International Journal of Applied Earth Observation and Geoinformation 36 (2015) 69–82

Contents lists available at ScienceDirect

International Journal of Applied Earth Observation and Geoinformation

journal homepage: www.elsevier.com/locate/jag

Monitoring land-use change by combining participatory land-use maps with standard remote sensing techniques: Showcase from a remote forest catchment on Mindanao, Philippines

François Mialhe[a,b,*], Yanni Gunnell[b], J. Andres F. Ignacio[c], Nicolas Delbart[d], Jenifer L. Ogania[c], Sabine Henry[a]

[a] Department of Geography, University of Namur, Namur, Belgium
[b] Department of Geography, University of Lyon, Lumière Lyon 2, UMR CNRS Environnement, Ville, Société, Lyon, France
[c] Environmental Science for Social Change, 1/F Manila Observatory Bldg., Loyola Heights 1108, Quezon City, Philippines
[d] Department of Geography, University of Paris 7 Diderot, UMR 8586 PRODIG, Paris, France

ARTICLE INFO

Article history:
Received 11 May 2014
Accepted 10 November 2014
Available online 3 December 2014

Keywords:
Land-use change
Remote sensing
Participatory land-use map
Methodology
Philippines

ABSTRACT

This paper combines participatory activities (PA) with remote sensing analysis into an integrated methodology to describe and explain land-cover changes. A remote watershed on Mindanao (Philippines) is used to showcase the approach, which hypothesizes that the accuracy of expert knowledge gained from remote sensing techniques can be further enhanced by inputs from vernacular knowledge when attempting to understand complex land mosaics and past land-use changes. Six participatory sessions based on focus-group discussions were conducted. These were enhanced by community-based land-use mapping, resulting in a final total of 21 participatory land-use maps (PLUMs) co-produced by a sample of stakeholders with different sociocultural and ecological perspectives. In parallel, seven satellite images (Landsat MSS, Landsat TM, Landsat ETM+, and SPOT4) were classified following standard techniques and provided snapshots for the years 1976, 1996, and 2010. Local knowledge and collective memory contributed to define and qualify relevant land-use classes. This also provided information about what had caused the land-use changes in the past. Results show that combining PA with remote-sensing analysis provides a unique understanding of land-cover change because the two methods complement and validate one another. Substantive qualitative information regarding the chronology of land-cover change was obtained in a short amount of time across an area poorly covered by scientific literature. The remote sensing techniques contributed to test and to quantify verbal reports of land-use and land-cover change by stakeholders. We conclude that the method is particularly relevant to data-poor areas or conflict zones where rapid reconnaissance work is the only available option. It provides a preliminary but accurate baseline for capturing land changes and for reporting their causes and consequences. A discussion of the main challenges encountered (i.e. how to combine different systems of knowledge), and options for further methodological improvements, are also provided.

1. Introduction

Changes in land-use typically result from government policies and from market forces, but they can also occur spontaneously as a consequence of natural hazards or local land husbandry practices. Monitoring land-use changes is important because of the global environmental threats that they are often associated with (Townshend et al., 2012). These threats are related to urban sprawl, deforestation, food production, the erosion of biodiversity; and affect the provision of marine, freshwater and terrestrial ecosystem services, climate change mitigation, and the containment of infectious diseases (Foley et al., 2005). Land-use studies, therefore, are central to the sustainable development agenda and have been facilitated by rapid progress in geospatial technologies. However, understanding the coupled social–ecological systems in which land-use changes are occurring ideally requires an integration of expert knowledge (technocratic or scientific) with other non-scientific knowledge (Rindfuss et al., 2004). The latter is usually observation-based empirical knowledge held by specific groups of

* Corresponding author at: Department of Geography, University of Lyon, Lumière Lyon 2, UMR CNRS Environnement, Ville, Société, Lyon, France. Tel.: +33 785401679.
E-mail address: Francois.Mialhe@univ-lyon2.fr (F. Mialhe).

http://dx.doi.org/10.1016/j.jag.2014.11.007
0303-2434/

local land users and stakeholders, which has accumulated over individual lifetimes and generations (Berkes and Folke, 2002; Halme and Bodmer, 2007; Shepard et al., 2004). The incorporation of non-scientific knowledge and practices into land management and planning strategies has been advocated because of the intrinsic limits of conventional science in solving complex ecological problems (Stevenson, 1996).

Knowledge about the environment (e.g. land-use changes) varies not only between experts and non-experts but also among local land users themselves (Robbins, 2001). Furthermore, holders of non-scientific knowledge are not necessarily indigenous (Huntington, 2000). Local, vernacular knowledge can contribute to explain landscape-scale change through an effort to understand local perspectives or mindsets. It has been suggested that local people hold rich and complex information about their local environment, about the distribution of the resources and the functioning of ecosystems, and that their knowledge is more practical and intimately connected to daily activities than Western knowledge (Agrawal, 1995; Stevenson, 1996). The hypothesis in this study is that combinations of various forms of knowledge, however incongruous they may initially appear to be, help to understand the dynamics, chronology and causes of land-cover and land-use changes.

How to combine local and scientific forms of knowledge and how to proceed analytically and to interpret the information acquired then becomes a methodological issue requiring independent controls on the variables of interest. Through the worked example of a case study in a remote area of the Philippines, where prior scientific data is unavailable and where opportunities for detailed ground-truth investigations were severely time-limited, this paper constructs and tests a methodology for combining seemingly disparate information sources ranging from remote sensing to indigenous land-use maps produced by focus groups after conducting participatory activities.

2. Reasons for combining different systems of knowledge, and ways of doing so

Remote sensing technologies and methodologies are adapted to assessing and to monitoring land-use and land-cover changes (Du et al., 2002). The diversity of spatial and spectral resolutions, the high frequency of data acquisition, and an increasingly unrestricted access to imagery place remote sensing in a key position for informing and measuring such events. Detection of change is routinely carried out using a range of techniques (see Coppin and Bauer, 1996; Lu et al., 2004). Expert knowledge is often the only form of knowledge involved in these procedures and works best when literature on the study area already exists and when field measurements or observations are available. International land-cover classification schemes are technocratic products based on expert scientific knowledge that tends to ignore idiosyncratic or local perspectives. For example, through its Land Cover Classification System (LCCS) the Food and Agriculture Organization (FAO) has adopted a normative approach based on a hierarchical set of classifiers (e.g. presence of vegetation, edaphic conditions, artificiality of cover, environmental attributes, etc.; Di Gregorio and Jansen, 1998). Such normative approaches need not, however, overshadow possible alternatives, particularly when local conditions make standard methods unworkable. Furthermore, expert-based studies present limitations when official records provide little or no information about past landscape patterns and fail to consider interactions between people and their environment. Inclusion of local knowledge can thus fill these gaps and be incorporated into the routine procedures of image processing and class interpretation.

In general terms, scientific and vernacular forms of knowledge present differences and similarities. For example, both are produced and embedded in specific social, cultural and political contexts, use similar methods such as trial and error, and intend to make sense of reality by classifying things and processes following certain criteria (Robbins, 2003; Stevenson, 1996). The different terminologies used to describe or name a landscape unit reflect different cultural meanings of landscape (Robbins, 2003). Some studies have revealed similarities between scientific and local classifications of plants, animals and soils (Holman, 2002; Briggs, 2005); others have emphasized the larger number of habitats recorded in indigenous inventories than in scientific classification schemes (Abraão et al., 2008; Halme and Bodmer, 2007). Differences between knowledge systems emerge from the different contexts in which they were produced: indigenous perspectives often ascribe a sacred significance to knowledge, whereas Western epistemologies treat knowledge with scepticism and place more emphasis on evaluation and validation (Stevenson, 1996; Laituri, 2002).

Local knowledge is often perceived as being more immediately practical and emotional, whereas scientific knowledge is rooted in theory, and more systematic and objective (Huntington, 2000; Briggs, 2005). Even though vernacular knowledge runs the risk of being unduly romanticized by culture-conscious scientists, complex subtleties of local knowledge may nonetheless remain misunderstood or unrecognized by narrowly technocratic or scientific approaches (Laituri, 2002).

The co-production of knowledge arising from cooperation between researchers and local communities has previously been used with some success in conservation, resource management and planning, climate change, development impact assessments, and environmental monitoring (Halme and Bodmer, 2007; Huntington, 2000; Berkes, 2009). Research conducted in the Canadian Arctic on the impacts of, and adaptations to, climate change have involved local communities for practical (greater chance of success and more meaningful results), ethical (because the locals will have to live with the impact of the research or experiment) and political reasons (e.g. locals gain control over the research conducted among their community: Pearce et al., 2009). However, achieving the involvement of community members is a complex and difficult task because it requires participatory activities such as community workshops, interviews, focus groups, mapping, or field guides (Pearce et al., 2009; Raymond et al., 2010). Different forms and degrees of participation exist, from the more manipulative and passive to the more home-grown, where the final decisions are taken by the participants (Chambers, 2006; Dunn, 2007; Weiner et al., 2002). Participation also involves positive and negative externalities because it can empower participants and locals but also marginalize or even endanger them (Chambers, 2006). The risks of marginalization or disempowerment need to be assessed. They should be predicated on basic questions such as who defines the purpose, who facilitates, who participates, who owns the outputs, who wins, who loses, who is empowered, who is disempowered? (Rambaldi et al., 2006; Chambers, 2006; Dunn, 2007; Ventura et al., 2002). In many cases, participatory approaches can lead to negative outcomes due to a lack of transparency, lack of trust, lack of time, or the repetition of activities that are inconsistent with local expectations. Cultural and language differences, controversies about who should conduct data collection, and the technology involved in data gathering are other major aspects that may prompt locals to prohibit further research (Chambers, 2006; Pearce et al., 2009; Laituri, 2002; Meredith et al., 2002).

Involvement in participatory activities requires a respect of local beliefs, traditions, rules and protocols, transparency, flexibility, all of which lead to trust. Whenever possible, participants should also become involved in the research design and in the data analysis (Berkes, 2009; Chambers, 2006; Corbett et al., 2006; Pearce et al., 2009). Dissemination of results and evaluation of activities also