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The benefits of cyclones: A valuation approach considering ecosystem services

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ABSTRACT

Cyclones (i.e. typhoons, hurricanes) are known for their destructive power and negative effects on livelihoods. Potential benefits are often ignored, when some people depend on cyclone impacts. Currently few publications on potential benefits exist, and most concern a single country or cyclone. This study documents an overview of the existing global knowledge on cyclone benefits and presents a regional focus on Bangladesh, the Philippines, and Japan. The results expand available options for ecosystem based adaptation schemes by highlighting how benefits can be valued as ecosystem services.

Responses from experts in South-East Asia suggest that although cyclones are commonly understood to result in detrimental effects; various cases proved to have practical benefits. Example benefits include an increase in soil organic matter content, eliminating the need for fertilizers; collecting increased wind power through wind farms; and selling collected debris as a form of additional income. The results further show which ecosystem service valuation approaches can be applied to the identified benefits of cyclones, and which type of services and valuation approaches require further attention. While cyclone impacts cannot be precisely anticipated, knowledge of their benefits and corresponding valuation approaches form an important basis to offset their devastation.

1. Introduction

Disaster risk managers are quite familiar with the negative aspects of cyclones, as these often cause loss of life, heavy damages in built environments, and have negative effects on shipping, fisheries, and tourism (UNISDR, 2015). Statistics show that the average global annual losses from cyclones and storm surges are estimated at US$80 billion (UNISDR, 2015). Since 1980 economic losses from risks of cyclones have been increasing, namely by 265% in the OECD, 181% in sub-Saharan Africa, and just over 150% in other regions (UNISDR, 2011). From 1980 to 2015, the total number of people killed by cyclones was nearly 450,000 and the average number of people affected annually was over 24 million (CRED, 2015), with people in developing Asian countries suffering the most (Doocy et al., 2013).

What is often neglected, from the perspective of ecosystem-based Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA), is the potential benefits of cyclones for both humans directly and the environment as a whole. This has led to a small number of studies on the benefits of cyclones, which often address either one area or one cyclonic event. The objectives of the current study are to bring together the studied beneficial effects of cyclones and identify the monetary valuation approaches applicable to the potential benefits of cyclones. This is done in response to the call for further studies that give insight in methods that take advantage of cyclone benefits (Tabios III, 2010). One notable study examining the reported literature on the beneficial effects of cyclones was performed 27 years ago by Conner et al. (1989), from the perspective of US coastal ecosystems in the Gulf of Mexico. While they mention 7 different types of cyclone benefits, they make no classification or connection to ecosystem services and valuation approaches, as performed in the current study. Since the 1989 study, many advances have been made in both technical and ecological approaches to sustainable development, warranting a deeper, comprehensive, and up-to-date literature review of the benefits of cyclones.

For this reason, the goal of this study was to create an up-to-date overview of the current body of literature addressing cyclone benefits, and arrange the identified benefits in a logical, and geographically

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scaled manner. This firstly answers what potential benefits of cyclones are reported by previous studies. In addition to a literature review, cyclone specialists working in Southeast Asia were asked to comment on which benefits are known to (potentially) occur in their work areas, and cases from Japan, the Philippines, and Bangladesh were taken into consideration. Secondly, the paper addresses how these benefits might be considered as ecosystem services. The combined literature and case study results were categorized according to the UNEP (2009) ecosystem functions and services (provisioning, regulating, supporting, and cultural services). Thirdly, corresponding valuation techniques were sought out according to approaches laid out in the Economics of Ecosystems and Biodiversity (Pascual and Muradian, 2010) in order to answer what possible valuation approaches for cyclone benefits could be identified. Finally, a brief exploration of practical policy measures incorporating the results of this study is included in the Discussion.

Here, the purpose of limiting the scope of this study to the benefits of cyclones should be made clear. As noted above, to date the damaging aspects of cyclones have been widely covered and well reported, whereas the potential benefits have not and are often forgotten. This may lead to the involved researchers and policymakers neglecting to consider that there may also be benefits for humans or the local ecosystem as a whole from certain habitats and species being negatively affected by cyclones. While it is essential to note that in any cost-benefit analysis, both costs and benefits must be considered, the goal of this study is not to weigh costs and benefits in general and conclude that for habitats and species it is likely that the costs always outweigh the benefits, but rather to illustrate which effects might be beneficial and how this may be quantified in relation to damages in future studies.

The final results provide a wide variety of valuation approaches linked to most of the identified benefits of cyclones. The identified benefits were least related to cultural ecosystem services, implying a lack of studies of benefits that might be considered to provide a cultural service. The most commonly found valuation approaches were cost based, namely replacement costs, direct market pricing, and avoided costs. This allows government officers or other practitioners who are utilizing an ecosystem-based DRR perspective while planning to select monetary valuation approaches relevant to the local, potentially occurring benefits of cyclones.

2. Methods

First the various terms and definitions for cyclone as used in different areas of the world were clarified. Next, the appropriate terms were applied to find relevant literature examples of cyclone benefits. Combining the nomenclature and examples of cyclone benefits, a questionnaire leading to information on case study examples was administered. The resulting benefits of cyclones were linked to corresponding ecosystem services, and, based upon these correspondences, they were linked to monetary valuation approaches.

2.1. Cyclone nomenclature

As there currently is no global consensus on how to scale cyclone intensities according to wind speeds, or how to name them (Commonwealth of Australia, Bureau of Meteorology, 2016a), this was clarified by the means of Figs. A.1 and A.2 in Appendix A. Cyclone naming and associated wind speeds vary between areas and Regionalized Specialized Meteorological Centers (RSMC). We compared the available nomenclature and associated wind speeds between monitored areas. Two monitored areas were excluded from comparison: the RSMC 7 in Nadi, Fiji, which does not provide any classification of wind speeds and nomenclature (Fiji Meteorological Service, RSMC Nadi-Tropical Cyclone Centre, n.d.) and the weather services in Australia, which provides a list based on the strongest gusts of wind experienced, rather than the average sustained surface winds (Commonwealth of Australia, Bureau of Meteorology 2016b, 2016c). For this reason, we compared the nomenclature and associated wind speeds of five RSMCs in La Réunion, New Delhi, Tokyo, Honolulu and Miami (see Fig. A.2), and included the names of the governing committees for each area. For the sake of completeness, the committee for region 6 (approximately covering Indonesia, Papua New Guinea, Australia, and New Zealand) and RSMC 7 in Nadi, Fiji are jointly named the "Tropical Cyclone Committee for the South Pacific and Southeast Indian Ocean" (World Meteorological Organization, n.d).

2.2. Literature review of existing benefits

A data gathering method developed by Johnson et al. (2014) was used to gather existing studies on the benefits of cyclones. This method consists of three general steps: 1) searching major academic databases (Scopus[1], Web of Science[2], and the Natural Hazards Center Online Library Catalog) by using keywords; 2) refining the search results by using specific keywords and removing duplicates; and 3) checking abstracts for relevancy and adding additional and focused search parameters.

The method was adopted in this study as follows. The initial search criteria consisted of 'benefit', and variants of 'cyclone' as understood in various parts of the world, namely 'typhoon' and 'hurricane'. The document types accepted for selection consisted of journal articles, reviews, books, conference papers, surveys, thesis works, and weather organization reports, in English. No restriction was placed on the time of publication. The first round of searching led to a total of 1895 documents. After removing duplicates, 1553 documents remained. However, these documents included unrelated topics along the lines of inhabitants receiving financial benefits after a cyclone affected the area, or the benefits of altering ship routes or early warnings and predictions. For this reason, titles, abstracts or the complete documents in question were individually evaluated to determine their relevance to the scope of the current study. This led to a total of 23 documents concerning one or more benefits of cyclones in the reviewed body of literature. The low number of studies relating to the potential benefits of cyclones supports the premise that this is a largely overlooked topic to date. Most of these studies cover one specific cyclone or one specific country or area, and no studies provided an overview of the known potential benefits of cyclones. Table 1 shows an overview of the search process and resulting documents for each database.

Given the low number of available literature sources, a google scholar search was performed to include additional related documents (e.g., power point presentations and web articles from weather organizations, as well as other publications not included in the referenced databases). The benefits that were found by reviewing the literature were structured according to location (troposphere, terrestrial biosphere, and epipelagic zone), and order of occurrence (cause and effect).

2.3. Examples from Asian countries – study area and questionnaire design

The focus was placed on the northern hemisphere where most cyclones occur and most exposed people are located: in South and Southeast Asian countries located directly in the known tracks of cyclones. This area covers the top six countries, and ten out of the top fifteen countries, with the most people exposed to cyclones worldwide

[1] Scopus consists of > 60 million records from 1995 – present in the form of peer-reviewed journals, trade publications, book series, conference papers, books, records, and patents (Elsevier, 2016).

[2] The Web of Science Core Collection Indexes consists of the Conference Proceedings Citation Index, Emerging Sources Citation Index, Science Citation Index Expanded, Social Sciences Citation Index, Arts & Humanities Citation Index, Index Chemicus, Current Chemical Reactions, and the Book Citation Index, from various years (Thomson Reuters, 2016)

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