Land Use Policy 49 (2015) 53–64

Contents lists available at ScienceDirect

Land Use Policy

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

Transitions in European land-management regimes between 1800 and 2010

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http://dx.doi.org/10.1016/j.landusepol.2015.07.003

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ARTICLE INFO

Article history:
Received 7 November 2014
Received in revised form 20 May 2015
Accepted 3 July 2015

Keywords:
Land-use change
Long-term socio-ecological research
Land-management regimes
Institutional change
Technological innovation
Policy
Path dependency

ABSTRACT

Land use is a cornerstone of human civilization, but also intrinsically linked to many global sustainability challenges—from climate change to food security to the ongoing biodiversity crisis. Understanding the underlying technological, institutional and economic drivers of land-use change, and how they play out in different environmental, socio-economic and cultural contexts, is therefore important for identifying effective policies to successfully address these challenges. In this regard, much can be learned from studying long-term land-use change. We examined the evolution of European land management over the past 200 years with the aim of identifying (1) key episodes of changes in land management, and (2) their underlying technological, institutional and economic drivers. To do so, we generated narratives elaborating on the drivers of land use-change at the country level for 28 countries in Europe. We qualitatively grouped drivers into land-management regimes, and compared changes in management regimes across Europe. Our results allowed discerning seven land-management regimes, and highlighted marked heterogeneity regarding the types of management regimes occurring in a particular country, the timing and prevalence of regimes, and the conditions that result in observed bifurcations. However, we also found strong similarities across countries in the timing of certain land-management regime shifts, often in relation to institutional reforms (e.g., changes in EU agrarian policies or the emergence and collapse of the Soviet land management paradigm) or to technological innovations (e.g., drainage pipes, tillage and harvesting machinery, motorization, and synthetic fertilizers). Land reforms frequently triggered changes in land management, and the location and timing of reforms had substantial impacts on land-use outcomes. Finally, forest protection policies and voluntary cooperatives were important drivers of land-management changes. Overall, our results demonstrate that land-system changes should not be conceived as unidirectional developments following predefined trajectories, but rather as path-dependent processes that may be affected by various drivers, including sudden events.

1. Introduction

The past 150 years have witnessed drastic expansion and intensification of land use (Ramankutty and Foley, 1999; Rudel et al., 2009; Vitousek et al., 1997), providing societies with essential ecosystem services. At the same time, the stark environmental trade-offs between land-based production and environmental protection are increasingly becoming apparent, from climate change, to land degradation and biodiversity loss (Foley et al., 2005; Millennium Ecosystem Assessment, 2005). Designing and implementing effective policies to mitigate unwanted land-use outcomes and to navigate land systems towards more sustainable modes is a key challenge (Smith et al., 2014). Understanding the underlying technological, institutional and economic drivers of land-use change, and how they play out differently against the background of varying environmental, socio-economic and cultural contexts are pivotal in this regard.

Yet our understanding of the underlying drivers of land-system change remains partial, with three factors contributing to existing knowledge gaps. First, land-change science has so far focused mainly on analyzing the spatial determinants of land-use change, such as topography, soil quality, market access, and infrastructure development, which typically only provide indirect insights into peoples' land use decisions (Müller et al., 2013; Munroe and Müller, 2007; Gellrich et al., 2007; Mertens and Lambin 2000). Conversely, assessments exploring land-use decisions, such as agent-based models (Gaube et al., 2009; Jepsen et al., 2006; Parker et al., 2003), are usually data-hungry and constrained to small regions and predefined actors.

Second, land-change science has been biased towards analyzing conversions among broad land-cover classes, such as agricultural expansion or urban growth (Kuemmerle et al., 2013; Rounsevell et al., 2012). Changes in management intensity, such as in fertilizer use, machinery, labor, increases in yields, changing grazing pressure, or varying forest harvesting intensity have received less attention, in part because spatially distributed information is limited (Erb, 2012). This is problematic, because much change in land systems occurs along intensification pathways (Rudel et al., 2009; Ellis et al., 2013; Erb et al., 2013), and intensification is expected to become the dominant future land change (Tilman et al., 2011; Garnett et al., 2013).

Third, most studies assessing land-use change and its drivers have focused on relatively short time spans (i.e., a few decades), mainly because most studies rely on satellite images to map land changes as historical statistics are often unavailable (Singh et al., 2013). This is unfortunate, because many underlying drivers of land change tend to change in parallel when observed over short time periods, making attribution difficult (Geist et al., 2006; Jones et al., 2011). Likewise, the location, timing and character of drivers determine the pace of land-use change. For example, population growth typically changes slowly, causing gradual land transformations (Whitmore et al., 1990; Ellis et al., 2013), whereas economic crises (Sunderlin et al., 2001; Gasparri, et al., 2013), policy shifts (Müller and Munroe, 2008), institutional shocks (Niedertscheider et al., 2012), environmental disasters (Hostert et al., 2011) or warfare (Rudel et al., 2005) can alter land systems rapidly (Lambin and Meyfroidt, 2010; Dearing et al., 2010).