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Mending man's ways: Wickedness, complexity and off-road travel

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GRAPHICAL ABSTRACT

- I examine off-highway vehicle travel as an example of the theory of wicked problems.
- I develop an agent-based simulation of travel using detailed case study data.
- Off-highway travel is a complex system with key attributes of a wicked problem.
- A conventional regulatory regime has low disturbance levels but high enforcement cost.
- A cooperative regulatory regime taps virtuous cycles from complex behaviors.

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ABSTRACT

While the concept of wickedness has been applied frequently in planning and design environments, its application to complex regulatory problems is less well-developed. Off-road and social travel has become a significant source of environmental degradation across many regions worldwide, and the widespread failures of travel regulation suggest that it has characteristics of a wicked problem as described by Rittel and Webber. This paper presents a simulation of a complex regulatory system – the interaction of cumulative travel decisions, alternative regulatory regimes, and landscape values – using a case study of a landscape adjoining Las Cruces, New Mexico. This research is built on a morphological analysis of change in travel patterns derived from historical remote sensing imagery. The findings of this paper suggest that the cumulative nature of travel demand among off-road users has important implications for the resilience of natural systems particularly in places of high demand such as metropolitan edges. Regulatory choices can create both virtuous and vicious cycles in travel behavior,which suggests opportunities for constructing adaptive strategy in off-road travel management.

1. Introduction

While the concept of wickedness has been applied frequently in planning and design environments, its application to regulatory problems is less well-developed. This paper uses a case study of off-road travel to explore problems of regulation in a complex system as described for example by Raghu, Kumaraswamy, and Karnøe (2010). Wicked problems are policy and management dilemmas that are intractable using historically conventional methods applied by engineering, planning and related professions (Rittel & Webber, 1973). The issues that regulators face in management of off-road travel evince key properties of wicked problems. For example, restrictions in one area may generate undesired repercussions in other parts of the landscape. Moreover, management decisions generate conflicts that cannot be addressed within the formal regulatory process. Similarly, off-road travel frequently occurs in environments with unique or localized physical and social characteristics that are difficult to manage by standardized agency protocol.

National, state and local agencies have created regulatory programs to manage travel. These operate on a variety of scales from dog leash rules in local public parks to rules regarding snowmobile access in US national parks and travel by ranchers in the Amazon basin (Perz et al., 2008). In the United States, off-road travel is guided by planning instruments such as travel management and park plans, and governed by regulations such as local land use ordinances and Forest Service or Bureau of Land Management rules. In spite of much regulatory effort, travel is viewed by many researchers as a significant risk to ecological health on open lands (e.g., Havlick, 2002; United States Department of Interior, 2007).

This paper presents a framework for simulating alternative modes of off-road travel regulation in a detailed physical and institutional setting. It explores the evolution of a landscape organized by interactive user behaviors and management rules. This research is built on a morphological inventory of travel routes developed from remote sensing information, which is used along with other

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spatial information to evaluate the effects of cumulative travel decisions and alternative regulatory regimes on landscape values. The results of the simulation are used as a basis for assessing overall stresses in the regulatory system and reflecting on off-road travel as a wicked problem. The findings of this paper suggest that the cumulative interactions of regulation and behavior among off-road travelers have important implications for the resilience of natural systems. Areas such as metropolitan edges may be particularly at risk because of cost, accessibility, conflicting stakeholder interests, and the complex character of use. Where cumulative travel activity forms virtuous cycles there also may be opportunities for innovation in regulatory design and a foundation for adaptive strategy (Batty, 2012).

While there are multiple definitions of off-road travel, it is classified in this article as travel along routes that were not constructed for public use by a legitimate public authority. Travel on and across U.S. public lands have increased dramatically over the last half century or more. This increase is due in part to a steady rise in recreation and second home ownership as well as resource production on lands primarily in the Western US. Rapid urban growth across the western United States is generating new centers of demand for use of public lands. Motorized off-road vehicles have become a major source of increased demand for use of trails and roads. Studies have shown that road building has multiple environmental impacts ranging from air, water and noise pollution, to habitat fragmentation and invasive species introduction (Forman et al., 2003). At least until recently, off-highway vehicle use has been one of the fastest growing recreational activities in the country (Gentle et al., 2004). Some researchers describe recreational travel to be a primary threat to the ecological integrity of open spaces in the United States (Havlick, 2002). Recreational travel may reinforce the effects of climate change through increases in CO2 emissions, generation of dust, disturbance of vegetation, introduction of invasive species and habitat fragmentation. In many parts of the world, regulators have had difficulty in their efforts to meet both environmental objectives, (e.g., minimizing disturbance of soils, water, vegetation and habitat) as well as a social objectives (e.g., sustaining historical uses of the landscape and supporting livelihoods of residents) (United States Department of Interior, 2007).

These failures suggest a fundamental question – what is it about off-road travel that makes it prone to regulatory failure? This leads to the motivating question for this paper: does the concept of wicked problems help explain the difficulties that many communities and countries face in designing and implementing effective off-route travel regulation? In this research the overlapping ideas of complexity and wicked problems are used to evaluate the problem of regulating off-road travel. Complexity is not a term that Rittel and Webber use in their classic article; nonetheless they describe something akin to what researchers describe as a complex system (e.g., Raghu et al., 2010). In the context of this research, complexity appears in three dimensions: effects of patterns of use on a natural system; effects of rules and alternative enforcement actions on patterns of use; and effects across the system of different types of interactions among stakeholders, managers, users and others. Complex user behaviors are also influenced by trajectories of technological change, as manufacturers build and market innovations that extend and channel activities available to users (David, 2002). The simulation of these systems is a class of models described in this paper as complex regulatory system (CRS) methods. In a planning context, complex regulatory models are typically used to test the urban or landscape effects of land use and activity policies and alternative profiles of demand or behavior. CRS models can also be used to test stresses in a regulatory system, that is, explore where problems are likely to emerge under different conditions. Finally, CRS models can be used to evaluate program design issues such as the relative effectiveness of coercion versus other types of behavioral guidance in implementation of rules. Complex regulatory systems may take on the characteristics of wicked problems, and these characteristics may in part be revealed by exploration of system stresses and program design problems. This paper describes the simulation of a CRS related to travel regulation, used to explore outcomes of adaptive strategies and effects of regulatory.

This paper draws on four ideas presented in Rittel and Webber's paper, described here as the blueprint, plural voices, complex behaviors and waves of repercussions. The blueprint is a comprehensive conceptual and design framework used in problem interpretation and management (Head, 2008). In a regulatory context, the blueprint is a template developed or endorsed by agency leadership and transferred to the sites at which the organization operates. Rittel and Webber (1973, p. 162) argue that wicked problems may have unique characteristics intractable to dominant managerial templates.

This paper explores alternatives to the blueprint rooted in the literature of adaptive strategies, as described for example, by Xiang (2013). Plural voices refer to the multiplicity of goals, the "pluralities of politics", which Rittel and Webber (1973, 160) consider to be characteristic of wicked planning and design environments. These are indicated as multiple stakeholders in the conceptual model below. Complex behaviors are the interactions and feedbacks among users and between users and landscapes, described by Rittel and Webber (1973, p. 162) as "the causal chains that link interacting open systems". "Waves of repercussions" are planning and design effects that may be short-term or unfold over a long period of time, and may be deliberate and goal-driven or unintended (1973, 159). In this model, landscape effects are a specific and limited case of repercussions. They are modifications of the landscape that may have ecological effects and lead to new patterns of use. Enforcement programs are used to implement either the dominant blueprint or an adaptive strategy. They are defined here to include rules and investment programs established to guide patterns of use. In a regulatory context the design of these programs, their legitimacy, command of resources and ability to fulfill their mission, are centrally important to the overall performance of the regulatory system. Fig. 1 below represents the relationships among these five regulatory elements.

In the diagram above, regulatory design occurs largely in the part of the diagram to the right, spanning the blueprint and multiple stakeholders and responding to stresses in the landscape and enforcement program. Implementation occurs largely in the bottom part of the diagram extending from enforcement to user behavior nodes and at times including stakeholders. Adaptation occurs largely in the top part of the diagram as the blueprint is modified in response to behaviors, landscape stresses and stakeholders. How do complex regulatory systems become wicked? Extending Rittel and Webber's argument, wicked problems emerge from concurrent and interacting changes across multiple dimensions of regulatory systems including shifts in the nature of planning authority itself. Rittel and Webber's ideas complement the discussion of path dependency and path formation associated with complexity theory (e.g., David, 2002; Raghu et al., 2010). In the context of off-road travel changes in technologies and behavior have stimulated both increases in demand and changes in patterns of demand as new technologies have been adopted such as dirt bikes all-terrain vehicles Global Positioning Systems (GPS) and mapping programs. As these evolve along with behaviors they inscribe new physical patterns on the landscape. Further extending Rittel and Weber's argument, these new demands in combination with broader social forces may act to erode the authority of the regulatory system, along with its capacity to plan, enforce rules, or deterministically channel physical travel patterns. As these stresses interact and multiply the system is at risk of progressively losing capacity for effective action.

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