CHAPTER 6. THE ECONOMIC LOSS ASSOCIATED WITH CORAL REEF DEGRADATION

PHOTO: WOLCOTT HENRY

Coral reefs have important ecosystem functions that provide crucial goods and services to hundreds of millions of people, mostly in developing countries. Within Southeast Asia, in particular, the potential sustainable economic value of coral reefs is substantial, as is the potential economic loss if these resources are degraded.

THE ECONOMIC VALUE OF HEALTHY REEFS

Coral reef fisheries are an important source of food and income for local populations. In the Philippines, for example, coral reefs supply between 11 and 29 percent of the total fisheries production.[158] In addition, the extraordinary biodiversity of coral reefs provides scientific, pharmaceutical, and educational value. Moreover, coral reefs are potent tourist attractions, and they protect countless coastal developments from shoreline erosion. Where tourism currently exists or the potential for development is good, tourism associated with reefs can be extremely valuable. Although reefs identified as having good tourism potential make up only a small percentage of the coral reefs of the region, they represent some of the highest value reefs in the region.

Over the past decade, several efforts have advanced our ability to quantify the economic value of coral reefs.[159] Table 4 provides a summary of the sustainable annual economic net benefits per square kilometer of healthy coral reef in Southeast Asia. These values are the potential monetary benefits to society after the costs of operation have been deducted. Estimates of total potential annual economic net benefit per square kilometer of healthy coral reef in areas with tourism potential range from US$23,100 to US$270,000. The range in potential benefits is large because of the variety and scale of different tourism operations. The range of total annual net benefits is lower for areas without tourism potential, US$20,000–US$151,000 per square kilometer. *(See Table 4.)*

TABLE 4. POTENTIAL SUSTAINABLE ANNUAL ECONOMIC NET BENEFITS PER KM² OF HEALTHY CORAL REEF IN SOUTHEAST ASIA

RESOURCE USE (DIRECT AND INDIRECT)	PRODUCTION RANGE	POTENTIAL ANNUAL NET BENEFITS (US$)
Sustainable Fisheries (local consumption)	10–30 tonnes	$12,000 – $36,000
Sustainable Fisheries (live fish export)	0.5–1 tonnes	$2,500 – $5,000
Coastal Protection (erosion prevention)		$5,500 – $110,000
Tourism and Recreation	100–1,000 persons	$700 – $111,000
Aesthetic/Biodiversity Value (willingness to pay)	600–2,000 persons	$2,400 – $8,000
Total (fisheries and coastal protection only)		**$20,000 – $151,000**
Total (including tourism potential and aesthetic value)		**$23,100 – $270,000**

SOURCES:
Adapted from A.T. White, H.P. Vogt, and T. Arin, "Philippine Coral Reefs under Threat: The Economic Losses Caused by Reef Destruction," *Marine Pollution Bulletin* 40, 7 (2000): 598-605; A.T. White and A.Cruz-Trinidad, *The Values of Philippine Coastal Resources: Why Protection and Management are Critical* (Cebu City: Coastal Resource Management Project, 1998) p. 28; and H.S.J. Cesar, "Economic Analysis of Indonesian Coral Reefs," Working Paper Series 'Work in Progress' (Washington, DC: World Bank, 1996).

NOTE:
Data are based on estimates for Indonesia and the Philippines only. *(See Appendix 2 for additional detail.)*

INDIVIDUAL GAIN AND SOCIETAL LOSS

This report has detailed the many human activities that damage or degrade coral reef resources. Degraded coral reefs lose value because they are less productive, providing fewer goods and services than healthy reefs. For instance, although a healthy coral reef might provide an average sustainable fisheries yield of 20 tonnes per year, the yield of a reef damaged by destructive fishing practices is likely to be much lower, under 5 tonnes per year.[160] Even if they are only partially destroyed, coral reefs do not quickly return to high levels of productivity. Blasted reefs can take up to 50 years to regain 50 percent of their original coral cover and be productive again.[161]

Activities that damage coral reefs can be lucrative to individuals in the short term. However, net benefits to those involved in the destructive activity are often small compared to the net losses to society from the decreased production of the coral reef ecosystem. Table 5 compares benefits to individuals and losses to society in terms of reduced goods and services over a 20-year period for many of the damaging activities described in this report. For example, fishers engaged in blast fishing may earn US$15,000 per square kilometer, but they generate losses to society over a 20-year period ranging from US$91,000 to US$700,000 per square kilometer. The wide range of losses reflects the wide range in the value of potential tourism benefits that could be lost. *(See Table 5.)*

VALUATION ESTIMATES FOR INDONESIA AND THE PHILIPPINES

By integrating information on potential net annual benefits per square kilomter of healthy coral reefs *(from Table 4)* with data on coral reef area from RRSEA, one can estimate the potential total sustainable annual economic net benefits from coral reefs for Indonesia and the Philippines. This analysis is based upon estimates of coral reef area, extent of areas with tourism potential, and level of coastal development. The estimate considers fisheries, tourism, coastal protection, aesthetics, and biodiversity benefits, but it does not include future value from potential pharmaceutical development. The potential sustainable economic net benefits per year from coral reefs are US$1.6 billion for Indonesia and US$1.1 billion for the Philippines. This benefit comes primarily from sustainable fisheries, followed by coastal protection and tourism. *(See Table 6.)* Assuming the same yield and prices for the rest of the region, the sustainable fisheries benefit for all of Southeast Asia is estimated to be US$2.4 billion per year.[162]

TABLE 5. TOTAL NET BENEFITS AND LOSSES ON SOUTHEAST ASIAN CORAL REEFS BY ACTIVITY (NET PRESENT VALUE[a] IN US$ 000 PER KM² OVER 20 YEAR PERIOD)

ACTIVITY	NET BENEFITS TO INDIVIDUALS	LOSSES TO SOCIETY				
		FISHERY	COASTAL PROTECTION	SUSTAINABLE TOURISM	OTHERS (E.G. BIODIVERSITY)	TOTAL LOSSES (QUANTIFIABLE)
Poison Fishing	33	37	N.Q.	3-409	N.Q.	40-446
Blast Fishing	15	80	8-170	3-450	N.Q.	91-700
Coral Mining	121	87	10-226	3-450	> 67	167-830
Sedimentation from Upland Activities	98	81	N.Q.	192	N.Q.	273
Overfishing	39	102	N.Q.	N.Q.	N.Q.	102

SOURCE:
Adapted from H. Cesar et al., "Indonesian Coral Reefs – An Economic Analysis of a Precious but Threatened Resource," *Ambio 26*, 1(1997): 345-58.

NOTES:
a. The Net Present Value (NPV) provides a summary of the value of the resource by aggregating annual benefits over a 20-year period, but it gives greater weight to the near future by using a "discount rate" of 10 percent per year. This discount means that the current benefits of a future good are reduced by 10 percent for each year into the future. Use of this high discount rate may underestimate future losses.
N.Q. = not quantified.

TABLE 6. POTENTIAL SUSTAINABLE ANNUAL ECONOMIC NET BENEFITS FOR INDONESIA AND THE PHILIPPINES (US$ MILLION)

RESOURCE USE (DIRECT AND INDIRECT)	INDONESIA (US$ MILLION)	PHILIPPINES (US$ MILLION)
Sustainable Fisheries	1,221	620
Coastal Protection (erosion prevention)	314	326
Tourism and Recreation[a]	103	108
Aesthetic/Biodiversity Value (willingness to pay)	9	10
Total Net Annual Benefits	1,647	1,064
Net Present Value (NPV)[b]	14,035	9,063

SOURCE:
Based on economic values of goods and services per km² from Table 4 and RRSEA estimates of reef area, area with tourism potential, and coastal development. *(See Appendix 2 for additional details.)*

NOTE:
a. Areas with tourism potential are defined as those within 10 km of current tourist centers.
b. For the definition of NPV, see Table 5.

ANALYSIS OF LOSS FROM DAMAGING ACTIVITIES

The majority of coral reefs across Southeast Asia are under threat from human activities. Table 7 uses economic data on potential losses from damaging activities and data from RRSEA on areas at risk from blast fishing, overfishing, sedimentation from upland sources, and areas with high tourism potential to estimate the economic costs of these human activities for Indonesia and the Philippines. *(See Table 7.)* The societal costs of these practices significantly outweigh the benefits in all categories examined.

Overfishing is the activity that is the most financially detrimental to reefs in Indonesia and the Philippines. In Indonesia, fishing sustainably can generate as much as US$63,000 per km² more over a 20-year period than overfishing on healthy reefs (the difference between a US$102,000 loss to society and a US$39,000 gain to the individual). *(See Table 5.)* The pervasiveness of overfishing in Indonesia—more than 32,000 km² of reefs are overfished—results in massive societal losses, estimated at US$1.9 billion over twenty years. Financial damage from overfishing more than 21,000 km² of reefs in the Philippines is estimated at US$1.2 billion. *(See Table 7.)*

TABLE 7. NET LOSSES TO SOCIETY OVER A 20-YEAR PERIOD FROM OVERFISHING, BLAST FISHING, AND UPLAND ACTIVITIES IN INDONESIA AND THE PHILIPPINES (US$ MILLION)

	BENEFITS TO INDIVIDUALS	LOSSES TO SOCIETY				NET LOSSES
	A	B	C	D	E=B+C+D	F=E-A
ACTIVITY	NET PRIVATE BENEFITS FROM ACTIVITY	FOREGONE SUSTAINABLE FISHERY INCOME	LOSS OF COASTAL PROTECTION	LOSS OF TOURISM REVENUES[a]	SUMMARY OF ECONOMIC LOSSES OF REEF SERVICES	NET LOSS TO SOCIETY FROM ACTIVITY
Indonesia						
Blast Fishing	370	570	160	210	940	570
Overfishing	1,160	3,030	0	N.Q.	3,030	1,870
Sedimentation from Upland Activities	20	20	0	100	120	100
Philippines						
Blast Fishing	360	640	520	370	1,530	1,170
Overfishing	740	1,950	0	N.Q.	1,950	1,210
Sedimentation from Upland Activities	60	50	0	124	174	114

SOURCE:
H. Cesar, "Economic Analysis of Indonesian Coral Reefs"; H. Cesar et al., "Indonesian Coral Reefs : An Economic Analysis of a Precious but Threatened Resource"; and H. Cesar, *Collected Essays on the Economics of Coral Reefs*, and RRSEA reef area estimates.

NOTES:
The values are presented in net present value (NPV) over 20 years using a 10% discount rate. They are based on cross-tabulations of Reefs at Risk results by threat category and benefit or loss estimates based on Table 5 and numbers from H. Cesar. For the definition of NPV, see Table 5. *(For technical details see Appendix 2.)*
a. Areas with tourism potential are defined as those within 10 km of current tourist centers.
N.Q.= not quantified

Blast fishing also results in substantial financial losses for both Indonesia and the Philippines. The total net losses from blast fishing are US$1.2 billion in the Philippines and US$570 million in Indonesia. Despite the greater area of Indonesian reefs, loss is higher in the Philippines because of the prevalence of blast fishing.

Although there are short-term gains, the rapid pace of inland development in Indonesia and the Philippines causes long-term societal losses. For this analysis, the project looked only at the impact of sedimentation caused by logging in tourism areas. Outside tourism areas, direct economic losses from sedimentation are much lower.[163] Because areas of high sediment do not always overlap with tourism centers, the estimated losses from sedimentation are relatively low (US$100 million in Indonesia and US$114 million in Philippines).

Total losses from unsustainable activities in Indonesia and the Philippines are significant. Not shown on Table 7 are potential losses from fishing with poisons, coastal development, marine-based sources of pollution, and sedimentation from upland sources in areas without significant tourism potential. Effective planning and management of coastal areas would have substantial economic benefits not only in the Philippines and Indonesia but also across Southeast Asia. These benefits could be particularly high in areas with good tourism potential.

For more information on the economic value of good stewardship, see www.wri.org/wri/reefsatrisk.