System of Environmental Economic Accounting

Regional Training Workshop on the SEEA Experimental Ecosystem Accounting

Handouts for compilation exercises

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1 OVERVIEW

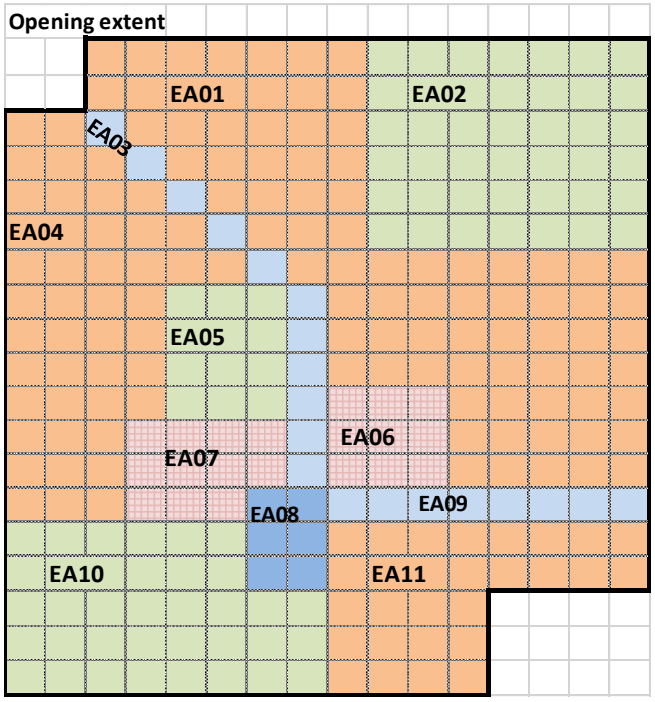
This handout contains:

- Exercises that will be made during the training
- Reference materials (in Annex)

2 EXERCISES

2.1 Units and ecosystem extent

Exercise 1: Calculate area of each EA (ecosystem asset) and ET (ecosystem type)



EA Table

Ecosystem Asset (EA)	ha
EA01 = Herbaceous crops	80
EA02 = Tree covered areas	42
EA03 = Inland water bodies	
EA04 = Herbaceous crops	45
EA05 = Tree covered areas	
EA06 = Artificial surfaces (urban)	
EA07 = Artificial surfaces (urban)	
EA08 = Shrubs..regularly flooded (wetland)	
EA09 = Inland water bodies	
EA10 = Tree covered areas	
EA11 = Herbaceous crops	
Total	288

Note: Each Basic Spatial Unit (BSU) = 100m*100m = 1 ha

Instructions:

Step 1: Count the number of BSUs for each EA and fill-in the EA table

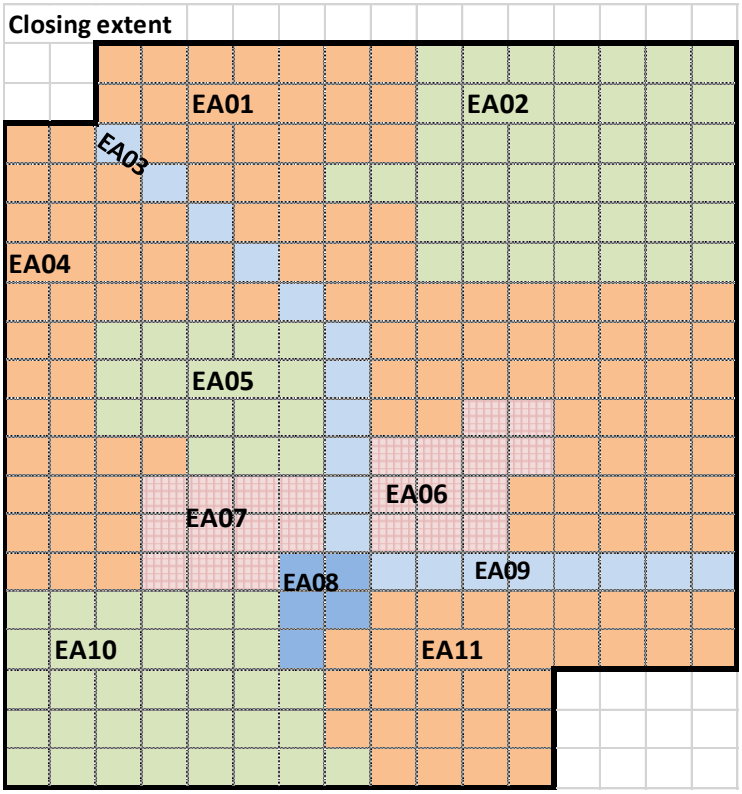
Step 2: Summarize the extent by ETs in the summary table

Summary Table

Ecosystem Type (ET)	ha
Artificial surfaces (urban)	
Herbaceous crops	
Tree covered areas	
Inland water bodies	
Shrubs..regularly flooded (wetland)	
Total	288

Exercise 2: Compile an ecosystem extent change matrix

See below the ecosystem extent at the end of the accounting period, the beginning period is shown in Exercise 1 above. As you can see there have been several changes in ecosystem extent from t1 to t2.



Instructions:
Step 1: Count the number of cells (hectares) for each EA that has changed its ecosystem type.
Step 2: Enter the opening ecosystem extent from exercise 1 in the opening column in the table below.
Step 3: Enter the closing ecosystem extent in the closing row in the table below.
Step 4: Record all changes in extent from one ET to another (tip – the diagonal are cells that remain unchanged)
Step 5: Check your answer by summing across columns and rows to get the correct totals.

		Closing Extent						
		Artificial surfaces (urban)	Herbaceous crops	Tree covered areas	Inland water bodies	Shrubs..regularly flooded (w	Other	**Opening**
Opening Extent	Code							
Artificial surfaces (urban)		20	0	0	0	0	0	**20**
Herbaceous crops		3						
Tree covered areas		0						
Inland water bodies		0						
Shrubs..regularly flooded (wetland)		0						
Other		0						
Closing		**23**						**288**

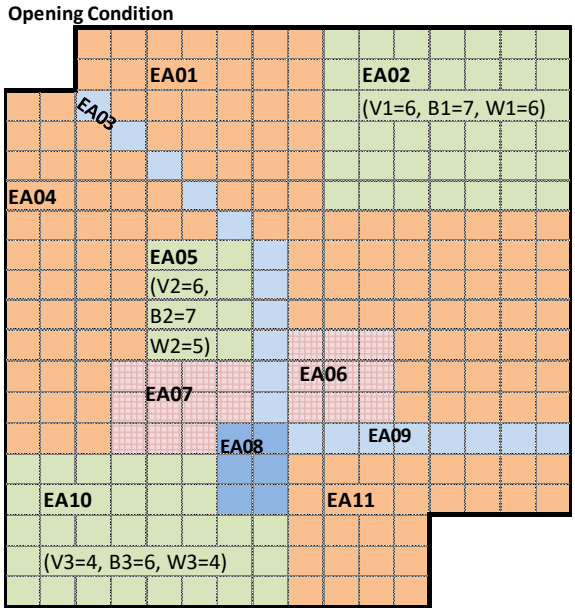
Exercise 3: Compile an ecosystem extent account

Another way of summarizing the changes from t1 to t2 is in the form of an ecosystem extent account that record opening and closing stocks and changes therein. Use the information from exercise 2 to compile the account.

Ecosystem extent account							
	Artificial surfaces (urban)	Herbaceous crops	Tree covered areas	Inland water bodies	Shrubs..regularly flooded (w	Other	**Total**
Opening Stock	**20**						
Additions to Stock	3						
Reductions in Stock	0						
Closing Stock	**23**						

2.2 Condition

Exercise 4: Calculate improvements and reductions in condition for tree covered areas



Assume we assess the condition of the various ecosystems by looking at three variables:

1) Vegetation as measured by Soil Organic Carbon (SOC)
2) Biodiversity (as measured by species richness)
3) Water quality (as measured by a relevant variable such as BOD – biological oxygen demand).

We assume that these variables have been normalized (with respect to a reference condition) and are expressed on a scale from 1-10, with 1 very poor condition, and 10 very high condition).

Condition Table

EA	Extent (ha)	(V) Vegetation (e.g. SOC)	(B) Biodiversity (species richness)	(W) Water (e.g. BOD)	Index
EA01 = Herbaceous crops	80	4.00	3.00	5.00	4.00
EA02 = Tree covered areas	42				
EA03 = Inland water bodies	11	5.00	6.00	6.00	5.67
EA04 = Herbaceous crops	45	3.00	2.00	4.00	3.00
EA05 = Tree covered areas	12				
EA06 = Artificial surfaces (urban)	9	2.00	2.00	4.00	2.67
EA07 = Artificial surfaces (urban)	11	2.00	1.00	3.00	2.00
EA08 = Shrubs..regularly flooded (wetland)	6	5.00	7.00	5.00	5.67
EA09 = Inland water bodies	8	3.00	3.00	4.00	3.33
EA10 = Tree covered areas	36				
EA11 = Herbaceous crops	28	3.00	2.00	3.00	2.67
	288				

EA Type	Extent (BSU)	Vegetation	Biodiversity	Water	Index
Artificial surfaces (urban)	20	2.00	1.45	3.45	2.30
Herbaceous crops	153	3.52	2.52	4.34	3.46
Tree covered areas	90				
Inland water bodies	19	4.16	4.74	5.16	4.68
Shrubs..regularly flooded (wetland)	6	5.00	7.00	5.00	5.67
Total	**288**				

Instructions:

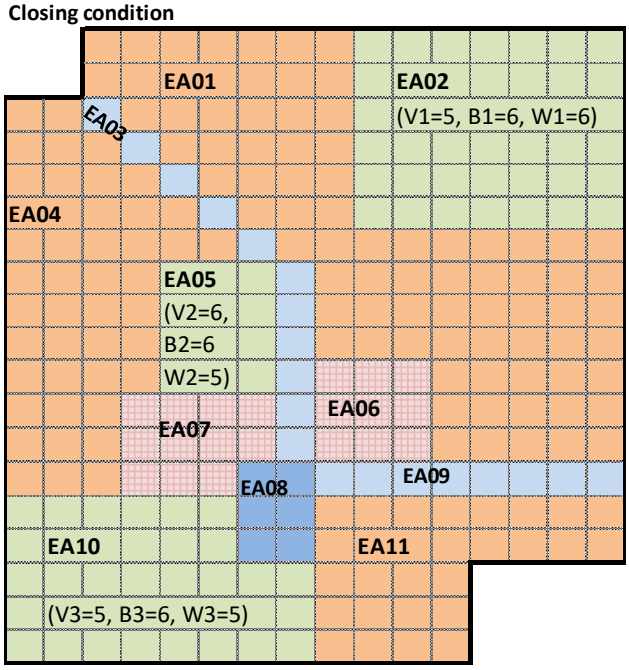
Step 1: Transfer the condition measures from the map to the Condition Table for EA02, EA05 and EA10.

Step 2: Calculate the Index for each of those EAs, i.e., (V+B+W)/3

Step 3: Calculate the averaged condition measure for Forest Tree Cover by multiply condition index * extent for each EA; sum them and divide by total extent). Calculate the index for the ET.

Exercise 5: Compile a condition account

Closing condition



Condition Table

EA	Extent (BSU)	Vegetation	Biodiversity	Water	Index
EA01 = Rainfed herbaceous cropland	80	4.00	3.00	6.00	4.33
EA02 = Forest tree cover	42				
EA03 = Inland water bodies	11	5.00	6.00	7.00	6.00
EA04 = Rainfed herbaceous cropland	45	3.00	3.00	5.00	3.67
EA05 = Forest tree cover	12				
EA06 = Urban and associated developed	9	2.00	2.00	4.00	2.67
EA07 = Urban and associated developed	11	2.00	1.00	3.00	2.00
EA08 = Open wetlands	6	5.00	7.00	6.00	6.00
EA09 = Inland water bodies	8	3.00	3.00	5.00	3.67
EA10 = Forest tree cover	36				
EA11 = Rainfed herbaceous cropland	28	3.00	3.00	4.00	3.33
	288				

EA Type	Extent (BSU)	Vegetation	Biodiversity	Water	Index
Urban and associated	20	2.00	1.45	3.45	2.30
Rainfed herbaceous cropland	153	3.52	3.00	5.34	3.95
Forest tree cover	90				
Inland water bodies	19	4.16	4.74	6.16	5.02
Open wetlands	6	5.00	7.00	6.00	6.00
Total	**288**				

Instructions:
Step 1: Repeat the calculations for the opening condition for the closing condition. NB: for sake of simplicity, we assume that the extent did not change during the accounting period.
Step 2: Transfer the values for Opening and Closing Conditions to the appropriate row of the Condition Account.
Step 3: Calculate difference between Opening and Closing Conditions (Closing - Opening)
Step 4: Record Improvements (positive values) in the Improvements row
Step 5: Record reductions (negative values) in the Reductions row

Condition Account

	Extent (BSU)	Artificial surfaces (urban)	Herbaceous crops	Tree covered areas	Inland water bodies	Shrubs..regularly flooded (wetland)
Opening Conditions	288	2.30				
Improvements in condition						
Reductions in condition						
Closing Conditions	288	2.30				

Which ecosystem has deteriorated in condition?

2.3 Carbon account

Exercise 6: Compile a carbon account

A technique often used to compile a carbon account is using a so-called look-up table approach (see below).

Look up table	Carbon storage (tC/ha)	Carbon uptake by biomass (tC/ha)
Artificial surfaces	5	1
Crops	40	4
Grassland	10	2
Tree covered area	200	15
Mangroves	800	100
Shrub covered area	80	5
Regularly flooded areas	300	24
Sparse natural vegetated areas	8	1
Terrestrial barren land	0	0
Permanent snow, glaciers and ir	0	0

Instructions:

Step 1 – Use the look-up table and the extent account to assess opening stocks of carbon
Step 2 – Use the look-up table and the extent change matrix to assess carbon uptake by biomass (i.e. assume that carbon uptake is only taking place in cells that are not converted from one ET to another)
Step 3 – For all converted areas make the assumption that the conversion takes place completely during the accounting period (e.g. the change in carbon stocks from forest to crops is 200-40 = 160).
Step 4 – Assume a forest fire takes place in EA02 that reduced the stocks from 215 to 25 for 4 BSUs.
Step 5 – Calculate the net changes. These net changes are called NECB (net ecosystem carbon balance – which is the metric proposed (aligned with IPCC guidelines) to estimate carbon sequestration.
Step 6 – Calculate the closing stocks.

Simplified Carbon Stock Account

	Artificial surfaces (urban)	Herbaceous crops	Tree covered areas	Inland water bodies	Shrubs..regularly flooded (we	Other	Total
Extent (opening stock)	**20**	**153**	**90**	**19**	**6**	**0**	**288**
Extent (closing stock)	**23**	**145**	**96**	**19**	**5**	**0**	**288**
Opening	**100**						
Addition - carbon uptake by biomass	20						
Addition - conversion	15						
Reduction - forest fire	0						
Reduction - conversion	0						
Net change	*35*						
Closing	**135**						

Questions for discussion:

- What about carbon in water bodies? (blue carbon)
- You will have found negative NECB for one ET- how to interpret negative numbers?
- How to interpret NECB by cropland (short-lived biomass)?

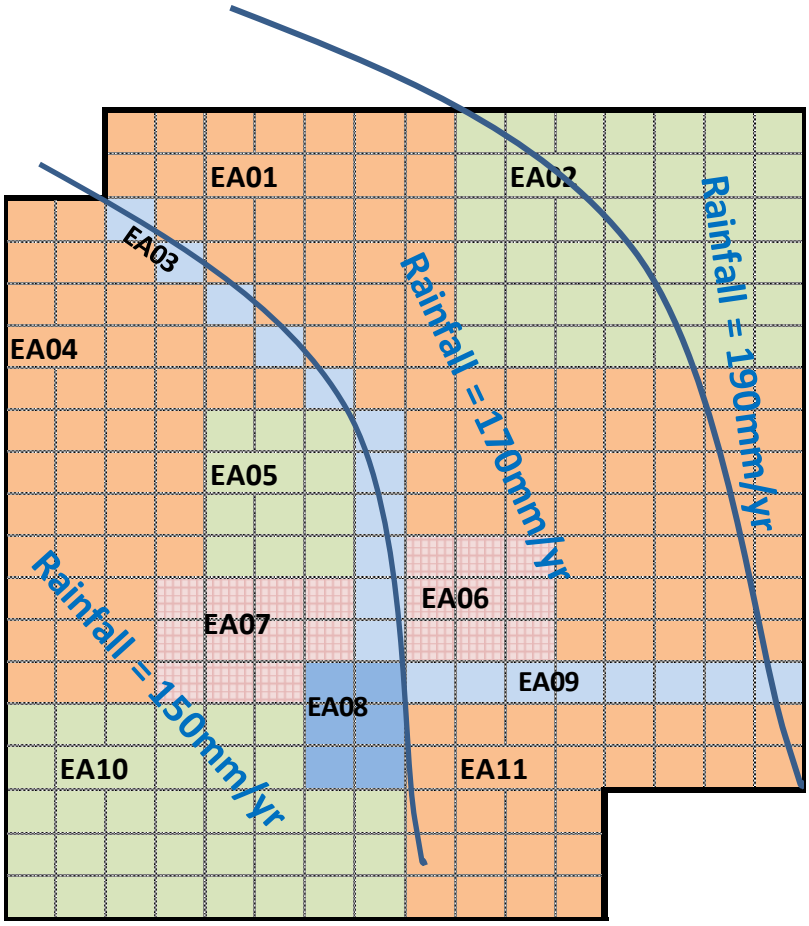
2.4 Ecosystem services - supply

Exercise 7: Model unknown crop service for EA04

Estimate the value of herbaceous crops of EA 04 (the orange cell) using the following simplified biophysical model:

crop yield is proportional to average rainfall.

Instructions:
Assume that the total crop yield in EA01 was 18,700 tons/year.
Step 1: Calculate average rainfall for EA01 taking into consideration that EA01 spreads across 2 rainfall zones.
Step 2: Calculate yield per ha for EA01
Step 3: Calculate yield per ha for EA04 based on the biophysical model
Step 4: Aggregate across whole extent of EA04.


EA01
EA02
EA03
EA04
EA05
EA06
EA07
EA08
EA09
EA10
EA11
Rainfall = 190mm/yr
Rainfall = 170mm/yr
Rainfall = 150mm/yr

Exercise 8: Estimate unknown ecosystem services and supply account

Services Supply Database

EU	Extent (ha)	(C) Crop tonnes/year	(R) Recreation trips/year	(W) Water m^3/year	(S) Carbon Sequestration tonnes /year
EA01 = Herbaceous crops	80	18,700	500	0	0
EA02 = Tree covered areas	42	0	1,500	0	270
EA03 = Inland water bodies	11	0	1,600	15,000	
EA04 = Herbaceous crops	45				
EA05 = Tree covered areas	12				
EA06 = Artificial surfaces (urban)	9	0	500	0	
EA07 = Artificial surfaces (urban)	11	0	700	0	
EA08 = Shrubs..regularly flooded (wetland)	6	700	5,000	0	
EA09 = Inland water bodies	8				
EA10 = Tree covered areas	36				
EA11 = Herbaceous crops	28	6,545			
Total	**288**				

Instructions:

The objective is to fill out all empty cells in the service supply table.

Step 1: use information from the carbon account to fill out the information on carbon sequestration.

Step 2: fill out the information on crop supply for EA04 (orange cell) from exercise 7 above.

Step 3: estimate the remaining values from nearest neighbour for (C), (R) and (W) for the missing EAs; e.g., Crop for EA11 = Crop for EA01 / 80 * 28.

Step 4: Calculate totals for each service

Step 5: Aggregate the results by ET in the table below.

Services Supply Account

EU Type	(C) Crop Tonnes	(R) Recreation Trips	(W) Water m^3	(S) Carbon Sequestration tonnes
Artificial surfaces (urban)				
Herbaceous crops				
Tree covered areas				
Inland water bodies			**25,909**	
Shrubs..regularly flooded (wetland)				
Total			**25,909**	

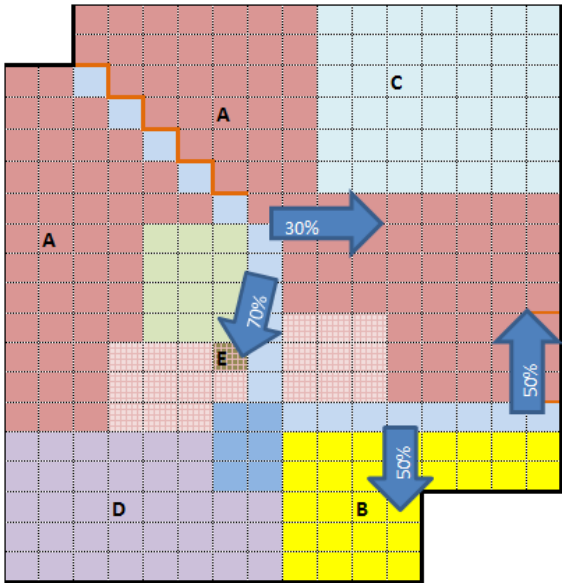
2.5 Ecosystem services - use

Exercise 9: Compile ecosystem service use account

In order to compile the ecosystem service use account we need information about the location of the beneficiaries of the various ecosystem services (see figure below). In addition to economic activities, the use table also has so called final demand categories (e.g. households / government) – see Annex for the format of the PSUTs.

Services Use Account

Beneficiaries (based on survey)	(C) Crop Tonnes	(R) Recreation Trips	(W) Water m^3	(S) Carbon Sequestration tonnes
Agriculture - cereals				
Agriculture - other				
Water supply sector				
Recreation				
Households				
Government				
Total				



Economic units	**ISIC - Classification of economic activities**
A	0111 - Growing of cereals (except rice), leguminous crops and oil seeds
B	Other agriculture
C	0113 - Growing of vegetables and melons, roots and tubers

D	5520 - Camping grounds, recreational vehicle parks and trailer parks
E	36 - Water collection, treatment and supply
F	Households
G	Government

Instructions

- Assume that all visits to the forest EA10 (i.e. D) are for a campsite
- Water use allocation percentages are indicated in the figure above.
- Check your answer as supply needs to equal use (for each individual ecosystem service)!

Discussion question?

- Who is the main user of carbon sequestration?

2.6 Valuation

Exercise 10: Calculate resource rent for crop provisioning

Estimate the resource rent for crop provisioning services using the following data for the EAA as a whole:

- Value of sales $500 thousands
- Costs of seeds, fertilizers $ 40 thousands
- Wages $200 thousands
- Replacement value of machinery $400 thousands
- Remaining lifetime of machinery 10 years
- Rate of return for investment 8 %
- Investment 50 $

Exercise 11: Compile the ecosystem services supply account in monetary terms

Assumptions:

- Water supply service has been estimated using a replacement cost approach. If river falls dry the cost of pumping groundwater: 0.01 USD/litre
- For valuing carbon sequestration use the social cost of carbon (SCC) of 100 USD/tC
- Recreation: assume the travel cost approach has found a price of: 8 USD per visit.

Services Supply Account (monetary)

EU Type	Extent (ha)	(C) Crop $	(R) Recreation $	(W) Water $	(S) Carbon Sequestrat $	Total $	per ha $/ha
Artificial surfaces (urban)	20						
Herbaceous crops	153						
Tree covered areas	90						
Inland water bodies	19						
Shrubs..regularly flooded (v	6						
Total	**288**						

Which ET has the highest value per hectare of supplied services?

Annex – PSUT (Physical Supply and use table including ecosystem services)

ECOSYSTEM SERVICES SUPPLY TABLE

	Measurement Units	Type of economic unit								Proxy ecosystem type (based on land cover)															TOTAL SUPPLY
		Agriculture, forestry and fisheries	Electricity, gas supply	Water collection, treatment and supply	Other industries	Governmens	Households	Accumulation	Rest of the world - Imports	Artificial surfaces	Herbaceous crops	Woody crops	Multiple or layered crops	Grassland	Tree-covered areas	Mangroves	Shrub-covered areas	Regularly flooded areas	Sparse natural vegetated areas	Terrestrial barren land	Permanent snow and glaciers	Inland water bodies	Coastal water and inter-tidal areas	Sea and marine areas	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15									
Ecosystem services																									
Provisioning services																									
Biomass accumulation																									
- Timber																									
- Crops																									
- Grass / fodder																									
- Fish																									
Water abstraction																									
Regulating services		A								B															
Carbon sequestration																									
Water regulation																									
Water purification																									
Air filtration																									
Nutrient/waste remediation																									
Pest & disease control																									
Soil retention																									
Cultural services																									
Enabling tourism and recreation																									
Enabling nature based education and research																									
Enabling nature based religious and spiritual experiences																									
Products		C								D															

ECOSYSTEM SERVICES USE TABLE

	Measurement Units	Type of economic unit								Proxy ecosystem type (based on land cover)															TOTAL USE
		Agriculture, forestry and fisheries	Electricity, gas supply	Water collection, treatment and supply	Other industries	Governmens	Households	Accumulation	Rest of the world - Exports	Artificial surfaces	Herbaceous crops	Woody crops	Multiple or layered crops	Grassland	Tree-covered areas	Mangroves	Shrub-covered areas	Regularly flooded areas	Sparse natural vegetated areas	Terrestrial barren land	Permanent snow and glaciers	Inland water bodies	Coastal water and inter-tidal areas	Sea and marine areas	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15									
Ecosystem services (detail correpsonding to supply table)																									
Provisioning services																									
Regulating services		E								F															
Cultural services																									
Products		G								H															