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The Asset Drivers, Well-being Interaction Matrix (ADWIM): A participatory tool for estimating future impacts on ecosystem services and livelihoods

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A B S T R A C T

Building an effective response for communities to climate change requires decision-support tools that deliver information which stakeholders find relevant for exploring potential short and long-term impacts on livelihoods. Established principles suggest that to successfully communicate scientific information, such tools must be transparent, replicable, relevant, credible, flexible, affordable and unbiased. In data-poor contexts typical of developing countries, they should also be able to integrate stakeholders' knowledge and values, empowering them in the process. We present a participatory tool, the Asset Drivers Well-being Interaction Matrix (ADWIM), which estimates future impacts on ecosystem goods and services (EGS) and communities' well-being through the cumulative effects of system stressors. ADWIM consists of two modelling steps: an expert-informed, cumulative impact assessment for EGS; which is then integrated with a stakeholder-informed EGS valuation process carried out during adaptation planning workshops. We demonstrate the ADWIM process using examples from Nusa Tenggara Barat Province (NTB) in eastern Indonesia. The semi-quantitative results provide an assessment of the relative impacts on EGS and human well-being under the 'Business as Usual' scenario of climate change and human population growth at different scales in NTB, information that is subsequently used for designing adaptation strategies. Based on these experiences, we discuss the relative strengths and weaknesses of ADWIM relative to principles of effective science communication and ecosystem services modelling. ADWIM's apparent attributes as an analysis, decision support and communication tool promote its utility for participatory adaptation planning. We also highlight its relevance as a 'boundary object' to provide learning and reflection about the current and likely future importance of EGS to livelihoods in NTB.

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Introduction

Rural communities in developing countries have a high reliance on local ecosystems to supply goods and services which support their livelihoods and contribute significantly to their well-being (Butler et al., 2014a). The current and future status of these ecosystem goods and services (EGS), and the resulting impact on well-being is therefore important for planning adaptation strategies designed to redress social-ecological systems' vulnerability to threats such as climate change and human population growth (Reed et al., 2013).

For communities to effectively plan and appropriately respond to future threats to their well-being there is a requirement for decision-support tools and information that are relevant and accessible to them and other stakeholders, and clearly explain the sources of future impacts (Kirono et al., 2016). More broadly, for expert-driven models to communicate science outputs, tools must be transparent, credible, and unbiased (Cash et al., 2003; Bagstad et al., 2013). Also, because adaptation policies are continually revised as updated data, models and projections become available, tools must be replicable, affordable and flexible enough to incorporate new knowledge into iterative decision-making (Webster et al., 2003; Wise et al., 2014).

Achieving these principles is challenging. Complex computational simulation models of social-ecological systems are typically the 'gold standard' for providing the most accurate projections of future system states under various scenarios (Plagányi et al., 2011). However, these approaches are often resource- and data-intensive, and have restricted application as only a few experts can follow the procedures. This excludes the lay person from the important learning and capacity building derived from analysis and reflection (Cash et al., 2006; Gidley et al., 2009). Furthermore, the detailed information required to populate such 'whole of system' models is often lacking or scant (Nelson et al., 2010; Dorward, 2014).

These challenges are acute in developing countries, where even data on primary EGS (e.g. agriculture and fisheries production) are often scattered, non-existent or inaccessible. Consequently, it is difficult to determine the potential impact that future climate and development scenarios will have on human well-being, exacerbating the vulnerability of resource-dependent communities (Ensor, 2011). A solution necessitates the integration of disparate data sources, augmented by experts' and local stakeholders' knowledge, often elicited relatively rapidly through participatory processes (Butler et al., 2014b). While perhaps sub-optimal from a purely scientific perspective, this approach has the benefit of empowering local stakeholders, and considering their knowledge and values through the process (Butler et al. 2015, 2016a,b,c).

In this study we demonstrate an approach for the assessment of cumulative impacts on livelihoods in a timely and transparent manner based on a novel participatory tool – the Asset Drivers Well-being Interaction Matrix (ADWIM) – which facilitates the integration of scientific and local knowledge. It is designed for data-poor situations, where stakeholder input is necessary to fill gaps in secondary data, and also to engage and empower them. Using Nusa Tenggara Barat Province (NTB), Indonesia, as an example, and as part of the multi-stakeholder participatory planning process described in this special issue (Butler et al. 2016a,b,c), we describe the tool and illustrate how it is sufficiently flexible to produce estimates of potential impact to EGS and human well-being for different locations of interest, enabling priority-setting at multiple scales. Based on our experiences of applying ADWIM in NTB, we discuss its assumptions and limitations, and its strengths and weaknesses relative to principles of effective science communication and ecosystem services modelling.

Methods

Study area

Nusa Tenggara Barat Province (NTB) is located in the island archipelago of eastern Indonesia (Fig. 1). The province consists of two large islands, Lombok (4725 km^2) and Sumbawa (15,448 km^2), which feature the volcanoes of Mount Rinjani and Mount Tambora. Due to the orographic effects of the volcanoes, steep climate gradients exist across the islands (Kirono et al., 2016; McGregor et al., 2016). Combined with variations in soil type, these micro-climates support diverse agricultural systems (Yasin et al., 2007) and results in a diversity of rural livelihoods which can vary over relatively short distances (Butler et al., 2014a).

At the time of the study in 2010–2012, the province was administratively divided into 8 rural districts (kabupaten) and 105 rural subdistricts (kecamatan; Fig. 1). Rural subdistricts ranged in area from 13.1 km^2 to 763.9 km^2, and their populations ranged from 2717 to 100,105 people.

Units of analysis

The adaptation planning process consists of three stages which combine 'top-down' with 'bottom-up' assessments of community vulnerability and adaptation needs, and applied the subdistrict as the administrative unit of analysis (Butler et al., 2015, 2016a,b,c). The process begins by analysing adaptation needs from the 'top-down' perspectives of government and other provincial level stakeholders based on future scenario planning. A 3-day scenario planning workshop was held where the 105 rural subdistricts were aggregated through a typology which clustered them into seven types based on EGS utilisation (Rochester et al., 2016). The output of this workshop was adaptation strategies designed for each of the subdistrict types. A similar 2-day 'bottom-up' scenario planning workshop was then held in each case study subdistrict to