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A typology of natural resource use for livelihood impact assessments in Nusa Tenggara Barat Province, Indonesia

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ABSTRACT

The vulnerability of less developed regions is exacerbated by a lack of information to inform appropriate adaptation planning. We addressed this challenge in the islands of Lombok and Sumbawa (Nusa Tenggara Barat Province, Indonesia) by combining multiple sources of knowledge to develop a typology of natural resource use by communities of the province. This enabled an assessment of future impacts of drivers of change such as population growth and climate change. The typology was developed by cluster analysis of an inventory of the use of ecosystem goods and services (EGS) by the 105 rural subdistricts in the province. The data were largely elicited from expert knowledge, augmented by a rapid rural appraisal of communities' marine resource use in Sumbawa. Exploratory analysis of existing secondary data on livelihoods and land use provided context and skeleton data, which were developed further by experts. Overall, 82 EGS were identified from nine terrestrial, coastal, marine and freshwater habitats. EGS included livestock, cropping, forestry, wildlife hunting, fishing, aquaculture, mining, water (for drinking and agriculture) and tourism. The typology comprised seven types that captured 42% of the variation in the data matrix. The types were moderately spatially aggregated and showed some congruence with administrative (district) boundaries. We discuss the implications of the results for planning livelihood adaptation strategies, and out-scaling these among subdistricts of matching types.

Introduction

The rural poor in developing countries are the most vulnerable to the impacts of climate change, predictions of which are reviewed by the IPCC (2013). Such communities and households are highly dependent on climate-sensitive natural resources and the ecosystem goods and services (EGS) that these provide, and they have limited adaptive capacity in terms of the assets which they can mobilise in response (Adger et al., 2003). The vulnerability of these groups is exacerbated by the

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generally poor quality and quantity of information available to inform decision-makers on appropriate adaptation strategies (Ensor, 2011). Furthermore, in comparison to rural areas of developed countries, livelihood systems tend to be diverse, potentially requiring replicated and therefore resource-intensive planning processes (Butler et al., 2014, 2015).

In such situations methods are required which can draw on multiple sources of quantitative and qualitative data, and simplify complex information across large spatial scales (Butler et al., 2016). One approach is to group system components of a given class into a manageable number of types based on an appropriate typology. This enables analysis of fewer cases and allows scaling out of results to similar types in other systems. Typologies are most effective when variability is maximised between types and minimised within types. Classification methods (particularly analytical methods) usually explicitly aim to optimise this objective. However, there is a trade-off between having highly specific types and having a typology that is practical for a given purpose (e.g. having a manageable number of types) (Ellis, 2000).

Such a typology approach is often applied to group households or communities by livelihood in socioeconomic research and to define bundles of ecosystem services in ecological research. Livelihood typologies are used for such purposes as developing strategies for enhancing the wellbeing of the rural people in developing countries, whereas ecosystem service bundles were developed for use in natural resource management.

A livelihood comprises the capabilities, assets and activities required for a means of living (Chambers and Conway, 1992). Livelihoods can be defined at different levels (e.g. individual, household, community), with household being the most common (Chambers and Conway, 1992). Livelihood typologies are similarly often defined with household as the classification unit (e.g. Yuerlita et al., 2013; Tittonell et al., 2010; Perret and Kirsten, 2000), but they may also be defined using broader units such as communities or towns (e.g. Stimson et al., 2001). Livelihood typologies are used for such purposes as reducing the number of cases that must be considered for research or policy development (Ellis, 2000). The kind of typology (e.g. the livelihood attributes considered) and the classification method (e.g. analytical versus descriptive) depend on the objectives and resources available (Perret and Kirsten, 2000), but typologies have been used in both developing (e.g. O'Brien et al., 2004) and developed countries (e.g. Nelson et al., 2010) to estimate the relative impacts of climate change and vulnerability, and to prioritise adaptation investments.

Ecosystem services are benefits people obtain from ecosystems (Millennium Ecosystem Assessment, 2005). Ecosystem service bundles are sets of services that appear together repeatedly (Raudsepp-Hearne et al., 2010). If functional relationships among ecosystem services within a bundle are understood, then strategies for managing ecosystems can account for synergies or trade-offs among ecosystem services, for example when they involve promoting one service at the expense of another (Bennett et al., 2009; Kareiva et al., 2007). In practice, however, ecosystem bundles are often identified empirically by analysis of correlations in ecosystem service production data (Raudsepp-Hearne et al., 2010; Queiroz et al., 2015) or in social data on perceived ecosystem service importance (Martin-Lopez et al., 2012). For climate adaptation, ecosystem service bundles can be used to predict and manage changes in covarying ecosystem services under predicted climate change (Dunford et al., 2015) and to identify and manage climate adaptation services, defined as ecosystem services that support climate adaptation (Lavorel et al., 2014).

Livelihoods and ecosystem services are connected because the diverse livelihoods of households in a community determine the aggregate use of many ecosystem services by the community (particularly of provisioning services). Although livelihoods depend on the ownership or availability of resources, ultimately they are also determined by factors such as cultural preferences, education, inheritance and gender (Chambers and Conway, 1992).

Although livelihood typologies and ecosystem service bundles group related livelihood attributes and ecosystem services respectively, they can in turn be used to group the households or communities on which they are based. This is necessary if we are to know the people or land area to which a strategy developed for a livelihood type or ecosystem bundle applies. This step can be simplified by the fact that analytical methods for defining livelihood typologies and ecosystem service bundles are in practice often based on clustering of households or communities by livelihood attributes or ecosystem services (Yuerlita et al., 2013; Raudsepp-Hearne et al., 2010; Queiroz et al., 2015).

Household livelihood strategies do not necessarily align with geographical regions or existing zones (e.g. political boundaries) because livelihoods can be diverse even within local communities (Yuerlita et al., 2013; Tittonell et al., 2010). However, aggregate ecosystem service use of communities or administrative units might be more spatially aggregated if important drivers of livelihoods tend to be shared by neighbouring units. In that case, a livelihood typology based on administrative units might be developed using a zoning approach or spatial aggregation might be included as a classification objective.

In this paper we develop a typology of natural resource use based on an inventory of ecosystem goods and services utilised by communities in Nusa Tenggara Barat Province (NTB), Indonesia. The typology is developed using the methodology for classifying ecosystem service bundles. Although our focus is on grouping communities by resource use rather than on identifying ecosystem services that are functionally related to one another, empirical relationships identified among ecosystem services may later be applicable to adaptation strategy development (Dunford et al., 2015; Lavorel et al., 2014). The primary purpose of the typology was to support an NTB-scale assessment of climate change and human population growth impacts on communities' natural resource base using the Assets-Drivers-Wellbeing-Impact-Matrix (ADWIM), which is presented separately in this special issue (Skewes et al., this 2016).

In presenting the typology we highlight how mixed sources of information can be integrated in a data-poor context to support adaptation planning, and discuss how limitations of the data can affect how directly the data can be included in quantitative analysis. We compare the typology with an administrative grouping (subdistricts within districts), and discuss