem Assessment, 2005.

Provisioning services

These are the products obtained from ecosystem:

- Food → includes the vast range of food derived from plants, animals, and microbes
- Fuel → biological materials serve as sources of energy
- Genetic resources → includes the genes and genetic information used for animal and plant breeding and biotechnology
- Biochemicals, natural medicines, and pharmaceuticals
- Ornamental resources → animal products, such as skins and shells, and flowers are used as ornaments
- Fresh water (linkage between provisioning and regulating services)

Regulating services

These are the benefits obtained from the regulation of ecosystem processed:

- Air quality maintenance

  ecosystem contribute chemical to (evaporation→ carbon dioxide diffused) and extract chemicals from the atmosphere
- Climate regulation → ecosystem influence both locally and globally
- Water regulation → the timing and magnitude of runoff, flooding can be influenced by changes in land cover
- Erosion control
- Water purification → ecosystem can help to filter out and decompose organic wastes introduced into marine ecosystem (carrying capacity)
- Biological control → ecosystem affect the prevalence live stock and disease
- Storm protection → coastal ecosystem (mangroves and coral reefs can reduce the damages caused by hurricanes and large waves

Cultural services

These are non material benefits people obtained from ecosystem through:

- Cultural diversity → ecosystem diversity is one factor influencing the diversity of cultures
- Spiritual and religious values → Many religions attach spiritual and religious values to ecosystem and their components
- Knowledge systems (both traditional and formal)

  Ecosystem influence the types of knowledge systems developed by different cultures
- Educational values

Cultural services

- Inspiration, Aesthetic values
- Social relations → ecosystem influence the types of social relations (ex: fishing societies)
- Cultural heritage values
- Recreation and ecotourism

These services are bound to human values and behavior

Supporting services

Services *that.....*support the production of all other services.

Characteristics: have indirect impact or occur in a very long time

Ex: soil formation (have indirect impact on food production)

climate regulation (regulating service and supporting services)

Production of oxygen to increase concentration oxygen in atmosphere

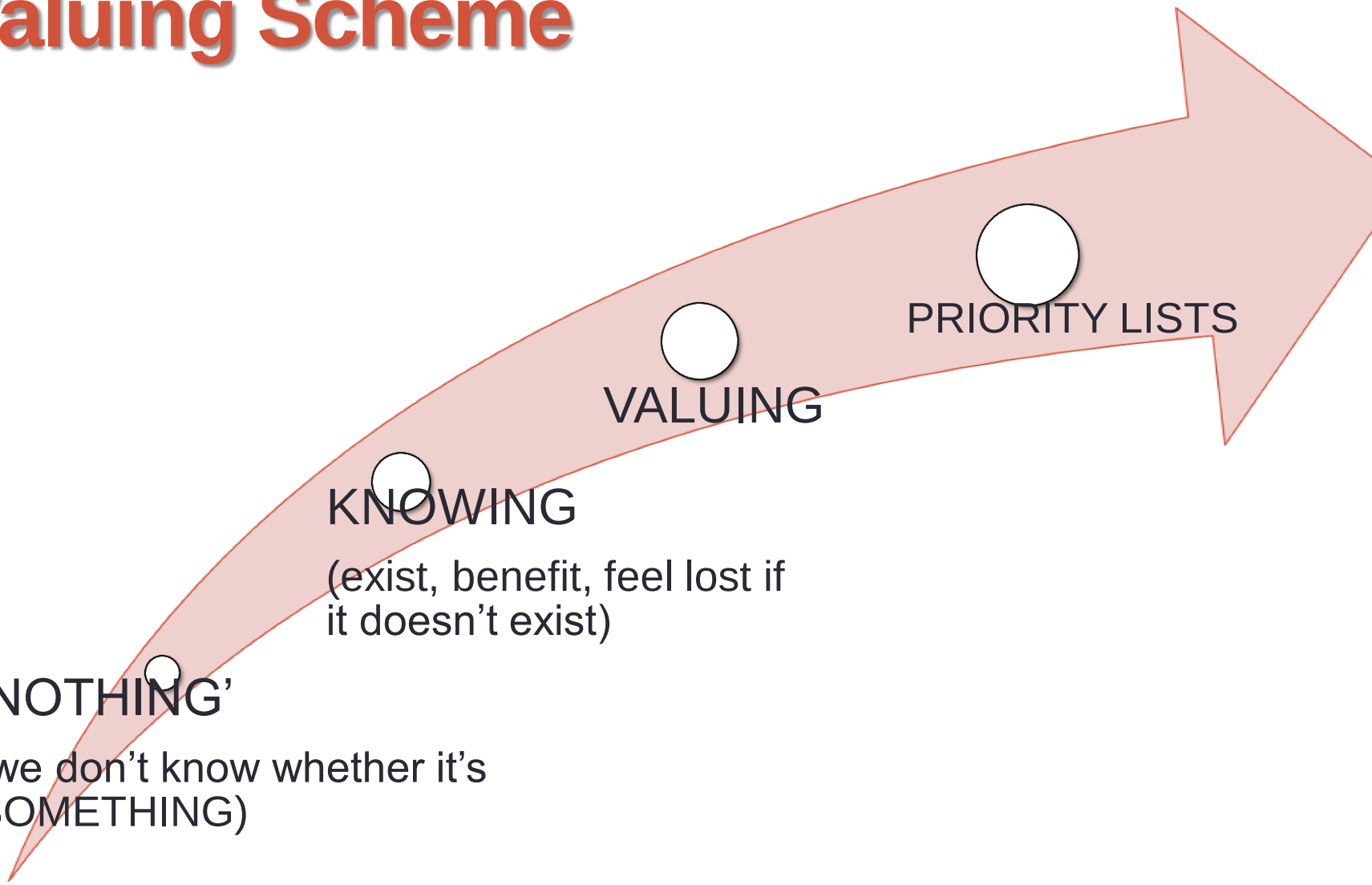
Primary production

Nutrient cycling

PAYMENTS FOR ECOSYSTEM SERVICES

Valuation methods

Valuing Scheme



Priority list: Cost Benefit Analysis

CBA "…a decision making tool to evaluate and compare project and policies by systematically:

- Identifying;
- Quantifying;
- Valuing; and
- Comparing

the positive (benefits) and negative (costs) effects".

It explicitly aims to express **all** effects in monetary terms

Steps in Cost Benefit Analysis

1. Identify alternatives
2. Identify incremental effects of alternatives
3. Quantify incremental effects
4. Monetize incremental effects
5. Discount all future effects
   - Calculate Present Value of benefits and costs
6. Compare discounted benefits and costs
   - Net Present Value
   - Internal Rate of Return
   - Benefit Cost Ratio

Example: Wind energy

On shore wind farm

Offshore wind farm

- CO_2 Neutral
- Costs
- Onshore: Effects on birds
- Offshore : Effects on benthos, birds

Three (or four) alternatives

The alternatives

- Do nothing
- Conventional power plant
- Onshore wind farm
- Offshore wind farm

Do Nothing

Year	1	2	3	4	5
Increase in energy production	0 Peta Joule	0 PJ	0 PJ	0 PJ	0 PJ
Costs	0 €	0 €	0 €	0 €	0 €
Change in bird collision	0	0	0	0	0
Change in benthos species richness	0	0	0	0	0
Change in CO2 emission	0	0	0	0	0

Conventional Power plant

Year	1	2	3	4	5
Increase in energy production	1 PJ	1 PJ	1 PJ	1 PJ	1 PJ
Costs	300 €	100 €	100 €	100 €	100 €
Change in bird collision	0	0	0	0	0
Change in benthos species richness	0	0	0	0	0
Change in CO2 emission	50	50	50	50	50

Onshore wind farm

Year	1	2	3	4	5
Increase in energy production	1 PJ	1 PJ	1 PJ	1 PJ	1 PJ
Costs	500 €	50 €	50 €	50 €	50 €
Change in bird collision	2000	2000	2000	2000	2000
Change in benthos species richness	0	0	0	0	0
Change in CO2 emission	0	0	0	0	0

Offshore wind farm

Year	1	2	3	4	5
Increase in energy production	1 PJ	1 PJ	1 PJ	1 PJ	1 PJ
Costs	1200 €	200 €	200 €	200 €	200 €
Change in bird collision	4000	4000	4000	4000	4000
Change in benthos species richness	50	50	50	50	50
Change in CO2 emission	0	0	0	0	0

Steps in Cost Benefit Analysis

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Monetary value of effects

Effect	Value	Possible methods
Energy production	€ 300 million per PJ	Market value of energy
Bird collision	€ 40,000 per bird	Contingent valuation survey
Number of benthic species	€ 400 million per year for the entire change	Contingent valuation survey Use value of nursery function
CO2 emissions	€ 2 per tonne	Expected damage from climate change

Calculate monetary of all incremental effects! (See excel file)

Steps in Cost Benefit Analysis

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Discounting

..Calculate PVB, TPVB, PVC, TPVC of all incremental effects of the alternatives at an interest rate of 5%!

Suatu nilai Vo akan bernilai:

$Vo(1+p)$	pada tahun depan (tahun pertama)
$Vo(1+p)(1+p)=Vo(1+p)^2$	pada tahun ke-2
$Vo(1+p)^t \rightarrow Vt$	pada tahun ke-t

Maka $Vo=Vt/(1+p)^t$

Discounted benefits in year t

$$PVB_t = \frac{B_t}{(1+\rho)^t}$$

Total discounted benefits in year t

$$TPVB = \sum_t PVB_t = \sum_t \frac{B_t}{(1+\rho)^t}$$

Discounted costs in year t

$$PVC_t = \frac{C_t}{(1+\rho)^t}$$

Total discounted costs in year t

$$TPVC = \sum_t PVC_t = \sum_t \frac{C_t}{(1+\rho)^t}$$

Steps in Cost Benefit Analysis

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Comparing costs and benefits

- Net Present Value (NPV)

  → Absolute differences between benefit and cost

- Benefit-cost ratio

  → Benefit divided by cost

- Internal rate of return

  → Interest rate at which PVB=PVC (NPV=0)

A project worthwhile if…:

- NPV > 0
- BCR > 1
- IRR > market interest rate

Notes

1. IRR is insensitive to interest rate
2. BCR depends on cost definition
3. Point 1 and 2 can’t use for comparing projects
4. NPV is the only measure to compare projects

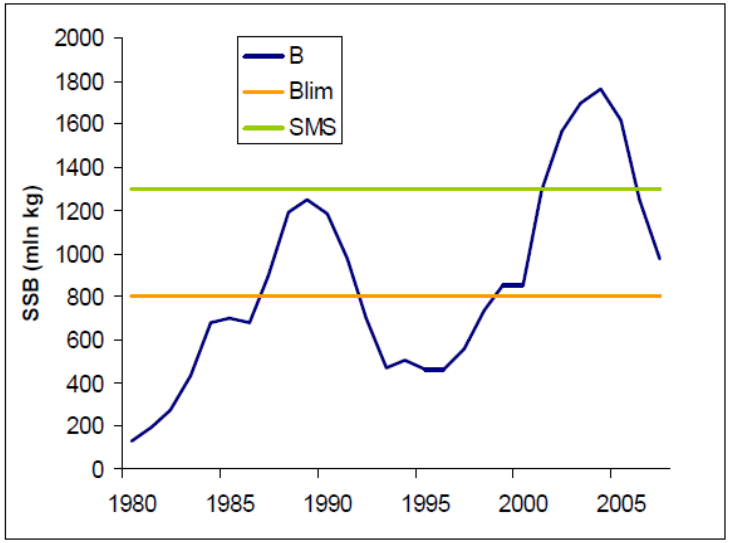
   When positive → project is worthwhile

   Choose project which the largest NPV

Contoh

Dampak yang ditimbulkan	**Satuan**	**2014**	**2015**	**2016**	**Total**
Produksi perikanan	juta rupiah	500	600	550	1650
Biaya	juta rupiah	100	120	120	340
Terumbu karang yang rusak	juta rupiah	150	160	160	470
Benthos species diversity	juta rupiah	50	50	50	150
Lapangan pekerjaan	juta rupiah	400	500	500	1400
Total Costs in each year	juta rupiah	300	330	330	960
Total Benefits in each year	juta rupiah	900	1100	1050	3050
Net Benefits in each year	juta rupiah	600	770	720	2090

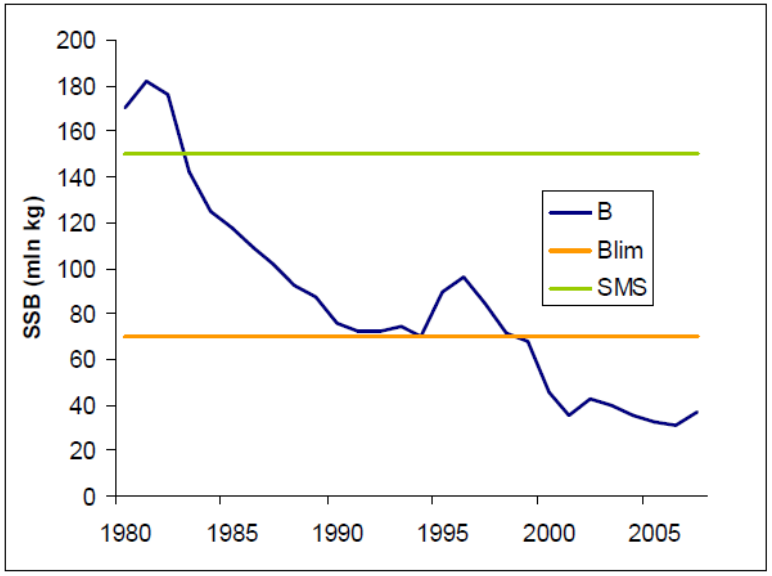
Safe minimum standards: herring



Safe minimum standard :

“ what large economic losses might be imposed on future generations by decisions to allow species extinction. It is recommended taking actions to conserve all species until we can value the species and assess costs of preservation correctly..”Bishop (1978)

Safe minimum standards: cod



Safe minimum standards: plaice