Practical for the course: Ecosystem Services

Valuation of Coral Reef Degradation in St. Lucia -Answers

Question 1: Please identify indicators that can be used to describe, in physical terms, the three services provided by coral reefs, as well as indicators to describe the capacity of the coral reefs to generate these services.

Answer:

	Flow	Capacity
Fisheries	'provisioning of fish to fisheries' (ton fish/year)	Maximum sustainable fish production (ton fish/year) (i.e.)
Tourism	Offering opportunities for tourism (number of divers on coral reefs/year)	Offering opportunities for tourism (number of divers on coral reefs/year)
Coastal Protection	Protection of coastal zones inhabited and/or used by people (km)	Protection of coastal zones (km)

Question 2: What is the flow of the ecosystem service 'provisioning of fish', and what is the capacity of St Lucian coral reefs to support fisheries ?

Answer:
The **flow** of this service, i.e. the actual harvest of fish is 10% of 1625 ton = 162.5 ton/year

To analyze the **capacity**: multiply reef productivity with the amounts of reef present in each category (assuming a total reef area of 90 km^2).

Status of the Reef	Productivity (metric ton/km^2/yr)	Share	Maximum sustainable production (ton/year)
healthy, low threat	4	0.1	36
medium threat	2.3 – 2.9	0.5	117
high threat,	0.7 – 1.7	0.4	43.2

Total capacity: 196.2 ton/year

Question 3: Calculate the flow of this service in physical terms, expressed as number of overnight stays that can be attributed to diving opportunities provided by coral reefs. What would be the capacity to support diving tourism ?

Answer:

The number of divers at present is: 32,051 (10% * 320,510)

It is very difficult to make a realistic assessment of the capacity of the number of divers. For the purpose of analyzing capacity in an accounting context, trends in diving numbers could be examined and it could be examined if these trends could be extrapolated into the future (i.e. if there would be no barriers to facilitate growth, for instance limited infrastructure or facilities that could not be resolved in the examined time frame). For the purpose of this practical, assume that capacity equals the current number of divers.

Question 4. How can this service be expressed in physical terms ? How can the capacity - in physical terms - to provide this service be expressed ? Assume for this exercise that a degraded coral reef provides the same level of protection, in the short term, as a non-degraded coral reef.

The capacity coastal protection is generated on 21% of 158 km of shoreline, i.e. on 33.2 km. The service flow is generated on 61% of 33.2 km = 20.2 km.

Question 5. Calculate the monetary value of fisheries on coral reefs in St. Lucia. Use resource rent as indicator for monetary value. Note that resource rent (RR) equals: TR (total revenue) - IC (intermediate consumption) – CE (labor costs) - CC (consumption of fix capita).

TR = Total production: 162,500 kg/year * market price = 6 US$/kg = 975000 US$/year
Aggregated costs = 162,500 kg/year * 3 US$/kg = 487500 US$/year
Resource rent = 487500 US$/year

Question 6. Calculate the NPV of the capacity of the reefs to support fisheries. Use a market discount rate of 8% and a 20 years discount period.

Answer:

Year	2014	2015	2016	..	..	2033
Cash flow	588,600	588,600	588,600	..	..	588,600
Discounted cash flow	588,600	545,000	504,630	..	..	136,386
Net present value (US$)	6,241,278					

Note that this simplified calculation assumes that there is no decline in capacity in the course of the coming years. At present, the flow does not exceed the capacity so overfishing does not appear to be a problem. Of course, there may be other factors (e.g. pollution) that may affect the capacity but such other factors are not considered in this practical.

Question 7. Imagine that a large proportion (e.g. over 40%) of the St Lucian labor force would be working as fisherman. How does this influence the calculation of the resource rent ? And what would happen to the resource rent generated by fisheries in case it was managed as a pure open access, common pool resource where over time resource rents would be driven to zero ?

Answer:
This would mean that the salary costs are influenced by the presence of the fishing opportunities provided by the reefs. The rent may in this case underestimate the economic value of the reef (i.e. because there would be few alternative employment opportunities for local people). These aspects are not considered in ecosystem accounting and do not need to be given the objective of being aligned with the SNA. However this example serves to illustrate one of the differences between economic valuation and monetary valuation in an accounting context.

Note that in an open access-common pool management system, new fishermen would keep on entering the market (or existing fishermen would expand their capacities) up to the point where the resource rent approaches zero. This means that the monetary value, in an accounting context, of this resource would be driven to zero. Giving a zero value to a natural resource on which many livelihoods may depend does not appear to be intuitively right and requires further consideration in the development of valuation approaches that can be applied to ecosystem accounting.

Question 8: Calculate the value of the tourism service provided by St Lucian coral reefs and the NPV of the capacity of the reefs to support tourism. Use the same assumptions as in question 6 above. Note that multipliers are not considered in monetary valuation consistent with SNA.

Resource rent = 2100 * 32051 * 0.35 = 23,557,485

Year	2014	2015	2016	..	2033
Cash flow	23,557,485	23,557,485	23,557,485	..	23,557,485
Discounted cash flow	23,557,485	21,812,486	20,196,746	..	5,458,553
Net present value (US$)	249,794,129				

Question 9. What is the monetary value of the coastal protection service as expressed through an avoided damage cost approach ? Consider both flow and capacity for this service as well. Note that an alternative approach would be the replacement cost approach, which would estimate the value of this service on the basis of the costs of constructing alternative coastal protection structures. A critical consideration here is if it can realistically be expected that such structures would indeed be constructed. This will generally be the case if: (i) this is technically feasible, and (ii) if damage costs exceed replacement costs. For reasons of simplicity this practical uses the avoided damage costs only.

Answer:

Development of shore line		Threat level		Coastline	Aggregate
category	US$/km	category	damage factor	km	US$
low	11,000	low	1	22.12	243320
low	11,000	medium	0.9	14.22	140778
low	11,000	high	0.8	25.28	222464
medium	45,000	low	1	3.16	142200
medium	45,000	medium	0.9	11.06	447930
medium	45,000	high	0.8	44.24	1592640
high	300,000	low	1	0	0
high	300,000	medium	0.9	1.58	426600
high	300,000	high	0.8	34.76	8342400
SUM				156.42	11,558,332

Hence, the current value of the coastal protection service according to this calculation method is US$ 12 million per year.

Question 10. Prepare a physical and a monetary accounting table for the LCEU (Land Cover/Ecosystem Unit) 'Coral reefs' in St. Lucia. Note that a comparable table can be produced to record the capacity of coral reefs to provide these services. Is the accounting table complete ? (i.e. does it over all benefits provided by coral reefs?). Which service may be missing ?

Table 6. Partial Physical Ecosystem Accounting table (1 LCEU only)

LCEU	Area (ha)	Fisheries (ton/year)	Diving recreation (divers/year)	Coastal protection (km developed coast line protected)
Coral reefs, of which	90 km^2	162.5	32051	20.2
- Healthy reefs				
- Medium degraded reefs				
- Highly degraded reefs				

Table 7. Partial Monetary Ecosystem Accounting table (1 LCEU only)

LCEU	Area (ha)	Fisheries ($/year)	Diving recreation ($/year)	Coastal protection ($/year)	Total ($/year)
Coral reefs, of which	90 km^2	588,600	23,557,485	11,558,332	35,704,417
- Healthy reefs					
- Medium degraded reefs					
- Highly degraded reefs					

Question 11. What are the total costs of coral reef degradation that has taken place in St. Lucia, expressed as capacity to generate ecosystem services ?

Fisheries: Fisheries production in case of pristine coral reef : 4 * 90 = 360 ton / year

Difference (i.e. loss as a consequence of coral reef degradation) : (360-196=) 164 ton/year

Costs: 164 ton * US$ 6/ kg * 50% = US$ 492,000 / year

Tourism: The annual loss in diver numbers can be calculated as follows (assuming for the purpose of this exercise that there has already been a loss of 10% in the number of divers coming to St Lucia):

Divers in the absence of degradation: 35,612 (10% * 320,510 / 0.9)

Divers at present: 32,051 (10% * 320,510)

Difference (i.e. loss that occurred already): 35,612 – 32,051 = 3561

Costs: US$ 2.6 million (3561 * 2100 * 0.35)

Coastal protection: For pristine coral reef the value is US$ 14.2 million per year (see below). The difference (i.e. the loss of the service due to reef degradation) = 14.2 – 11.6 = US$ 2.6 million per year.

Development of shore line		Threat level		Coastline	SUM
category	US$/km	category	damage factor	km	
low	11,000	low	1	22.12	243320
low	11,000	medium	1	14.22	156420
low	11,000	high	1	25.28	278080
medium	45,000	low	1	3.16	142200
medium	45,000	medium	1	11.06	497700
medium	45,000	high	1	44.24	1990800
high	300,000	low	1	0	0
high	300,000	medium	1	1.58	474000
high	300,000	high	1	34.76	10428000
				156.42	14,210,520