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Explaining rural land use change and reforestation: A causal-historical approach

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ABSTRACT

Research on human-environment interactions is bedeviled by two key analytical challenges: integrating natural and social science information and demonstrating causal connections between proximate and distant influences. These challenges can be met by adopting an event-focused, causal-historical approach to research methodology, referred to here as Abductive Causal Eventism (ACE). With ACE, researchers construct causal histories of interrelated social and/or biophysical events backward in time and outward or inward in space through a process of eliminative inference and reasoning from effects to causes, called *abduction*. ACE is contrasted with three leading approaches to human-environment research: Land Change Science (LCS), Socio-ecological Systems (SES), and Political Ecology (PE). For illustration, ACE is applied to a study of post-War environmental change in two rural watersheds in Saint Lucia, West Indies. Findings reveal that the most consequential change has been the widespread reforestation of lands abandoned from farming. This change occurred irrespective of the type of land tenure, but was especially commonplace on lands with steeper slopes and further from roads. Reforestation during the 1960s and 1970s was caused by a combination of commodity market challenges, abandonment of subsistence cultivation in response to smaller family sizes, and sizable out-migrations of younger adults overseas. The expansion of banana cultivation in the 1960s and then again in the 1980s slowed and in places reversed this trend. But an especially large wave of farmland abandonment swept the island from the mid-1990s to early-2000s because the banana export market collapsed as a result of preferential market access being eroded by a series of WTO trade rulings. These effects have been reinforced by a surge in investment from return migrants and the tourism industry which has drawn labour out of farming while also creating economic incentive and political support for protecting more forests on both private estates and public lands. Yet, the post-War trend in reforestation may have ended as agriculture displays signs of rebounding and residential and tourism development expands unabated into the countryside. This study demonstrates the advantages of using ACE where explanations entail diverse types of causes operating across space and over time.

1. Introduction

Calls for interdisciplinary human-environment research have multiplied as human impacts on the biosphere have grown (Lambin et al., 2001; Ludeke et al., 2004; Newell et al., 2005; IGBP, 2006; Young et al., 2006; Rudel, 2008; Holm et al., 2013; Ogden et al., 2013; Palsson et al., 2013; Agnoletti and Rotherham, 2015). Despite many advances, human-environment researchers continue to wrestle with two central analytical challenges: first, how to integrate natural and social science information coherently and rigorously and, second, how to confirm causal connections between environmental changes and causal influences both proximate and distant in space and time (GLP, 2005:3; Turner et al., 2007:20667; Pooley et al., 2013). The analytical methodology, Abductive Causal Eventism (an expanded version of what was formerly called Event Ecology), has been proposed as a way to address these twin challenges (Walters and Vayda, 2009, 2011; Walters, 2012a).

Abductive Causal Eventism—hereafter 'ACE'—is a form of causal-historical analysis that entails constructing causal histories of interrelated social and/or biophysical events backward in time and outward or inward in space through a process of eliminative inference and reasoning from effects to causes, called *abduction*. In this paper, ACE will be described and its application illustrated with an empirical case study of research that seeks to explain recent, widespread reforestation in rural Saint Lucia, West Indies. Small island states like Saint Lucia provide an opportune, living-laboratory for doing human-environment research given the decisive historical relationships between local socio-economic and environmental changes and wider international influences wrought by colonialism, migration and the agricultural commodities trade.

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The paper is organized as follows. First, I will review three methodological approaches commonly applied in leading subfields of human-environment research. Abductive Causal Eventism (ACE) will then be described and contrasted with these. This is followed by an empirical case study of the application of ACE to explain reforestation in Saint Lucia. The paper concludes with a discussion of research findings and reflections on how the case study relates to different research methodologies.

2. Analytical methodologies in human-environment research

Research on the human environment is diverse and influenced by many academic fields. In this section, I review three leading sub-fields of human-environment research: Land Change Science (LCS), Socio-Ecological Systems (SES) and Political Ecology (PE), highlighting their respective theoretical orientations and analytical approaches, in each case considering how these inform research methodology. This is challenging given the range of research being done within each subfield and because there is some crossing-over between them (e.g., Brannstrom and Vadjunec, 2013a). Nonetheless, there are important, broad distinctions that reflect both explicit theoretical and methodological commitments as well as underlying assumptions (Turner and Robbins, 2008; Cote and Nightingale, 2011; Watts, 2011).

Since the focus here is methodology, it is useful first to distinguish this from methods, theories and hypotheses. *Methods* are the tools and techniques of research. *Methodology* is the logic and justifications guiding deployment of methods and interpretation of research results (Vayda and Walters, 2011:2). Theory has diverse meanings (Abend, 2008). For the purposes here, *theories* are explanations of empirical phenomena that have attained some degree of generalizability by virtue of their prior confirmation elsewhere (theories that attain extremely high levels of confirmation may become established 'facts' or 'laws'). *Hypotheses* are conjectured explanations for the case at hand, so may or may not be recognized theories.

2.1. Land change science (LCS)

Land change science (LCS) emerged as a coherent program of human-environment research during the 1990s, propelled by a series of international research collaborations—the Land-Use and Land-Cover Change Project (LUCC) and then Global Land Project (GLP)—conducted under the auspices of the International Geosphere-Biosphere Program (Lambin et al., 1999; GLP, 2005). In short, LCS entails "the linking of natural, social and geographic information sciences to study land surface changes and their consequences" (IGBP, 2006:29).

A stated priority of LCS is advancing understanding of the causes of land change (Geist et al., 2006:42). To do this, researchers employ a range of methods and analytical tools, but typically approach investigations inductively by searching for general patterns within quantitative data sets using inferential statistics and modeling (e.g., Chowdhury and Turner, 2005; Mena et al., 2006; Mendoza et al., 2011; Redo et al., 2012; Silva et al., 2016; see Turner and Robbins, 2008:6.7-6.8). As empirical findings have multiplied, however, general theories and models have emerged and introduced a more explicitly deductive[1] bent to some LCS work (Veburg et al., 2006:120). Forest Transition Theory (FTT) is perhaps the best known example of this (Mather, 1992; Rudel et al., 2005; Turner et al., 2007). Most LCS researchers now presume elements of FTT are credible and some design studies, not to explain changes in forest cover *per se*, but rather to test the validity of FTT as it is currently understood (Perz, 2007; Barbier et al., 2010; Lambin and Meyfroidt, 2010; Costa et al., 2017).

LCS researchers recognize that causes of land use change are often complex and site-specific, with both proximate and underlying factors ('drivers') needing to be considered (e.g., Lambin et al., 2001; Geist et al., 2006; Turner et al., 2007; Dalla-Nora et al., 2014; Shaver et al., 2015; Plieninger et al., 2016). Qualitative methods are not categorically ruled-out, but the guiding research strategy for LCS is explicitly founded on the application of quantitative methods and data collection, preferably standardized across case studies (Geist et al., 2006; Lambin et al., 2006). This approach has encouraged use of social science methods common to quantitative sociology and economics, notably regression modeling of discrete variables (i.e., factors) using data derived from national statistics or large sample, pre-structured household surveys. Using these methods, LCS studies have shown statistical associations between land use/land-cover changes and various socio-economic and demographic factors.

However, such statistical approaches can be severely limiting where explanations of change entail multiple, conjunctural causes, as they often do (Ragin, 1987; Gaddis, 2002; Goba, 2008; Ylikoski and Kuorikoski, 2010; Efroymson et al., 2016). In the absence of in-depth, contextual knowledge of the actual cases under study, such analyses are best viewed as exploratory as they tend to generate findings which beg more questions than they answer about why identified factors *actually* correlate or not with land use decisions, practices or land-cover changes in specific places (Walters and Vayda, 2009; see also Redo et al., 2012:799-802).[2] Thus, Geist et al. (2006:45) acknowledge the obstacles created for LCS where factors "crucially important in explaining change in one place may be irrelevant in other nearby places" and where "a given factor may be implicated in opposite land-cover outcomes" (see also Meyfroidt, 2015).[3] Modeling is also challenged by the fact that causal dynamics of land change in a given place change over time (Aspinall, 2004). As argued below, LCS researchers facing confounding or ambiguous results like this might benefit from adopting a more explicitly, causal-historical approach to their analysis (cf. Freedman, 1991; Goba, 2008; Ebach et al., 2016).

2.2. Socio-ecological systems (SES)

Socio-ecological Systems (SES) thinking emerged in the late 1990s, the result of collaboration between ecologists and social scientists seeking to bring a more holistic, ecosystem-inspired perspective to research on the human environment (Berkes and Folke, 1998; Adger, 2000; Gunderson and Holling, 2002; Folke, 2006). The SES approach is founded on appeals to a loose cluster of conceptual heuristics and theoretical propositions, adapted mostly from systems thinking in the natural sciences (Holling, 1996; Turner et al., 2003a; Walker et al., 2006; Liu et al., 2007; Leslie and McCabe, 2013).[4] In this respect, SES differs from LCS in being more deductively-oriented in its analytical approach, although among researchers there is little consensus regarding the ontological status of theory in SES. For some, SES concepts and ideas comprise the building blocks of a solid theoretical foundation (actual or in-the-making), but others appear to view them as just analytical heuristics (Folke, 2006; Walker et al., 2006; Ostrom, 2009).

Consider, for example, the SES concept of *resilience* which has

[1] *Inductive reasoning* is the drawing of generalizations or probabilities from empirical observations (including experiments); e.g., *every farmer surveyed in this village had planted tree crops; therefore, all farmers plant tree crops in this village*. *Deductive reasoning* uses existing generalizations or theories to account for empirical observations; e.g., *all farmers plant tree crops; this is a farmer; therefore, she plants tree crops*.

[2] Quantitative-statistical methods suffer from other limitations beyond the scope of this paper to discuss (see Ragin, 1987; Freedman, 1991, 1997; McKim, 1997; Gaddis, 2002: chap. 4; Goba, 2008; Barnes, 2013; Nuzzo, 2014).

[3] For example, the influence of tenure on land use and tree cover is surprisingly ambiguous: tenure insecurity may encourage or discourage tree planting and other land investments depending on wider circumstances or historical contingencies (Walters et al., 1999; Walters, 2012b).

[4] SES researchers advocate a diverse array of systems concepts to aid in analysis, among these *resilience*, *adaptive capacity*, *adaptive cycle*, *response diversity*, *biocomplexity*, *reciprocal effects*, *feedbacks*, *non-linearity*, *indirect effects*, *emergent properties*, *path dependency*, *vulnerability*, *thresholds*, *cross-scale interactions*, *heterogeneity*, *time lags* and *legacy effects*.