Integrating Social and Biophysical Research to Support Community Flood Resilience in the Driftless Area (USA)

Intégration de la recherche sociale et biophysique pour soutenir la résilience des communautés face aux inondations dans la région de Driftless (USA)

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RÉSUMÉ

Les impacts des inondations fluviales ont augmenté de façon spectaculaire ces dernières années en raison du changement climatique anthropique et des modifications de l'utilisation des terres, et les communautés sont à la recherche de stratégies de résilience aux inondations qui atténuent les pics de crue tout en s'éloignant des infrastructures dures. Cette communication met en évidence notre travail actuel dans la région de Driftless (USA) pour soutenir les stratégies communautaires d'atténuation des niveaux de crue et de gestion de leurs impacts, y compris la restauration des hautes terres, des plaines inondables et des canaux. Nous nous concentrons sur l'intégration de méthodes sociales et biophysiques, y compris l'observation participative, les entretiens, les enquêtes et la modélisation hydrologique et hydraulique des inondations, pour aider les communautés à envisager et à évaluer une série de stratégies de réduction des inondations et d'adaptation.

ABSTRACT

Fluvial flood impacts have increased dramatically in recent years due to anthropogenic climate change and land use changes, and communities are searching for flood resilience strategies that lessen flood peaks while moving away from hard infrastructure. This communication highlights our current work in the Driftless Area (USA) to support community-based strategies for attenuating flood levels and managing their impacts, including upland, floodplain, and channel restoration. We focus on integrating social and biophysical methods, including participatory observation, interviews, surveys, and hydrologic and hydraulic flood modeling, to support communities as they envision and assess a range of flood reduction and adaptation strategies.

KEYWORDS

Community-based research, flood attenuation, interdisciplinarity, resilience, restoration

1 INTRODUCTION - INTEGRATING SOCIAL AND BIOPHYSICAL RESEARCH TO SUPPORT COMMUNITY FLOOD RESILIENCE

Across the Upper Mississippi River Basin (UMRB) in the USA, the major question is no longer whether the next catastrophic flood will happen, but how soon. The UMRB has seen increasingly frequent flooding in recent decades, damaging cities, towns, farms, and rural infrastructure in a trend that climate change will almost certainly worsen. Southwestern Wisconsin's Kickapoo River and Coon Creek watersheds—in the UMRB's Driftless Area, an unglaciated and highly dissected landscape with broad, loess-covered uplands, steep hillslopes, and deeply incised valleys—have experienced at least one 100-year and two 50-year floods in the last decade, and climate forecasts predict this pattern will intensify. Communities in the Driftless Area—like communities across the world living with climate-amplified flood events—are beginning an increasingly public discussion about what flood resilience might look like, and what role restoration (both along stream corridors and in upland areas) might play in flood attenuation strategies. These Driftless Area watersheds offer ideal systems for exploring complex eco-social interactions between reach-based stream restoration and upland best management practices in the context of urgent decision-making about community-level climate vulnerability and resilience.

There is a dearth of research on the interactions of stream restoration and flooding, called for as an increasingly urgent need (Reich and Lake, 2015). Some studies have addressed the impacts of flooding on restoration projects, but few focus on the impacts of channel-based and/or upland restoration projects on flood attenuation. Previous hydraulic modeling has shown that changes in channel and floodplain geometry and roughness can attenuate flood peaks during moderate (10- and 25-year) flood events, and hydrologic modeling of hillslope changes similarly revealed moderate reductions in flood peaks for small to medium events and minimal reductions for large events. But research is needed that integrates flood hydraulic with watershed hydrologic approaches to investigate how local-floodplain vs. catchment-scale approaches interact and compare to reduce flood peaks. Just as important, that work is most usefully conducted in the context of iterative, participatory modeling workshops with local stakeholders. A multiscalar modeling approach with a deep grounding in diverse engagement mechanisms can offer a methodologically innovative, partner-centered, resilience-focused systems approach to flood risk management. This work heeds recent calls to offer empirical studies of both community-level climate vulnerability and response, and is critical to understanding and responding to the interactive dynamics of stream restoration and flood resilience in a changing climate.

2 INTERDISCIPLINARY, COMMUNITY-BASED APPROACHES TO FLOODING

As in many parts of the world, both chronic and recently intensified flooding across the Driftless Area is a result of eco-social feedbacks at historic and current time scales. Settler agriculture and logging beginning in the 1840s accelerated soil erosion across steep hillslopes, contributing over four meters of post-settlement alluvium to valley floors in some places and creating a flume-like riparian corridor that efficiently conveys flood peaks downstream. More intense and more frequent storms associated with climate change exacerbate a legacy of poor land management, negatively impact water quality, and degrade world-class trout fishing, a major economic focus in the region. Because the drivers of flooding in the Driftless Area are biophysical and social, both the way we study flooding and the solutions proposed should be, too (Lave et al., 2018) (Figure 1).

To investigate the interactive eco-social dynamics of flood resilience in a changing climate, researchers need to integrate hydrologic, social science, and humanities-based approaches. Because of the importance of drawing on local knowledge and of building political consensus around a suite of proposed flood resilience solutions, participatory research with long-time local partners in federal, state, and local government agencies and non-profit organizations should be a crucial component. In this research, we combined methods iteratively rather than working either in series or in parallel, so that initial results from one approach help to shape the subsequent assumptions of the others, and vice versa. These methods include: qualitative interviews and surveys with stream managers, flood decision makers, and landowners; archival research on past conservation and flood control approaches; geomorphic surveys; multiscalar hydrologic and hydraulic modeling to investigate the dynamic feedbacks between in-stream restoration practices,

upland conservation measures, and flood peaks; and model-based participatory workshops that allow community groups to analyze eco-social tradeoffs related to flood vulnerability and resilience across the reach and watershed scales (Figure 1).

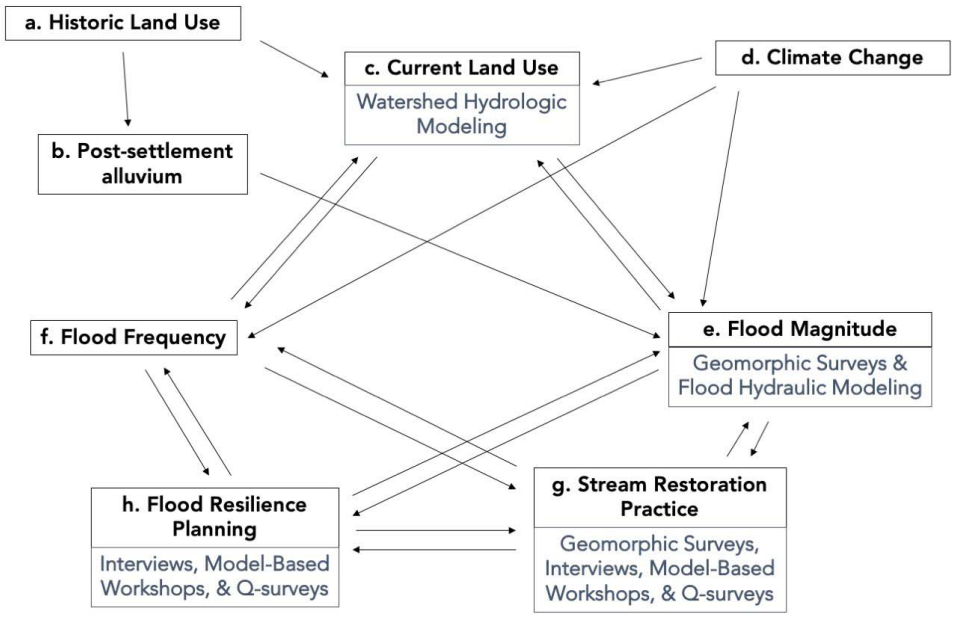

Figure 1. Key eco-social dynamics of Driftless Area flooding and methodologies for addressing them.

3 ADVANCING INTEGRATED RESEARCH FOR A FLOOD-FILLED FUTURE

By creating innovative methodological approaches that meaningfully integrate qualitative, quantitative, and spatial humanistic, social scientific, and biophysical methodologies (Lave et al., 2018), this work contributes to research about scales of intervention needed to achieve more resilient river systems; community-level climate vulnerability and responses to climate change; impacts of stream restoration on flood attenuation; and the feasibility of natural flood management.

The process of carrying out interdisciplinary, community-based research is messy but productive. Key challenges have included:

- Overcoming long-standing community distrust of university-based researchers.
- Facilitating communication between public agencies with very different mandates (e.g., emergency management vs. water quality improvement).
- Addressing community concerns within the framework of academic research norms.
- Fostering communication and collaboration across researchers and community partners with different methodological backgrounds, disciplinary training, and goals.
- Developing hydrologic modeling tools that are sophisticated enough to represent various watershed and stream network flood management interventions, but simple enough for use in community level scenario planning and visioning.

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