



Original Articles

On the vulnerability of Small Island Developing States: A dynamic analysis

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ARTICLE INFO

Keywords:

Vulnerability index
 Small Island Developing States
 Climate change
 Adaptation policies
 Composite indicator

ABSTRACT

Small Island Developing States (SIDS) are generally considered highly vulnerable to climate change because they suffer from most common environmental problems due to their smallness, remoteness and exposure to natural hazards, though they contribute less to climate change. However, international cooperation can improve the negative impacts of climate change by incentivizing adaptation policies. The vulnerability assessment becomes crucial because it can be used to allocate the international cooperation resources targeted to adaptation plans.

The aim of this paper is to assess of the vulnerability in Small Island Developing States.

Using a comprehensive dataset including 32 variables, we synthesize the vulnerability with a composite indicator. Then, we analyze the vulnerability's dynamics over time from 2009 to 2014. Lastly, we explore the dimensions of vulnerability to assess those that have a greater weight on overall vulnerability. Our findings show that the vulnerability of Small Island Developing States is partly driven by common characteristics, such as isolation and extreme exposure to the effects of climate change, but the degree of vulnerability of identified dimensions is different among countries. Our results give indications to better target development aid, giving suggestions on the more relevant dimensions for action to reduce the vulnerability of each country.

1. Introduction

Small Island Developing States (SIDS) were first recognized as a distinct group at the United Nations Conference on Environment and Development in June 1992 where it was stated: "Small Island Developing States, and islands supporting small communities are a special case both for environment and development. They are ecologically fragile and vulnerable. Their small size, limited resources, geographic dispersion and isolation from markets, place them at a disadvantage economically and prevent economies of scale".¹ The United Nations – Department of Economic and Social Affairs (UN-DESA) currently recognizes 57 SIDS (37 UN-Members and 20 Non-UN), which are categorized into three main geographic areas: i) Caribbean, ii) Pacific and iii) Atlantic, Indian Ocean, Mediterranean and South China Sea (AIMS).

These countries suffer from the most common environmental problems (i.e., land degradation and biodiversity losses) due to their smallness, remoteness from the mainland and world markets, and high exposure to natural disasters (see, e.g., Briguglio 1995); these problems are further facilitated by population growth and urbanization (e.g., Barnett, 2011; Connell, 2013). SIDS are generally considered highly vulnerable to climate change. Climate change amplifies the negative consequences on these lands as sea-level rises or precipitation patterns

change (Nurse et al., 2014) thereby reducing agriculture and fisheries, for example. The negative issues affect food security and employment and income, both because they are the main economic sectors and because they affect tourism, which represents one of the main components of the economy in these countries (see, e.g., Barnett, 2011; Yamamoto and Esteban, 2014). Another important sector linked to tourism and international trade is transportation, which is crucial in most SIDS due to the isolated location (Pratt, 2015).

To contrast and reduce the impacts of climate change, the UNFCCC, in 1992, highlighted two fundamental strategies: i) the cuts in GHG emissions from large emitters and ii) engaging in policies of climate adaptation. To reach these goals, a general framework requires assessing and monitoring the vulnerability of SIDS.

Although the interest to quantify vulnerability in the literature is high, divergences exist about a universally accepted definition (Beroy-Eitner, 2016; Hinkel, 2011). Kaspersen and Kaspersen (2001) define vulnerability as "the degree to which an exposure unit is susceptible to harm due to exposure, to a perturbation or stress, in conjunction with its ability to cope, recover, or fundamentally adapt". Füssel (2010) argues, indeed, that vulnerability can be interpreted narrowly as a lack of socio-economic capacity and entitlements to cope with the adverse impacts of climate change. Pratt et al. (2004a), in the manual of

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Environmental Vulnerability Index (EVI), state “When we talk about vulnerability, we are automatically also talking about resilience because the two are opposite sides of a single coin”. On the other hand, the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) (2014) defines vulnerability as the propensity or predisposition to be adversely affected, including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.² Some authors (see e.g., [Guillaumont, 2015, 2016](#)) include the concept of resilience in the assessment of vulnerability. Moreover, the concept of vulnerability and/or resilience can regard specific aspects (i.e., economic vulnerability, environmental resilience) and/or particular areas (i.e., Pacific area, developing countries). [Garschagen and Romero-Lankao \(2015\)](#) focus their attention on urbanization-vulnerability, suggesting that urbanization may have blurred effects on overall vulnerability whereas [Nguyen et al. \(2016\)](#), analyzing eco-tourism destinations, assess that eco-environmental vulnerability is the result of the composite of more processes affected by hydrometeorology, society economics, land resources, and topography. When the vulnerability – related to the intrinsic sensitivity to exposure to exogenous or endogenous risks and the capacity to manage or adapt to them – is discussed with respect to SIDS, the concept is mainly linked to their remoteness from main markets, dependence on energy and food and their small size, including the large range of impacts from climate change ([UNDESA, 2015; UN-ECLAC, 2011; Beroya-Eitner, 2016; Bates et al., 2014; Briguglio, 2014](#)). [Guillaumont \(2010\)](#), analyzing the economic vulnerability index built by the [United Nations – Committee for Development Policy \(UN-CDP\)](#) (see the [United Nations report, 1999](#)) argues that vulnerability in SIDS countries consists of three components, including the size and frequency of the exogenous shocks, the exposure to them and the country’s resilience. Moreover, the IPCC Fifth Assessment Report identifies the effects of climate change in SIDS in three main areas: coastal systems, terrestrial systems and human systems.

The identification of the determinants of human and natural systems’ sensitivity to climate change become strategic for targeting and evaluating adaptation plans for SIDS countries. The resource allocations to developing countries should be guided by reasonable and clear goals related to sector-specific or hazard-specific criteria ([Füssel, 2010](#)). Recently, [Betzold and Weiler \(2017\)](#) assessed that countries that are more exposed to climate change effects received more adaptation aid, although global climate finance is still fragmented ([Pickering et al., 2017](#)).

It follows that vulnerability is a multidimensional concept linked to management and governance of social-ecological systems ([Miller et al., 2010](#)). As complex dynamic system, vulnerability can be affected by feedback mechanisms inherent in social-ecological relations. Moreover, the feedback loop may be delayed in time and/or covered by economic alterations. For these reasons, researchers need to define the concept and the purposes to focus on specific intervention areas to improve the efficiency and effectiveness of adaptation policies.

The aims of this research are threefold: *i*) evaluating the vulnerability in SIDS and synthesizing it with a composite indicator (CI); *ii*) analyzing its dynamics, and then, *iii*) exploring its identified dimensions to assess those that have a greater weight on the vulnerability index. The results of these analyses are useful to better address policy-makers’ interventions to promote the adaptation measures with respect to climate change. To reach these goals, we first built a vulnerability index that includes 32 variables representing four main areas (social, economic, environmental and remoteness) during the time span from 2009 to 2014. The importance of adaptation becomes even more marked if

we consider that the economic development of a country depends not only on the improved coordination of received aid but also on the way aid is organized and distributed. This aspect is relevant in developing countries where the lack of natural resources and a low level of social development make the problem of vulnerability a key issue. Thus, this paper proposes a temporal and geographic comprehensive indicator for vulnerability in SIDS. Moreover, in this paper we identify the factors (economic, socio-demographic, etc.) that can negatively or positively affect the SIDS’ vulnerability.

The remainder of the paper includes a presentation of the frameworks and data employed (Section 2) and the conceptual and methodological review (Section 3), results analysis and discussion (Section 4) and the check of robustness of proposed indices (Section 5) and concluding remarks (Section 6).

2. Framework and data

2.1. Framework

Several methods to assess vulnerability have been proposed in recent decades in all fields related to natural hazards, poverty analysis and sustainable livelihoods. The vulnerability assessment is crucial when it can be used to address the policies and funds for specific needs and priorities ([Pickering et al., 2015](#)). The concept of vulnerability, which varies widely across communities, sectors and regions, is the starting point for its assessment. As a consequence, the frameworks proposed in the literature for the construction of vulnerability indices are various and fragmented. Moreover, a second relevant issue concerns the lack of data for SIDS.

For the sake of simplicity, we can divide the framework proposed into two classes: one class in which vulnerability embeds the concept of resiliency, and a second class in which vulnerability is a multi-dimensional phenomenon that includes aspects linked to intrinsic characteristics of analyzed systems.

In the first class, we include several indices proposed by various international organizations and researchers. SOPAC ([Pratt et al., 2004b](#)) proposes a vulnerability index that assess the SIDS’ vulnerability. This index synthesizes three aspects of vulnerability: *i*) risks to the environment, *ii*) the intrinsic ability of the environment to cope with the risks (resilience) and *iii*) ecosystem integrity. [Bates et al. \(2014\)](#), [Bates and Angeon \(2015\)](#), and [Angeon and Bates \(2015\)](#) propose a Vulnerability-Resilience index classifying the variables in five dimensions representing the economic, environmental, social, political/governance and peripheral dimensions. The UN-CDP (2015) proposes an economic vulnerability index that has two main components: an exposure index and a shock index. The indicator, assessing the size, location, economic structure, environment, trade and natural shocks of countries, includes some of the structural features of the latter that reflects resiliency. [Guillaumont \(2016\)](#) proposes an index of structural vulnerability. The author considers, in a conceptual framework, some structural factors in the resilience of a country as the human assets index, the structural economic vulnerability and the state fragility as a sociopolitical dimension of vulnerability. [Maiti et al. \(2017\)](#), based on socio-economic and biophysical indicators, assess the social vulnerability in India’s districts, considering the exposure, sensitivity and adaptive capacity as sub-sectors of vulnerability whereas [Tapia et al. \(2017\)](#) develop an indicator-based vulnerability assessment for European countries based on potential hazard-receptor combinations (impact chains) (i.e., heatwaves, drought and flooding).

Other indices can be included in the second class. [Briguglio \(2014\)](#) develops a framework to assess, separately, the economic vulnerability (inherent conditions that expose a system to harm) and economic resilience (associated with policy induced) for small states. The author identifies four components for economic vulnerability (trade openness, export concentration, dependence on strategic imports and proneness to natural disasters) and five components for economic resilience

² The IPCC, on the other hand, distinguishes vulnerability from resilience, defining the latter as the capacity inherent to social, economic, and environmental systems to cope with hazardous events, resuming a definition used in an Arctic Council report. For these reasons, the IPCC considers the adaptation in response to the impacts of climate change and the reduction of vulnerability as two important components of climate-resilient pathways.

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