Ecosystem Accounting in the Philippines – Workshop 2: Recap lecture

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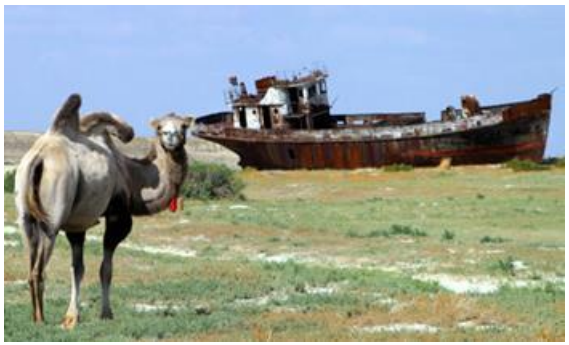
Contents

- Concept and methods for ecosytem accounting
- The System of National Accounts and the the System for Environmental Economic Accounting (SEEA)
- Mapping Methdologies
- Valuation of ecosystem services in an accounting context
- Work of Verna Duque
- The different ecosystem accounts

Policy applications of ecosystem accounts

- Measuring and monitoring sustainability: what are the changes in ecosystem capital / ecosystem assets from one year to the next
- Identifying ecosystem types/ areas / services under particular threat
- Understanding the contribution of ecosystems to economic activities (and the monetary value of these ecosystems)
- Spatial approach: land and resource use planning

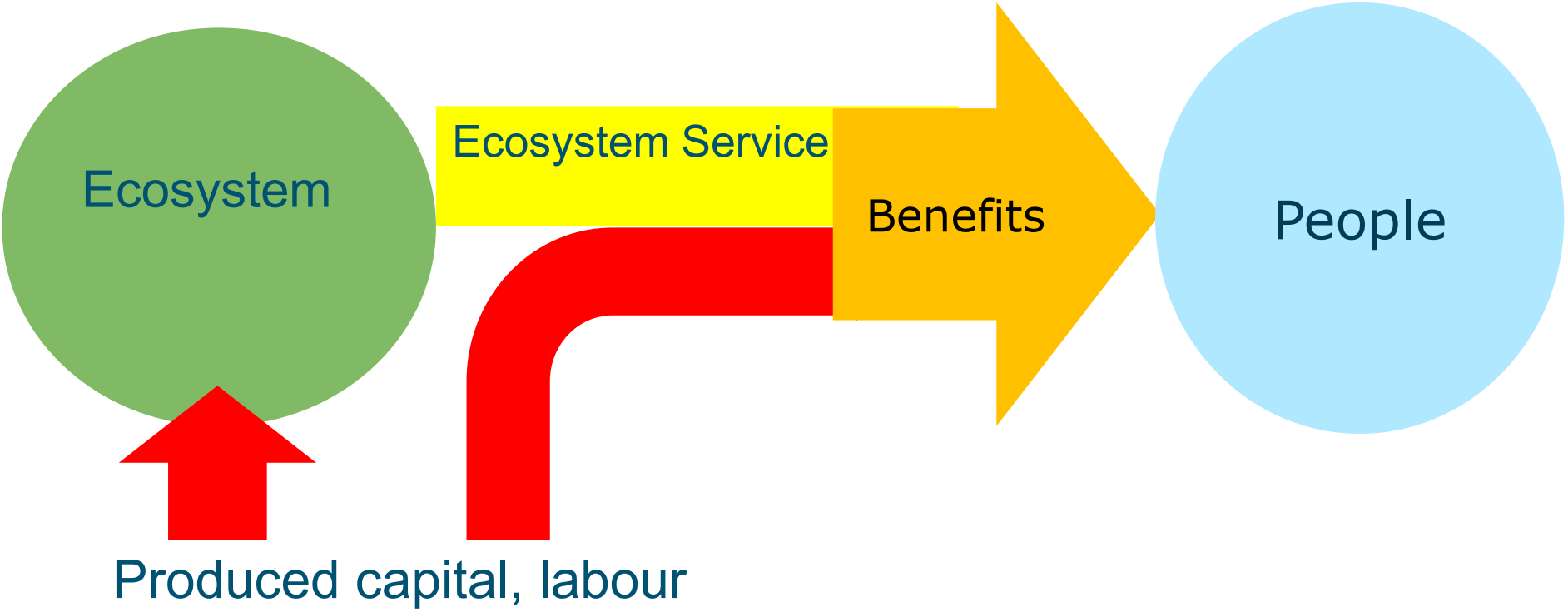


Types of ecosystem services

- **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)

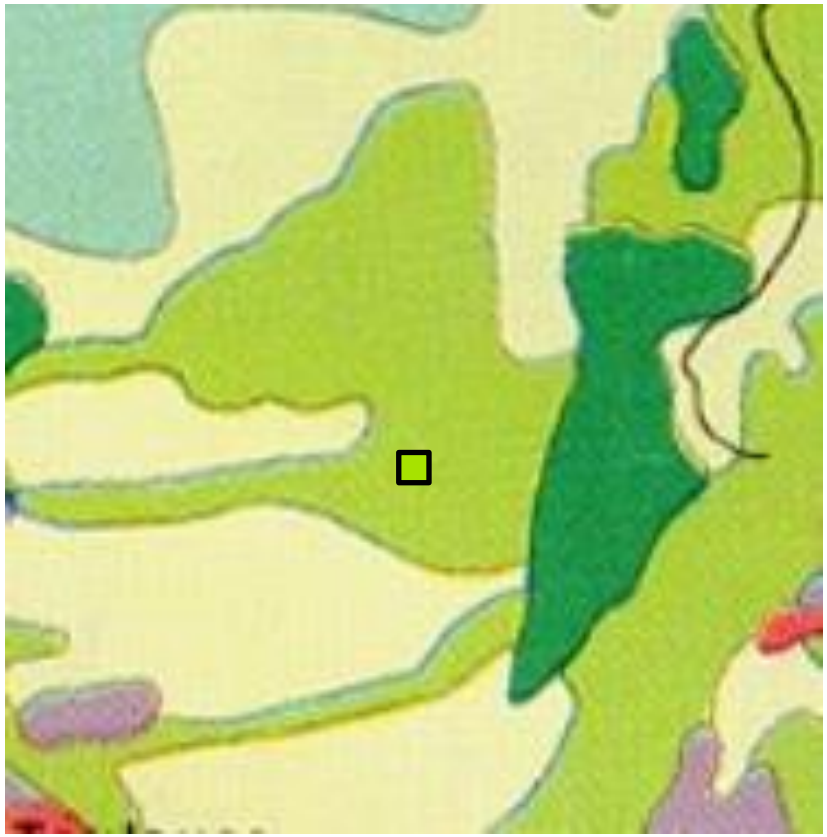
- **Different classifications**
  - Millennium Ecosystem Assessment
  - TEEB
  - CICES
  - IPBES (framework can be downloaded)

Services versus benefits



Key elements of Ecosystem Accounts

Land cover map of Province X



Scale

Pine forest

Deciduous forest

- Ecosystem Accounting Unit (EAU) = a country, province or watershed
- Land cover/ecosystem functional unit (LCEU) = e.g. Deciduous forest
- Pixel / BSU = a pixel

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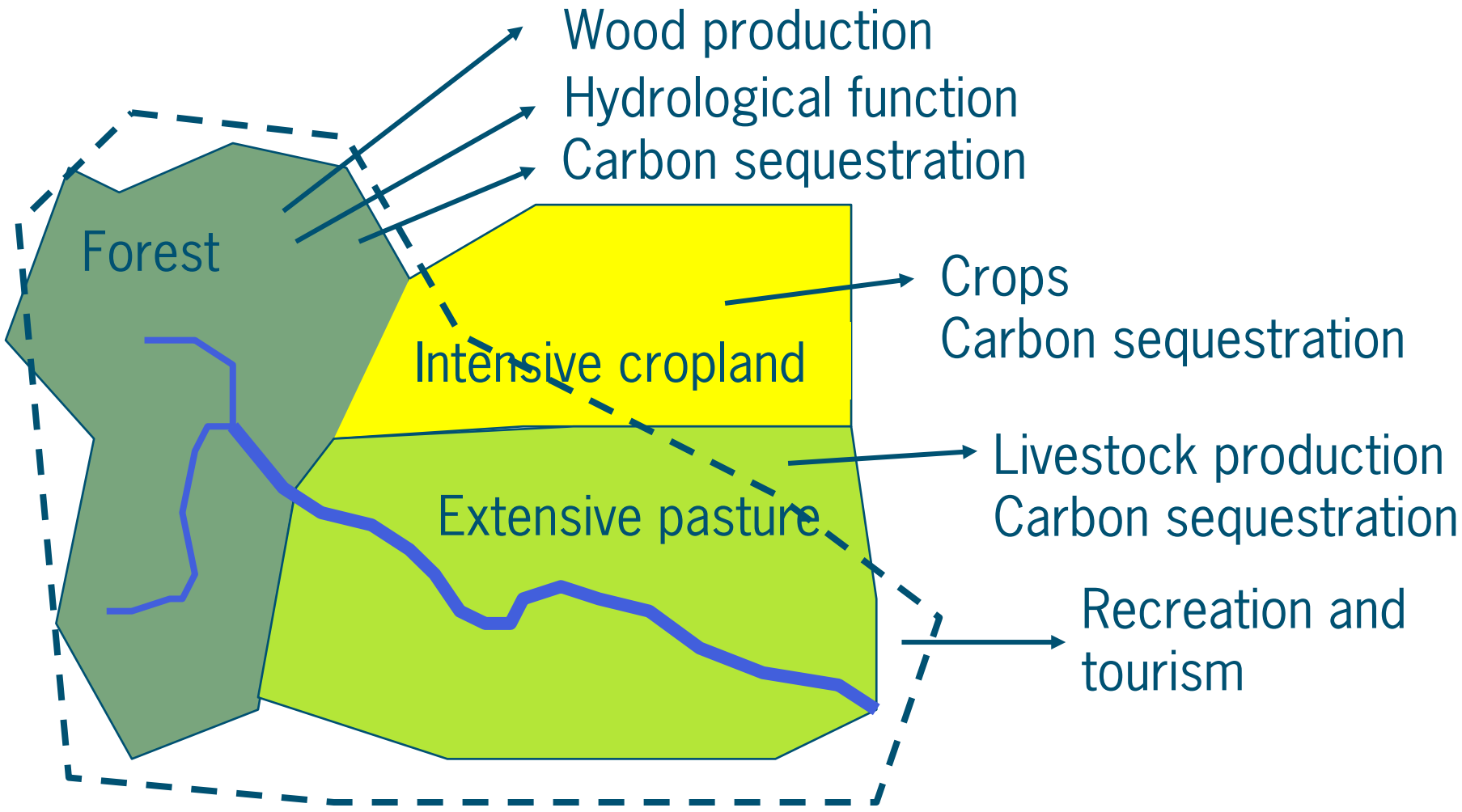
Accounting Units and ecosystem services



what are services and benefits ?

- Service = contribution of the ecosystem to the benefit !
  - Criteria: there need to be people using the service
- For instance:
  - wave dissipation: process.
  - this may be of use to people (when people live in the area affected by storm surge), then it becomes a service
  - The service can lead to different benefits: safe living environment, crop production

What is the service in the case of crop production

- Benefit: crop production
- Service: contribution of the ecosystem to crop production
  - Convention: express the service, in physical terms, as the amount of crops produced by the ecosystem
  - Value the contribution of the ecosystem using the resource rent approach

Services and benefits

- An ecosystem service can provide multiple services
  - If they are non-exclusive: the values can be added !
  - If they are not (e.g. wood harvest and tourism): the present flows can be added, but future flows will need to be based on the flows of the service that can be expected !

Multiple benefits

- One service can lead to multiple benefits !
    - Support to fisheries (ecosystem service)
        - Can support recreational and commercial fisheries (two types of benefits)
- Mangrove giving coastal protection can provide many benefits: allowing housing, crop production, recreation (e.g. protecting a hotel)
- In this case it may be easiest to value this with a replacement cost method (if it can be assumed that the service would be replaced it it was lost)

The System of National Accounts

Describes transactions (e.g. buying a product, or paying a tax) between institutional units such as households, the central government, or enterprises (classified in sectors such as agriculture or mining).

Transactions are described in a sequence of accounts:

- The current accounts (production, distribution and use of income) provide information on production, value added and income : gross and net domestic product (GDP and NDP) and national income (NNI).
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Source: Edens and Hein, 2013

Environmental and Environmental Economic Accounting

- Basis: System of National Accounts (2008) (UN-DESA)
- **Environmental** Accounting: measuring and recording water and energy use, emissions, discharges, environmental expenditure, environmental taxes
- **Environmental Economic** Accounting
  - Central Framework
  - Land and Water Accounts
  - Carbon Accounts, Biodiversity Accounts
  - **Ecosystem Accounting**

Ecosystem services and SNA

- SEEA EEA is consistent
- Aim: to make contribution of ecosystems explicit: would not 'change' the SNA
- Would GPD change ?
  - Value of most/(almost) all services is already in SNA (all provisioning services, all regulating services, tourism sector)
  - New service is carbon sequestration. Disservice: carbon emission is not valued...
- What is also new: value of ecosystem assets

On including services with no monetary value in physical terms

- Some services may have high economic value but low value in terms of production !
- Value may increase in the future (e.g. climate change)

Hence there can be a rationale to include such services in the accounts

Methodologies for ecosystem accounting

- Spatial / ecological modelling
  - Interpolation
  - Modelling services that can not be observed directly (erosion control, carbon sequestration, flood regulation)
  - Modelling future flows of services to analyse the value of ecosystem assets
- Valuation
  - Resource rent approach for provisioning services
  - Replacement costs (under certain assumptions)

Modelling 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)

Valuation of non-market goods in Ecosystem Accounting (in order of preference..)

- Production factor approaches: Production function approaches estimate the contribution of ecosystem services to production processes in terms of their contribution to the value of the final product being traded on the market (e.g. pollination).
- Replacement costs (not restoration costs !): In case an ES provides input into a whole range of different benefits (e.g. a coastal protection service). It is required that it can be reasonably be expected that society would indeed replace the service if it was lost.
    - Example: the value of coastal protection equals the costs of dykes ***if*** it can be expected that these dykes would indeed be constructed
- Avoided damage cost: This valuation approach may be applicable where replacement investments are not likely to be made.

Valuing provisioning services in ecosystem accounting: basic approach

RR = TR – (IC + LC + CC)

where

RR = resource rent

TR = total revenue

IC = intermediate consumption

CE = labour costs

CC = consumption of fix capital

Valuing regulating services

- Carbon sequestration:
  - Carbon market (but: prices strongly dependent on set-up of the market)
  - Marginal damage costs (but: strongly dependent on discount rate, and the way complex dynamics (large-impact, low probability events) are taken into account).
  - Marginal damage costs range from US$ 20 to over US$ 1000/ton C (Ceronsky et al., 2009)
- Hydrological services:
  - Production factor approach (if flood risk can be linked to one or few economic activities)
  - Replacement costs (costs of levees, dykes)
  - Avoided damage costs (avoided costs of flooding)

Valuing recreation

- Benefits for recreation industry: resource rent approach
- Benefits for visitors: consumers surplus to be excluded (alternative valuation options are being explored, e.g. by Campos, Camparrós, Edens)

Valuing capacity

Capacity is valued on the basis of the discounted flows of services provided by the ecosystem

This is a forward looking valuation approach and requires assumptions on future output of ecosystems (present management or sustainable management)

It also requires the selection of a discount rate. SNA: market discount rate. But: many ecosystem services are public benefits, two options:

- Market discount rate for all services
- Market discount rate for private services, public discount rate for public services

The discount rate and the Net Present Value (NPV)

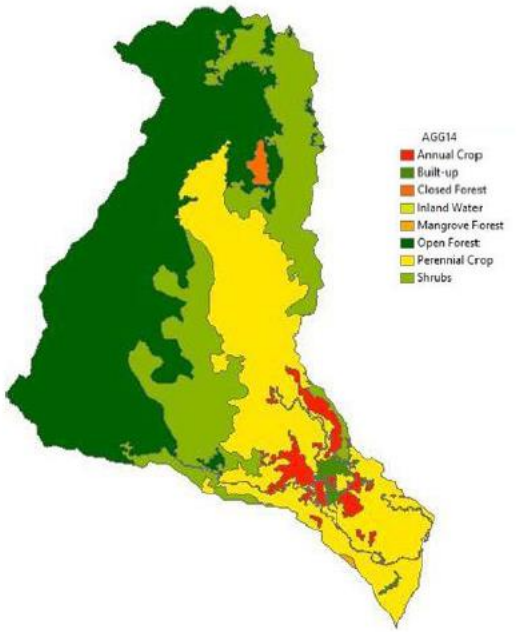
$$NPV = \sum_{t=0}^{T} \frac{Ct}{(1+r)^t} = C_0 + \frac{C_1}{(1+r)^1} + \frac{C_2}{(1+r)^2} + \frac{C_3}{(1+r)^3} + \ldots$$

- NPV = Net Present Value
- C = Net benefits in year t
- T = Discount period (e.g. 20 year)
- r = Discount rate

The NPV reflects the monetary value of an investment on the basis of it's cash flow during a discounting period and a discount rate

Results thesis Verna Duque Palawan (1)

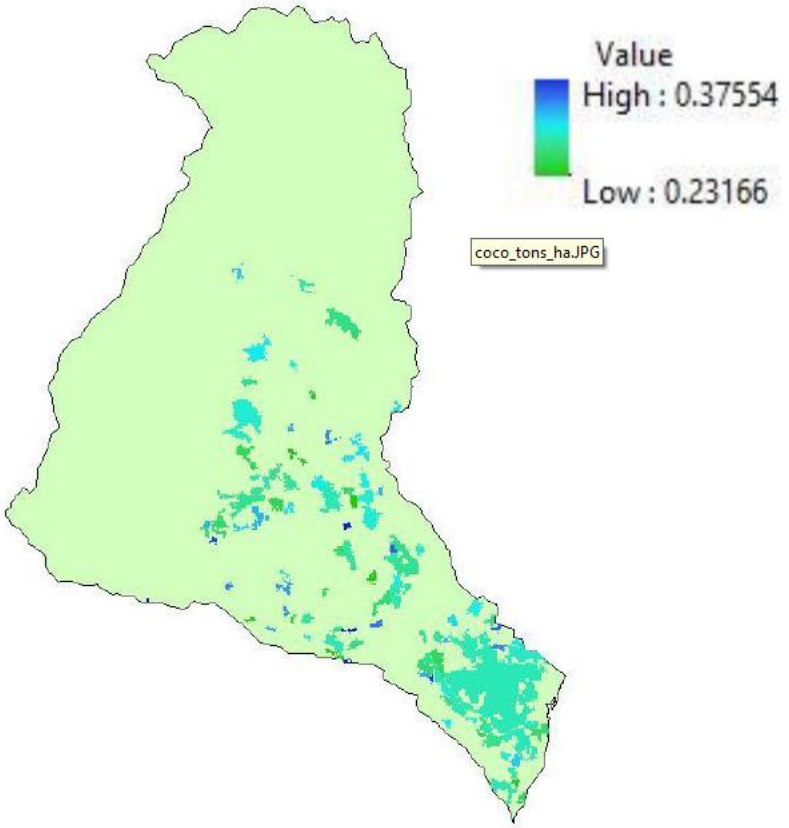
1. **Land-use map**



Source: pulot_lancover.shp
Palawan Council for Sustainable Development
Year: 2010

Results thesis Verna Duque Palawan (2)

1. Coconut production (Copra)



Mapped per pixel not hectare (yet)

Figure 1 Map of Copra yield (tons pixel^{-1}) in Pulot Watershed

Table 2 Detailed statistics of Coconut Map (Copra)

Average yield (tons ha^{-1}yr^{-1})	Mean (tons pixel^{-1})	STDEV	MAX	MIN	Area (ha)	# of Pixels	Area per pixel	Total Yield (tons yr^{-1})
1.32	0.38	0.01	0.38	0.23	903	6350	0.142205	1319

Results thesis Verna Palawan (3)

2. Paddi rice production (Palay)

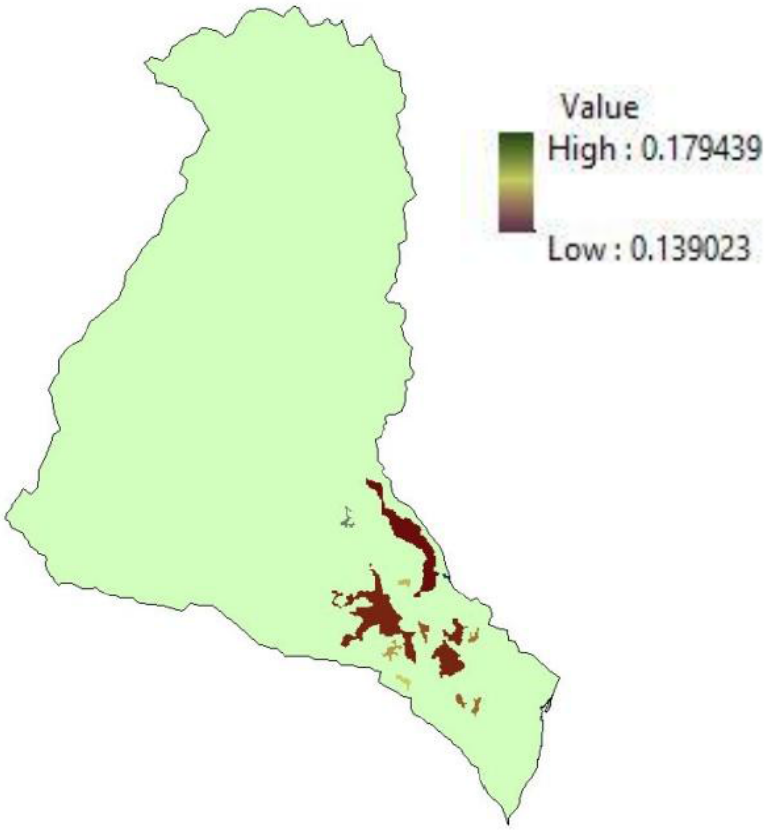


Figure 3 Map of Palay yield (tons pixel^{-1}) in Pulot Watershed

Table 3 Detailed statistics of Paddi Rice Map (Palay)

Average yield (tons ha^{-1}yr^{-1})	Mean (tons pixel^{-1})	STDEV	MAX	MIN	Area (ha)	# of Pixels	Area per pixel	Total Yield (tons yr^{-1})
4.06	0.14	0.01	0.18	0.14	496	15057	0.032941	3689

Results thesis Verna Palawan (4)

3. Palm oil production (Palm fruit bunch)

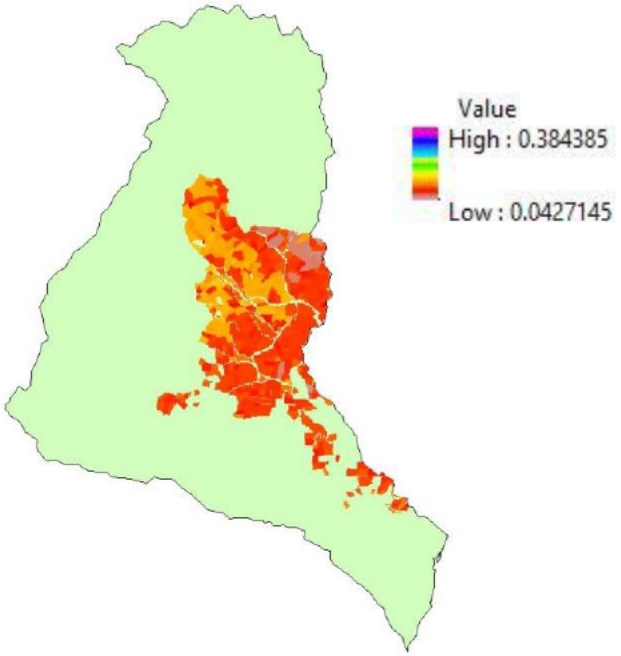


Figure 5 Map of Palm fruit yield (tons pixel^{-1}) in Pulot Watershed

Table 4 Detailed statistics of Palm Oil Map (Palm fruit bunch)

* Average yield (tons ha^{-1}yr^{-1})	Mean (tons pixel^{-1})	STDEV	MAX	MIN	Area (ha)	# of Pixels	Area per pixel	Total Yield (tons yr^{-1})
0.39	0.10	0.04	3.06	0.00	665	22936	0.028994	165,167
**0.61								
0.83								

* Average yield was based on data from Cooperatives.

** Represents the average value of the other two average values which was assigned for lot numbers not belonging to any Cooperatives but is classified as Palm oil plantation using SPOT 2.5 image.

Results thesis Verna Palawan (12)

4. Water yield

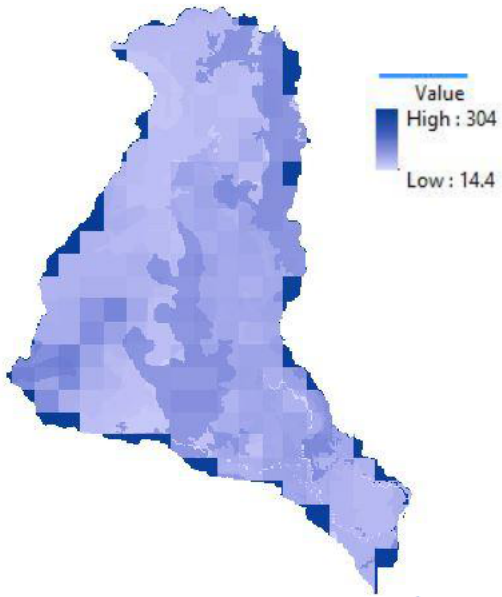


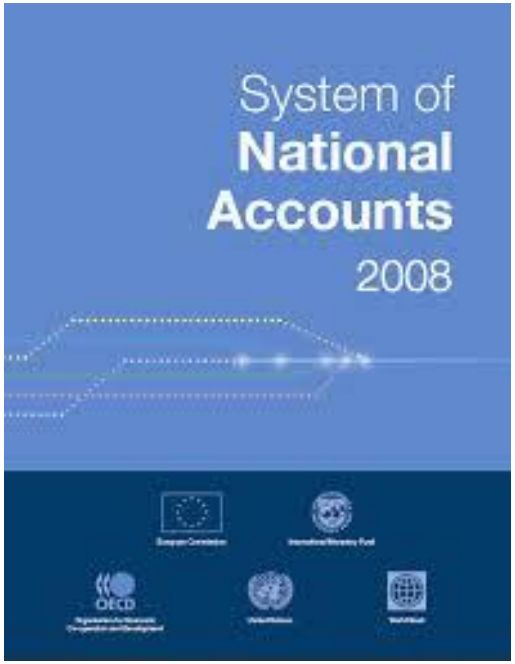
Figure 7 Map of water yield (mm pix^{-1}) in Pulot Watershed

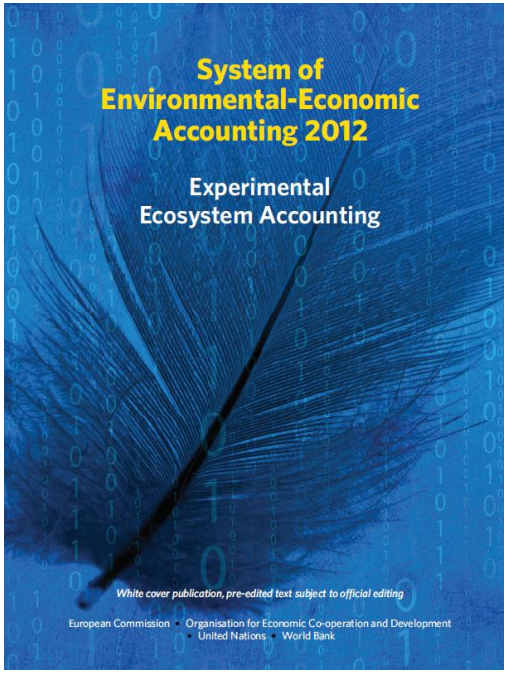
But: the model only results in water yield, not in water storage (and water flows are not taken into account)

Table 5 Detailed statistics of water yield in Pulot Watershed

ws_id	num_pixels	precip_mn (mm)	PET_mn (mm)	AET_mn (mm)	wyield_mn (mm)	wyield_vol (m^3)
1.00	40942.00	137.46	81.66	68.05	78.62	14450093.34

From models to accounts





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Source: Edens and Hein, 2013

The ecosystem accounts (as currently under development)

- Ecosystem condition account
- Physical ecosystem production account
- Monetary ecosystem production account
- Physical ecosystem asset account
- Monetary ecosystem asset account
- Supply- Use Table
- Biodiversity account

The system is somewhat flexible: allowing countries to select accounts and indicators that are most relevant to their setting.

The ecosystem condition account

- Contains indicators that reflects the condition/state of the ecosystem
- Indicators are specific to countries and ecosystems
- Contains indicators may reflect, e.g.:
  - Physical condition, e.g. soil fertility (for instance soil organic matter concentration), water table, (ground)water quality
  - Biological condition, e.g. crown cover, standing biomass
  - Processes: e.g. Net Primary Production
  - The presence of species that indicate ecological quality, e.g. species sensitive to pollution
  - The presence of conservation flagship species indicating ecological condition and important for ecotourism and biodiversity conservation such as the orangutan
  - The presence of species that reflect ecosystem functioning such as keystone species

Production account – physical and monetary

- Expresses the supply of ecosystem services in physical and monetary terms, in a map
- Supply of each ecosystem service is calculated for each grid cell (i.e. BSU)
- Information can also be organised in a table, for instance per land cover unit (LCEU) (or per administrative unit if relevant)
- With GIS, the spatial variability can be calculated (mean, standard deviation)
- The map is essential, examples of the summary tables are provided in the next slides

Physical ecosystem production account, example

Land cover/ ecosystem unit	Rice production (ton)/1	Vegetable production (ton)	Oil palm production (ton FFB)	Coconut production (ton)	Timber production (ton)	NTFP production (ton)	Carbon seque-stration (ton C)	(dry season) River water generated (ton)	Erosion avoided (ton sediment)
Paddy field									
Annual cropland									
Oil palm plantation									
Forest									
Etc.									
TOTAL									

Note: in the map: all units in ton per ha; in the table: total ton per LCEU (plus SD)

Ecosystem accounting table

EAU	Ecosystem service													
	Crop production		Fodder production		Drinking water extraction		Hunting		Air quality regulation		Forest carbon sequestration		Recreational cycling	
	Total	Mean (SD)	Total	Mean (SD)	Total	Mean (SD)	Total	Mean (SD)	Total	Mean (SD)	Total	Mean (SD)	Total	Mean (SD)
	Mtons MEQ	kg MEQ ha^{-1} yr^{-1}	ktons dm	kg dm ha^{-1} yr^{-1}	10^3 m^3 water	m^3 water ha^{-1} yr^{-1}	kg meat	kg meat km^{-2} yr^{-1}	tons PM_{10}	kg PM_{10} km^{-2} yr^{-1}	ktons C	kg C ha^{-1} yr^{-1}	10^3 trips	trips ha^{-1} yr^{-1}
Pasture	-	-	521	12,041 (1,573)	9,110	3,099 (2,231)	9,100	21 (17)	405	911 (532)	-	-	1,872	103 (78)
Cropland	2.46	36,314 (1,785)	-	-	14,855	3,082 (2,422)	14,732	20 (17)	715	956 (534)	-	-	2,631	99 (73)
Forest	-	-	-	-	4,577	3,214 (2,624)	8,100	24 (20)	686	2,040 (1,221)	55	1,563 (263)	1,472	126 (94)
Water	-	-	-	-	3,289	9,460 (3,698)	-	-	40	624 (569)	-	-	147	110 (92)
Urban	-	-	-	-	7,862	4,321 (3,527)	-	-	285	547 (562)	-	-	2,735	70 (57)
Heath	-	-	-	-	219	1,293 (821)	678	32 (25)	45	2,062 (1,111)	-	-	30	82 (59)
Peat	-	-	-	-	0	0 (0)	70	13 (3)	7	970 (345)	-	-	3	92 (44)
Other nature	-	-	-	-	1,187	3,093 (2,567)	1,513	25 (20)	69	1,155 (710)	-	-	226	128 (93)
Provincial total	2.46		521		41,099		34,193		2,252		55		9,116	

Source: Remme et al., submitted

Monetary ecosystem production account, e.g.

Land cover/ ecosystem unit	Rice production ($)	Vegetable production ($)	Oil palm production ($)	Coconut production ($)	Timber production ($)	NTFP production ($)	Carbon seque-stration ($)	(dry season) River water generated ($)	Erosion avoided ($)
Paddy field									
Annual cropland									
Oil palm plantation									
Forest									
Etc.									
TOTAL									

Valuation of provisioning services follows the same logic as the SNA production account, i.e. the resource rent approach. For regulating services different valuation methods apply as discussed

Ecosystem asset account, principal components:

- Opening, changes in assets and closing stocks
- Challenges remain for including regulating services, perhaps for some services not useful to work with opening and closing stocks, in this case there is a need to reflect on different indicators to express the asset and its value.
- Again, the maps are essential, the summary tables just organise the data at a higher aggregation level to make it easier to communicate (see next ppt slides).
- Opening stock, natural increases and losses, harvest and closing balance are to be defined for every pixel (/BSU)

Physical ecosystem asset account, e.g.

	Paddy fields	Annual cropland	Oil palm plantations	Forests				
Ecosystem service	Rice production	Vegetable production	FFB production	Timber production	NTFP production	Carbon seque-stration	Water regulation	Erosion control
Unit	ton/ha	Ton/ha	ton/ha	ton/ha	Ton/ha	Ton/ha	Water storage capacity in mm	not relevant
Opening stock	x (may be zero)	x (may be 0)	x	x	x	x	x	not relevant
Natural replenishment	x	x	x	x	x	x (sequestration)	? (e.g. soil formation)	not relevant
Natural losses	x	x	x	x	x	x (e.g. fire)	x (e.g. due to erosion or land use change)	x (erosion rate)
Harvest	x	x	x	x	x	x (e.g. wood)	not relevant	not relevant
Closing stock	x	x	x	x	x	x	x	not relevant

Monetary asset account, e.g.

	Paddy fields	Annual cropland	Oil palm plantations	Forests				
Ecosystem service	Rice production	Vegetable production	FFB production	Timber production	NTFP production	Carbon seque-stration	Water regulation	Erosion control
Unit	$/ha	$/ha	$/ha	$/ha	$/ha	$/ha	$/ha (as a consequence of avoided floods or avoided water storage costs downstream)	$/ha (expressed as benefits of avoided erosion due to vegetation ?)
Opening stock	x (may be zero)	x (may be 0)	x	x	x	?	x	not relevant
Natural replenishment	x	x	x	x	x	x (sequestration)	x (?)	not relevant
Natural losses	x	x	x	x	x	x (e.g. fire)	x (?)	x
Harvest	x	x	x	x	x	x (e.g. wood)	not relevant	not relevant
Closing stock	x	x	x	x	x	Not relevant	x	not relevant

Biodiversity account

- Useful in order to capture biodiversity, which is of key interest for environmental management and policy making.
- Note that some biodiversity data may also be captured in the condition account, (the biodiversity account may build upon the condition account, for instance to express habitat quality)
- Relevant indicators depend on the country and ecosystem, but may include aspects such as species diversity, species numbers, red list species, mean species abundance, occurrence of specific flagship species, habitat quality etc.
- Complementary to the other ecosystem accounts, since many aspects of biodiversity are not reflected otherwise in the accounts.
- Also requires a spatial approach, i.e. a map expressing the selected indicators per pixel, complemented with summary tables organised as per the requirements of the user (e.g. per administrative unit, or land cover unit) – in particular to express trends over time (since biodiversity in different ecosystems is difficult to compare)

Supply – Use table

- Reflecting supply and use from non-financial, financial co-operations, central government, households, NPISHs and the ecosystem sector (see bullet point 1 next slide)
- The suppliers of the service are the land owners (in case of private goods) or the 'ecosystem sector' (in the case of intermediate or final regulating services) (– see Edens and Hein paper for details and an example)
- The final users of provisioning services may be industries (e.g. using oil palm fruit to produce palm oil), governments, or households (picking berries)
- The user of the regulating services may be the household sector (e.g. in case of reduced air pollution) or the government sector (perhaps in case of flood control)

Thank you