



Flood concerns and impacts on rural landowners: An empirical study of the Deerfield watershed, MA (USA)



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ABSTRACT

Riverine flooding is the most common and costly natural hazard. While there has been substantial research on the perception and management of flood risk among urban and agricultural landowners, we have little knowledge about the ways different groups of rural landowners are impacted by and manage floods. To address this gap, we investigate the impacts of flooding on rural landowners in Massachusetts, USA, the actions they have taken to protect their property, and the ways these concerns and actions vary by land use. We show that floods impact rural landowners in ways that are directly linked to the rural context of their land and livelihoods. Rural landowners face multiple flood risks that include damage to the land itself and rural infrastructure as well as to residential structures. The ways landowners use their land can influence the ways they experience floods and the specific concerns they hold about flood damages. Further, many of these landowners often utilize flood management strategies that involve physical manipulation of riparian areas. Our findings draw attention to the unique context of rural flooding. We argue that more research is needed to understand how these experiences and other factors drive landowners' perspectives on flood management and how these perspectives and management activities influence the practice of flood management at the basin-scale.

1. Introduction

Riverine flooding poses a substantial risk to human life and property. Already the most frequent and costly natural hazard (Bates et al., 2008; UNISDR, 2011), the risks of riverine flooding are expected to increase due to changes in the timing and intensity of precipitation arising from anthropogenic climate change (Collins et al., 2014; Blöschl et al., 2015); in land uses and land cover (Wheater and Evans, 2009; Pattison and Lane 2012); and in exposure of human populations and assets (Bouwer, 2011; Merz et al., 2012; Kundzewicz et al., 2014). Despite billions of dollars spent on levees, dams, and other flood control infrastructure, flood damages continue to rise throughout the United States (Pielke, 1999), Europe, and worldwide (Kreibich et al., 2015).

In light of these rising costs, and in recognition that floods are inevitable, the paradigm for addressing flooding in the USA and Europe has shifted to focus on managing flood risks at the catchment scale, reducing vulnerability to flooding, and 'living with' or 'making space for rivers' (Warner et al., 2012; Biron et al., 2014; Morris et al., 2014; Buchecker et al., 2016). This has led to an increased examination of the contributions of land use to flooding and of the potential of land use-

based, or "natural" flood mitigation measures (hereafter NFM), such as restoration of floodplains, removal of embankments, riparian buffers, and restrictions on encroachments, in reducing the impacts of high precipitation events (Kundzewicz 2002; Opperman et al., 2009; Butler and Pidgeon, 2011).

As approximately 60% of land in the USA is privately owned (Natural Resources Council of Maine, 2000), successful implementation of NFM will be largely determined by the attitudes and actions of private landowners. In managing their lands, landowners may or may not choose to engage in actions that are aligned with NFM (Milman and Warner, 2016). Furthermore, disagreement over the methods and potential impacts of flood management policies may lead to landowner resistance to those policies (Harries and Penning-Rowsell, 2011). For example, in the UK, public pressure has led to the partial reversal of flood management policies promoting a return to nature (Emery and Hannah, 2014). Recent flooding in the UK has also led to substantial public outcry against the EU Water Framework Directives regarding flood management (Walling, 2015).

Of particular importance are the perspectives and circumstances of rural landowners – i.e., landowners in low-population density areas,

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separated from areas of with large populations and high-population density development, large tracts of impervious surface and other substantial built environment (US Census Bureau, 2010). Seventy-two percent of the land area of the USA is classified as rural (Economic Research Service, 2015). These rural areas are generally characterized by large amounts of open space and fewer existing structural flood control measures. Consequently, policy-makers and scientists have promoted implementation of NFM on rural lands as a potential mechanism for alleviating downstream flood risks (O'Connell et al., 2005; Parrott et al., 2009; Morris et al., 2014; Rouillard et al., 2014).

While there has been substantial research on flood management, we lack a rich picture of how the diversity of rural landowners experience and respond to floods. To address this gap, this study examines rural landowners in the Deerfield River Watershed in Massachusetts, USA. We investigate the impacts of flooding on rural landowners, the actions rural landowners have taken to reduce the potential impacts of flooding, and how these vary across rural land uses. Our research reveals how rural landowners' experiences and responses to floods are directly tied to the rural context of their property. Our findings show both the shared experiences of landowners across different land use categories as well as some key differences in how they experience floods. These findings highlight the need for new theoretical perspectives on flood management that better reflect the rural context and diversity of rural landowners. We argue that more research is important to further understand the heterogeneity of rural landowner concerns and actions and how these shape possibilities for basin-wide flood management.

2. Flood management and rural landowners

Recognition that private lands have an important role in reducing the potential damages from flooding has led to a growing interest in the perspectives, motivations and actions of individual landowners. Behavioral theories, derived from empirical studies, have shown broadly that motivations to respond to natural hazards, including flooding, and the selection of actions to undertake are largely influenced by perceptions of risk and the ability to reduce that risk (Rogers and Prentice-Dunn, 1997; Grothmann and Patt, 2005; Lindell and Perry 2012). This includes questions related to the likelihood of flooding, potential damages from floods, implications of those damages, as well as the actions that could be undertaken to reduce that risk and expectations regarding the outcomes of those actions.

The experiences and perceptions of rural landowners in relation to these questions are understudied, and, quite likely, are influenced by the contextual factors that distinguish rural from urban areas. Rural economies tend to be natural resource dependent, reliant on agriculture, forestry, tourism and recreation (Lal et al., 2011; Hales et al., 2014; Kusmin, 2016). Land is a key rural asset that rural landowners value not only for financial investment and income but also for natural amenities such as aesthetics, privacy, and recreational opportunities (see, for example, Bengston et al., 2011; Ferranto et al., 2011). Many rural landowners also rely upon and maintain their own private infrastructure, including privately owned roads, bridges, wells, and septic systems. Rural areas also differ from urban areas in terms of their social context. In the USA, many rural areas also have older, less affluent, and less educated populations; more limited financial and human resources; and weaker relationships with state and federal agencies than urban areas (Lal et al., 2011; Hales et al., 2014; Kusmin, 2016). Yet, we know little about how flood impacts are experienced by landowners in this rural context.

Most studies that examine impacts from flood events tend to group damages by sector (i.e., residential, business, public health) and do not describe the specific nature of the damage incurred or the specific impact at the individual-level (Chatterton et al., 2010, 2016). To the extent that rural flood damages have been investigated, we primarily understand impacts in relation to agriculture; as studies have estimated

the costs of flooding impacts such as crop loss and reduced yield, livestock relocation expenses, damage to pastures, machinery and fences, and increased need for agrochemicals, among others (e.g., Posthumus et al., 2009; Penning-Rowsell et al., 2013; Morris and Brewin, 2014). Yet rural landowners are diverse and many are not agriculturalists. Of the few detailed accounts of the impacts of flooding to non-agricultural landowners, the focus is specifically residential structures in urban areas (Oliveri and Santoro 2000; Pistrika and Jonkman, 2010) with the exception of one 1998 survey of flood victims in Canada (Rasid and Haider, 2002). None of these studies examine the full suite of damages rural landowners may face.

Similarly, the emergent research on measures undertaken by private individuals to protect themselves from potential flood damages are either focused solely on households in an urban area (e.g., Grothmann and Reusswig, 2006) or do not distinguish between rural and urban areas (Kreibich et al., 2005; Thieken et al., 2007; Terpstra and Gutteling 2008; Bubeck et al., 2013; Poussin et al., 2014; Joseph et al., 2015). These studies primarily examine actions aimed at protecting residential housing structures and household goods from flood impacts, including the choice to adapt interiors or building use to flooding through the location/placement of goods or appliances inside the house (Kreibich et al., 2005; Grothmann and Reusswig, 2006; Thieken et al., 2007; Bubeck et al., 2013; Poussin et al., 2014; Joseph et al., 2015), the choice to install water barriers on windows, doors or to use pumps (Kreibich et al., 2005; Grothmann and Reusswig, 2006; Thieken et al., 2007; Bubeck et al., 2013; Poussin et al., 2014; Joseph et al., 2015), the purchase of insurance or development of emergency plans (Thieken et al., 2007; Bubeck et al., 2013; Poussin et al., 2014; Joseph et al., 2015) and in some instances, the redirecting of flow through small measures (Thieken et al., 2007; Joseph et al., 2015). As these studies are urban-centric, they do not examine the broader range of damages outside the household structure that may pose problems for rural landowners, nor do they consider the potential actions rural landowners may take to managing floods by addressing their land-use practices (e.g., riparian buffers, rip-rap, etc).

Furthermore, understanding rural perspectives is important because preferences for specific flood management measures are context dependent. Individuals evaluate flood management measures based not only on the extent and manner in which they reduce flood damages, but also in terms of impacts to the environment, aesthetics, economics and other social practices (Kenyon, 2007). For example, concerns about economic development leads to less support for nonstructural measures (Næss et al., 2005; Scolobig et al., 2008); concern about the environmental protection and ecological management increases support for nonstructural flood management (Rouillard et al., 2015; Buchecker et al., 2016); and concerns about the aesthetics, including the tidy appearance of a kempt river corridor, reduce support for nonstructural measures (Rouillard et al., 2015). Perceived risk can also have a role: while recent flood events tend to trigger support for structural mitigation measures; a longer history of repetitive flood loss drives non-structural techniques; and the expectation that there will be an increase in future floods increases support for non-structural measures (Kenyon, 2007; Brody et al., 2010; Buchecker et al., 2016). While research on the perspectives of agricultural landowners suggests economic considerations make them resistant to implementing natural flood mitigation measures (Posthumus et al., 2008; Howgate and Kenyon 2009; Holstead et al., 2015; Rouillard et al., 2015), little is known about the preferences of non-agricultural rural landowners.

3. Methods and study area

Our primary research objectives are to examine the experiences of rural landowners, and thereby to identify their unique concerns and perspectives regarding the impacts of flooding and how to best respond. Specifically, we ask (1) what are the primary concerns rural landowners have about floods, and how have floods impacted rural landowners; (2)

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