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Analysis

National Estimates of Values of Philippine Reefs' Ecosystem Services

Natasha Charmaine A. Tamayo[a,*], Jonathan A. Anticamara[a], Lilibeth Acosta-Michlik[b,c]

[a] Institute of Biology, College of Science, University of the Philippines, Diliman, Quezon City 1101, Philippines
[b] Department of Community and Environmental Resource Planning, College of Human Ecology, University of the Philippines Los Baños (UPLB), Philippines
[c] Potsdam Institute for Climate Impact Research (PIK), Telegraphenberg, 14473 Potsdam, Germany

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ABSTRACT

Ecosystem Services (ES) – the direct (e.g., food and natural medicines) and indirect (e.g., cultural diversity and aesthetic values) benefits people obtain from various ecosystems – need to be assessed to aid decision makers and concerned public in creating policies that ensure continuous flow of ES to their beneficiaries (e.g., fisheries, food, income, livelihood, and traditional way of life to fishers and consumers). However, to date, ES assessments in Philippine reefs are mostly concentrated only on fisheries and tourism or on few areas in the Philippines (e.g., Pangasinan and Bohol Marine Triangle). This study fills research gaps by assessing coral reefs across 15 regions in the Philippines by estimating the following: (1) potential reef fisheries and Willingness-To-Pay (WTP) biodiversity values using underwater surveys and literature data, (2) reef fisheries value using Bureau of Fisheries and Aquatic Resources (BFAR) and literature data, (3) tourism value using Department of Tourism (DOT) and literature data, and (4) Total Economic Value (TEV). The TEV of Philippine reefs' ES amounted to 4 billion US $/yr or 140,000 US$/km^2/yr. Furthermore, in each region of the Philippines, annual TEV ranged from 100 to 800 million US$, with potential reef fisheries value contributing the most in the TEV, followed by reef fisheries, tourism, and WTP biodiversity values. In addition, the Visayas regions have the highest values of benefits from coral reefs. Although the Philippines is deriving millions to billions of dollars of economic benefits from coral reefs, the observed degradation and temporal decline in coastal ecosystems could lead to a decline in the potential reef fisheries value, subsequently the TEV. The Philippines need to improve accounting and managing the derived benefits from coral reefs to ensure the sustainability and continuous flow of these benefits for present and future Filipino beneficiaries.

1. Introduction

Ecosystem Services (ES) are the benefits people obtain from various ecosystems. ES may be obtained in the form of provision, support, regulation, or cultural activities that may be accessed by their beneficiaries directly (e.g., food, water, and natural medicines), indirectly (e.g., cultural diversity, spiritual or religious values, and aesthetic values), or both directly and indirectly (Boyd and Banzhaf, 2007; MA, 2003; Wallace, 2007). Considering the importance of these services to human well-being, the distribution and flow of ES across space and time needs to be properly assessed in order to manage ES and to ensure its continuous supply (Pratchett et al., 2014; Rees et al., 2010). But due to an unsustainable use, there is a continuous deterioration in ecosystems, from global to local scale; and consequently, the services that these ecosystems provide (Pratchett et al., 2014; Rhodes et al., 2014; Wilkinson et al., 2006).

In assessing ES, scientists use various approaches including the Total Economic Value (TEV) framework, surveys, and tools or toolkits. TEV surveys are conducted either through questionnaires given to citizens in order to understand people's perception on benefits; or through the use of the Delphi technique, which is an expert-based approach (Polasky et al., 2011; Turoff, 1970). Tools, toolkits, and modeling software are also developed and applied to estimate ES variations across different spatio-temporal scenarios (Peh et al., 2013; Vigerstol and Aukema, 2011).

Most ES studies, however, focus only on the economic evaluations aspect (e.g., fisheries and tourism) of ES – making non-economic aspects (e.g., cultural and spiritual) of ES categories underrepresented (Daniel et al., 2012; Vihervaara et al., 2010). Non-economic values must be integrated in ES studies since those values have an important role in motivating the public in managing and conserving ecosystems (Daniel et al., 2012; Wallace, 2007). Socio-cultural aspects of ES must be studied as well to understand what benefits are prioritized by individuals (Hicks et al., 2014; Martín-López et al., 2012). The Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) strongly advocates for the reflection of multiple values (e.g., holistic-

* Corresponding author.
E-mail addresses: natamayo1@up.edu.ph (N.C.A. Tamayo), lilibeth@pik-potsdam.de (L. Acosta-Michlik).

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indigenous, biophysical, economic, health-based, and socio-cultural) in accounting for ES or Nature's Contribution to People (NCP); however, to date, the assessment of ES is mostly limited to particular types of values and therefore needs to be expanded (Pascual et al., 2017).

Among centers of marine endemism, the Philippines was ranked as the country with the highest average coral reef threat (Roberts et al., 2002). Philippine coral reefs are threatened by climate change and anthropogenic activities, such as fisheries overexploitation and destructive fishing practices (Lavides et al., 2009). The ineffective management of coral reefs and fisheries would lead to a continual decline of species richness at a local level; and consequently, at a national level (Alcala and Russ, 2006; Anticamara and Go, 2016a; Anticamara et al., 2015; Nañola et al., 2011). Improving local to national management of protected areas, including ES assessments, is vital in reviving a healthy biodiversity (Nañola et al., 2011).

The assessments of the Philippine ES are being conducted (Arin and Kramer, 2002; Cruz-Trinidad et al., 2011; Samonte-Tan et al., 2007; White et al., 2000a). However, most of these studies are focused mainly on economic evaluations of fisheries and tourism, and are conducted only on few areas in the country (e.g., Pangasinan and Bohol Marine Triangle) (Cruz-Trinidad et al., 2011; Samonte-Tan et al., 2007). This study fills research gaps by conducting a more comprehensive coral reef ES assessment to capture economic values of fisheries (bio-physical), tourism (socio-cultural), and biodiversity (partly holistic e.g., including inherent value) across 15 Philippine regions. Specifically, it aims to assess the following: (1) potential reef fisheries and Willingness-To-Pay (WTP) biodiversity values using underwater surveys and literature, (2) reef fisheries value using data from the Bureau of Fisheries and Aquatic Resources (BFAR) and literature, (3) tourism value using data from the Department of Tourism (DOT) and literature, and (4) Total Economic Value (TEV); although here, upfront, we declare that we have not represented all possible multiple values due to lack of data. The paper is structured as follows: Section 2 discusses the conceptual framework for the empirical estimation of the TEV and its components; Section 3 describes the methods used in assessing Philippine coral reef ES; Section 4 shows and discusses the results; Section 5 discusses the implications of the Philippine ES assessment; and Section 6 concludes the study.

2. Conceptual Framework

The TEV framework, which accounts for use and non-use values of ES, was applied in this study (Fig. 1) (Gómez-Baggethun et al., 2009; Subade, 2007). In the 1990s, Turner and Pearce explained that use values involve the actual use of the resource, while non-use values involve people's preferences (Subade, 2007; Turner and Pearce, 1993). Years later, Barbier et al. further differentiated use and non-use values by stating that use values involve human interaction with the resource or habitat; while non-use values do not involve human interaction (Barbier et al., 1997; Subade, 2007). In addition, use values may be gained directly (e.g., reef fisheries and tourism) or indirectly (e.g., potential reef fisheries) from the ecosystem (Barbier et al., 1997; Barton, 1994; Subade, 2007). On the other hand, non-use values include the option value, which is gained from avoiding the loss of biodiversity and its future use (Subade, 2007). Although bequest and existence values are not explicitly included in this study, Subade (2005) noted that biodiversity values may also be accounted in bequest and existence values.

3. Methods

3.1. Study Sites and Sampling

Fish biomass in 97 reef sites and coral cover in 130 reef sites, from 14 Philippine regions, were studied and determined using standardized underwater survey techniques (Fig. 2) (Go et al., 2015). The reef sites, which were selected using Google Earth satellite image of Philippine reefs, represent all three major island groups of the Philippines (Luzon, Visayas, and Mindanao) and six marine biogeographic regions (Northern, Southern, and West Philippine Seas; Visayan Sea, Sulu Sea, and Celebes Sea) (Go et al., 2015; Ong et al., 2002). In addition, the reef sites were selected based on factors such as site accessibility, travel time, and travel costs (Go et al., 2015).

To survey fish biomass in the chosen reef sites, Underwater Visual Census (UVC) belt transect method was utilized. From March 2012 to August 2013 at around 9 AM to 2 PM, 313 transects (3–4 transects per reef site) with a total area of 100 m^2 per transect (20 m long × 5 m wide) were surveyed (Go et al., 2015). The transects were laid parallel to reef slopes with a depth between 3 and 6 m; and in each transect, the count and length estimates of all diurnally-active and non-cryptic reef fishes with a minimum length of 1 cm were recorded (Go et al., 2015). Underwater photographs were also taken during the surveys to verify the identification of the reef fishes. Reef fish species length estimates

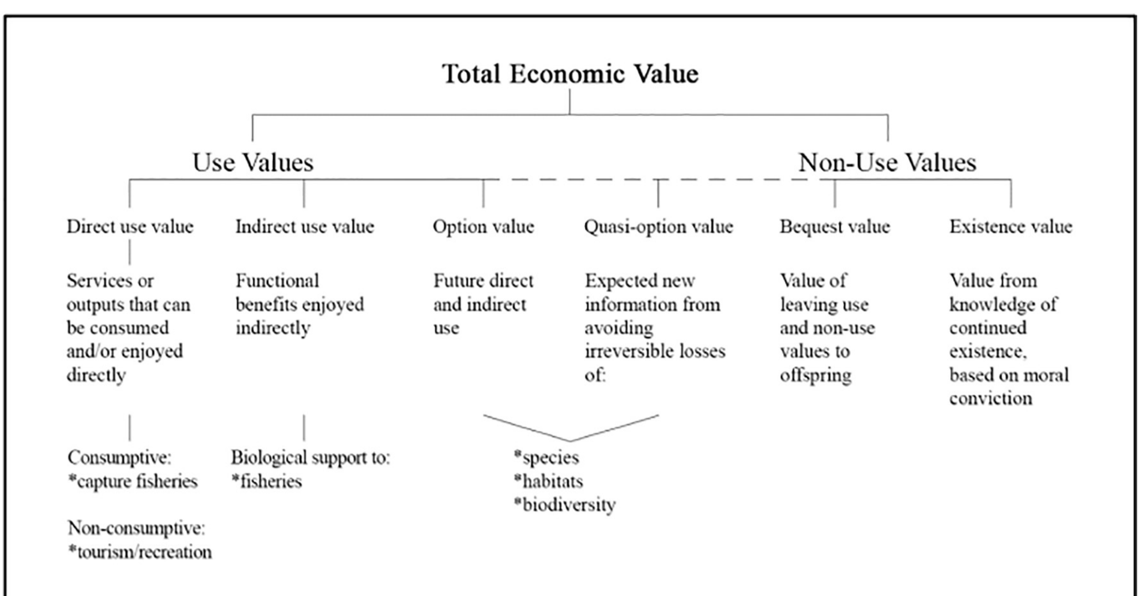

Fig. 1. Coral reef Total Economic Value and attributes adapted and modified from Subade (2007).