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Mapping in and out of "messes": An adaptive, participatory, and transdisciplinary approach to assessing cumulative environmental justice impacts

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HIGHLIGHTS

- Cumulative environmental impacts are presented as wicked planning problems.
- Environmental and social disparities imperil health in rural California regions.
- Participatory mapping can inform action on cumulative environmental impacts.
- Two cases from rural California represent innovations in addressing wicked problems.
- Community-university partnerships are crucial for effective participatory mapping.

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ABSTRACT

The transition from single-media, single-location, and single point-in-time analysis to a cumulative approach represents a profound challenge – and opportunity – for policy makers, planners, advocates and researchers. These challenges and opportunities are, in part, methodological (e.g., data availability of pollution sources, uncertainty of chemical reactions among multiple pollutants, evaluating combined health effects of multiple environmental stressors). However, the social complexity of this issue has been acknowledged, but not systematically documented and analyzed. As a result, there is a significant gap between the development of cumulative impacts analysis and a limited ability to reap their benefit in resolving environmental justice conflicts. Framing cumulative impacts as a "wicked problem" can help highlight some of the challenges in implementing such approaches and can point the way towards applying these approaches to improving collaboration between policy makers, planners, and advocates.

We present two case studies of cumulative impacts analysis in California using socio-spatial mapping and public participatory geographic information system (PPGIS). These cases will illustrate the challenges and opportunities for combining quantitative and socio-spatial science with PPGIS as strategies to address the wicked nature of assessing and acting to address cumulative environmental impacts. The case studies will emphasize the value of an adaptive, participatory, and transdisciplinary approach as an effective response to the wicked qualities of cumulative impacts themselves. These cases can help planners, policy makers, and community advocates to apply a cumulative impacts approach to their own wicked problems.

1. Introduction

A primary concern of environmental justice scholarship, policy, and social movement organizing is addressing the disproportionate impacts of environmental hazards and restricted access to environmental goods experienced by people of color and low-income people (Cole & Foster, 2001; Pulido, 1996; Sze & London, 2008). The experience of environmental injustices by these, and other, underserved populations, combined with their systemic marginalization from public policy decision-making, has provoked a series of heated conflicts between environmental justice advocates, public agencies, businesses, and other social actors (Cole & Foster, 2001; Pulido, 1996; Sze & London, 2008).

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While environmental legislation and single-media regulation (e.g., the Federal Clean Air Act and Clean Water Act) have achieved tremendous success in reducing overall pollution levels, more recent efforts to identify and address disparities in the cumulative impacts on human health from multiple cross-media environmental hazards represent a new policy frontier. These approaches represent a fundamental shift from a linear cause and effect model of regulation to a more complex ecological model that considers the interconnections of biophysical and social systems (Pickett, Cadenasso, & Grove, 2005; Turner et al., 2003). A cumulative impacts approach has been advocated by environmental justice activists who seek comprehensive approaches to environmental protection that focus on the places where people live, work, play, and learn (Cole & Foster, 2001). Recent academic scholarship (Huang & London, 2012; Morello-Frosch, Zuk, Jerrett, Shamasunder, & Kyle, 2011; Sadd, Pastor, Morello-Frosch, Scoggins, & Jesdale, 2011) and public policy initiatives (Alexeeff et al., 2012; Faust, 2010) have begun to conduct and systematize cumulative impacts analyses. In broad terms, cumulative impacts analysis integrates a range of environmental hazard indicators with a range of social vulnerability factors into one or more combined indices. Such indices can be used to identify populations and places that are both subject to elevated environmental hazards that also lack the economic, political, and social resources to avoid, mitigate, or adapt to these impacts (Krieg & Faber, 2004). In contrast to a formal health risk analysis, which quantifies potential health impacts of a given chemical or development project, a cumulative impacts analysis serves best as a screening tool to highlight places that require additional study, investments, and other precautionary actions (Alexeeff et al., 2012; Faust, 2010).

The transition from single-media, single-location, and single point-in-time analysis to a cumulative approach represents a profound challenge – and opportunity – for policy makers, planners, advocates, and researchers. These challenges and opportunities are both social and technical. Major technical issues include limited data availability of pollution sources, uncertainty of chemical reactions among multiple pollutants, and evaluating combined health effects of multiple environmental stressors (Huang & London, 2012; Krieg & Faber 2004; Morello-Frosch et al., 2011; Sadd et al., 2011). While these technical challenges have been acknowledged, systematic documentation and analysis focusing on the "wicked" or "messy" social character (Xiang, 2013) of cumulative impacts analysis is less well developed. Underestimating this social complexity, especially in instances in which participants hold different, and even divergent world views which represent competing interests, may create unrealistic expectations that cumulative impacts problems could be eliminated merely with better data and analysis (Balint, Stewart, & Desai, 2011; Fineberg & Stern, 1996).

We aim to fill this gap about the understanding of the challenges and opportunities in planning, policy, and advocacy approaches to cumulative impacts through the framework of wicked problems (Xiang, 2013). In particular, we argue that the wicked or messy problem of cumulative impacts requires a participatory process through which planners, researchers, and community advocates contribute their unique knowledge and develop collaborative solutions. While such an approach is unlikely to resolve the complex political, economic, social, and environmental factors that produce environmental injustice, we suggest that it can help reduce or mitigate some of the most extreme conditions.

In Section 2 we briefly introduce the framework of wicked problems and how it can help to articulate the social complexity of cumulative impacts analysis. Section 3 presents two case studies of cumulative impacts assessments in California's Eastern Coachella Valley (ECV) and San Joaquin Valley (SJV). The extreme social, political, economic, and environmental disparities in these regions of the state reflect conditions in many less-developed regions and nations and the social movements that have arisen to confront them (Agyeman, 2003; Martinez-Alier, 2014; Schlosberg, 2013). Therefore, these cases should be of interest to planners, policy makes, advocates, and researchers around the world. We summarize our approaches of using cumulative impacts analysis to address environmental injustices in Section 4, and conclude with reflections in Section 5.

2. Cumulative impacts as wicked problem

Framing cumulative impacts as a "wicked problem" can help highlight some of the challenges and opportunities in applying this approach to addressing environmental injustices and improving collaboration between policy makers, planners, and advocates. The term "wicked problem" (Rittel & Webber 1973, 1974) or "social messes" (Horn, 2001) refers to planning and design problems that defy technocratic solutions. This concept has been synthesized by Xiang (2013) to include five criteria: (1) indeterminacy in problem formulation, (2) non-definitiveness in problem solution, (3) non-solubility, (4) irreversible consequentiality, and (5) individual uniqueness (Table 1).

Cumulative impacts share these characteristics of wicked problems. First, the problem formulation of cumulative impacts is challenging because they are driven by a wide range of individual, behavioral, institutional, and structural factors. Identifying and analyzing the most significant factors and the pathways for their interactions does not follow any easily-standardized or agreed upon formula. Furthermore, assessing and acting to reduce cumulative impacts on the health of vulnerable populations and places requires active and collaborative engagement of multiple stakeholders (e.g., policy makers, advocates, business interests) that are often at odds with each other. Second, conflicting problem definitions make solutions to avoid or mitigate such complex and incompletely understood impacts difficult to identify and agree upon. Third, the lack of agreement on a non-arbitrary "stopping point" for identifying relevant indicators, collecting data, and analyzing results impedes the ability for policy makers and planners to shift decisively from tool development to implementation in planning and policy. Fourth, any approach to address the complex systems of cumulative impacts can themselves have unintended, negative, and possibly irreversible consequences. Finally, cumulative impacts analysis must be place-specific to account for unique characteristics, while still conforming to accepted standards of scientific rigor and regulatory frameworks.

We argue that the wickedness of cumulative impacts is a function of the complex experiences of overlapping environmental and social hazards experienced by vulnerable communities, which in turn, requires a complex policy and advocacy response. Recent scholarship on wicked problems has suggested that strategies to navigate, if not solve, wicked problems require adaptive, participatory, and transdisciplinary approaches (Xiang, 2013) and deliberative social learning processes (Balint et al., 2011; Fineberg & Stern, 1996). We assert that if cumulative impacts analysis is conducted in this adaptive, participatory, and transdisciplinary manner, it can address many of the wicked problem characteristics outlined above. In particular, such an approach to cumulative impacts analysis requires spanning scientific cultures (e.g., natural, health, social sciences) and integrating formal research science with the "street science" developed by communities through their lived experiences in place- and community-based participatory research (Brown, Morello-Frosch, & Zavestoski 2011; Corburn, 2005; Liévanos, London, Sze, Ottinger & Cohen, 2010).

In the two case studies that follow, we describe how a research team worked with a diverse range of community partners to document and intervene in the production of cumulative environ-

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