
MISMATCHED PROPERTY RIGHTS

Ostrom, Floods and Mismatched Property Rights

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How societies can cope with flood risk along coasts and riverbanks is a critical theoretical and empirical problem – particularly in the wake of anthropogenic climate change and the increased severity of floods. An example of this challenge is the growing costs of publicly-funded flood defense in Britain and popular outcries during the regular occasions that the British government fails to protect property and land during heavy rains. Traditional approaches to institutional analysis suggest that flood management is either a public good that only the government is competent to provide or a private good to which individual landowners are ultimately responsible for supplying. We argue that an important cause of failure in flood management is mismatched property rights. This is where the scale of natural events and resources fail to align with the scale of human activities, responsibility and ownership. Moreover, the spatial dimensions of floods mean that their management is often appropriately conceptualized as a common pool resource problem. As a result, commons institutions as conceptualized and observed by Elinor Ostrom are likely to be major contributors to effective flood management. What governance process should decide the size and scope of these institutions? We argue that bottom-up responses to problems of mismatched property rights are facilitated within larger societies that are characterized by market processes. Moreover, the wider presence of price signals delivers to local communities essential knowledge about the cost of maintaining private property and the relative scarcity of the communal goods. We discuss how our theoretical positions align with experience in Britain and what the implications of our theoretical approach are for facilitating the development of better institutions.

Keywords: Ostrom; common goods; floodplain; drainage; Britain; externalities; market failure

1. Introduction

What role can commons institutions play in ameliorating mismatched property rights? Hardin (1968) asserted that the existence of commons produced a ‘tragedy’ remediable through strict division of natural resources into private property or state control. Ostrom (1990), and the Bloomington School of Political Economy, revealed instead a range of long-lived, productive and peaceful commons institutions that rely on neither a central state nor individual private property. Common pool resource problems frequently underlie mismatched property rights (Yandle 2007).

The challenge of flood management is an important and timely example of this. Britain, a famously wet country, offers a helpful case to illustrate our general theoretical link between mismatched property rights and common pool resource problems. In the twenty-first century, floods have grown in national salience in Britain and prompted greater government intervention to contain them (Lodge 2019). Initially, there was widespread consensus that increased flooding was due to climate change and misguided urban development on floodplains (Environment Agency 2001; Howe and White 2001; Marsh and Dale 2002). However, since the 2010s, some responsibility has been attributed to the government’s passive approach to flood management. The latter approach reflects a post-industrial rationale that humanity must work within natural ecological systems as well as a new public interest in preserving wetland wildlife habitats (Adams,

Perrow, and Carpenter 2004; Fleming 2001; Mainstone and Wheeldon 2016; Wharton and Gilvear 2007). However, the passive approach was dictated also by budgetary austerity. The Conservative-led Coalition Government (2010–2015) cut local government budgets across the board and this included flood defenses (Bennett and Hartwell-Naguib 2014).

Public opposition to the passive strategy escalated sharply in 2014 when flooding in the Somerset Levels left over 17,000 acres of land under water and several villages isolated for more than a month (Morris 2014). Local groups blamed the reduction in river dredging for the damaging and long-lasting flood.¹ Reviewing the failures and responding to local activists, the government adopted a more pro-active approach to handling flood risk and greater recognition of local interests (Smith, Porter, and Upham 2017, 352). Yet the costs and long-term implications of river-dredging and other pro-active interventions remain controversial.

These local challenges are examples of flood management problems that are emerging globally as humanity continues to live in and develop coastal areas and river catchments, particularly in the wake of climate change. There is a growing consensus that it is critical to include local stakeholders and develop community resilience when implementing environmental reforms even when they have global ramifications (Begg, Walker, and Kuhlicke 2015).

We make three points to inform this generational challenge. First, much of the problem of effective flood management results from mismatched property rights. Second, underlying this mismatch is a common pool resource problem. As a result, we would expect commons institutions to have a more positive contribution to ameliorating harms from flooding than has traditionally been acknowledged in theory and practice. Third, in order to determine the appropriate size and scope of these institutions, providers of commons governance benefit from accessing information about demands and scarcities in the broader society. Market institutions are essential for providing this information. Institutions that allow the emergence of local commons governance solutions set within a commercial society are the most promising for finding effective flood management solutions.

Having made these arguments, we show how this perspective resonates with the experience and contemporary challenges of flood management in Britain. In this way, we contribute to situating commons institutions into the 'new governance' research agenda, where various scholars have outlined how novel governance structures, often based on contracting and public-private partnerships, lead to the successful control of landscapes and natural resources (S. E. Anderson et al. 2019; Bradshaw and Lueck 2015; Bradshaw Schulz 2013; Epstein 2016; Fennell 2011; 2016; Leonard and Regan 2019; Libecap et al. 2018; Lifshitz 2015). Moreover, we show how the emergence of better performing governance structures can be made more probable when market prices, representing needs and scarcities throughout a society, are accessible to local decision-makers.

2. Mismatched property rights and floods

A property mismatch occurs when a set of rights established to achieve certain ends leads to gaps in responsibility or conflict for some other interest or practice (c.f. Bradshaw and Leonard, this volume; Epstein, this volume; Ehrman, this volume; Lifshitz, this volume; Facemire and Bradshaw, this volume; Richards; this volume; Christmas 2019). They have been observed especially when the scale of human activities in a given territory fails to align with the scale of ecological activity (Yandle 2007; Cash et al. 2006; Crowder 2006). Although the mismatch literature has yet to consider flooding as an example in detail, flood management is a good candidate because the spatial properties of floodplains commonly exceed the boundaries of private property rights (W. Howarth 2003), and because various kinds of flood abatement schemes aimed at defending human interests have environmental costs (Turner, Dent, and Hey 1983).

Conceptualizing flood management as a property rights mismatch pre-empts a common presumption that it is fundamentally a state competence and that any private attempts to ameliorate flooding will constitute a market failure due to intractable externalities (Meade 1952; Millward 1970). The market failure account suggests that any contribution from private sector activity to socially beneficial outcomes breaks down as soon as reality departs from the assumptions underlying fully competitive markets: that is of perfectly rational actors in possession of complete information with effectively unlimited buyers and sellers for all desired goods and services (Boettke 1997). These assumptions only apply, in principle, to the production of private goods; goods that are rival and excludable. On this account, any goods that produce positive externalities (benefits that cannot be charged directly to consumers) or negative externalities (costs that

¹ Dredging is the physical removal of naturally accumulating mud and sand at the bottom of a riverbed, usually to ensure increased water flow.

cannot be properly priced as part of the cost of production) will cause a misalignment between the private benefit and social cost.

A key premise of the market failure account is that there is no scope for the parties to alter the underlying rules through which they attempt to cooperate. By contrast, when Demsetz (2000) relaxes that assumption, he shows how private property is not always the source but the solution to externalities. Making individuals residual claimants of profit and loss over land can discipline them towards rational behavior. Domains notorious for negative externalities, from traffic congestion to firewood shortages, are those where private property is absent or suppressed. Freedom of contract among property-owners enables individuals to internalize much of the negative externalities (Ostrom 1990, 3).

Demsetz' (2000, 164) account of private property institutions includes the existence of externalities within the model and suggests 'a primary function of property rights is that of guiding incentives to achieve a greater internalization of externalities'. What the property mismatch description adds is that property lines that suit some sorts of activities are likely to be ill-suited for others. These conflicts in property use can sometimes be ameliorated through modifying the bundle of rights associated with each property such that actors with different interests in an area contract for a different set of rights (Yandle 2007).

2.1. Floods as a common pool resource problem

Flood management presents an additional complexity on top of the mismatch between human and natural scales of activity. Insofar as flood management is a private good, then mismatches can be ameliorated through changing the scale and scope of individual property rights and permitting contracting between private parties. If flood management is chiefly a public good, then the mismatch account would suggest the problem can be solved by establishing a government jurisdiction over flood management at the appropriate scale (Bradshaw and Leonard, 2019, this volume, p. 3). However, many flood management schemes take the form of common goods (Geaves and Penning-Rowsell 2016).

The classic private good in this sector, with a well-established market in the United Kingdom, is flood insurance (Penning-Rowsell 2015). The classic public good, provided by the Environment Agency in England, are flood monitoring and early warning systems (Penning-Rowsell et al. 2000). However, moving beyond these schemes to more pro-active and pre-emptive solutions presents difficulties. Private physical flood defenses, unless established by large landowners, are likely to fail because they struggle to coordinate across the whole of a water course (W. Howarth 2003, 8). Flood waters do not respect gaps in defensive barriers or uncoordinated schemes that result from property lines that do not follow natural boundaries. On the other hand, public management has its own challenges since effective flood prevention requires not just resources but establishing and consistently maintaining infrastructure on private land.

Moreover, unlike pure public goods, the costs of flooding are partially rival and subtractable (Cf. Ostrom 2010a, 644). It is rival because flood waters can be channeled from one parcel of land or piece of territory to another (W. Howarth 2003, 5). Moreover, freeriding off the flood abatement strategies of others does not only impose inequitable expenditures on contributors to the common good but leaves more water for other landowners to absorb. By contrast, a classic public good like professional military defense is generally not rival and subtractable, at least not in such a straightforward way. The bad associated with floods is not the flow of water over a given course in itself but rather the consequences of over-saturation. For these reasons, flood management is better conceived as a common pool resource problem (Ostrom 1990).

2.2. Commons solutions

What common good approaches are there for flood management? While dredging has been the most salient in the British public debate, there is substantial disagreement about how effective it is likely to be in any particular instance. Among skeptics of dredging, there is support for other flood defenses that align more closely with environmental values; for example, planting trees alongside river banks and cultivating wooded areas in which excess water can be diverted (Thomas and Nisbet 2007; Wilkinson, Quinn, and Welton 2010). The deep and thick roots make the soil stronger and capable of absorbing more water. This strategy requires landowners to set aside portions of land otherwise available for private uses like crop cultivation. Just as with dredging, trees along a riverbank do not simply protect the land where they are planted but contribute to preventing floods throughout a vulnerable area.

Other strategies include installing permanent (or deployable) flood barriers and sluices, as well as investing in emergency pumping systems. Each have their own costs and differential impacts on other property uses, natural habitats and the aesthetic character of an area (Green and Robins 1993). Exactly how and where dredging should happen or riverside forestry cultivated is not something that policymakers

operating from the center can know with accuracy (McEwen and Jones 2012). Yet these strategies only work through significant collective coordination across a floodplain. This is why we would expect locally situated communal governing institutions, rather than isolated private actors or national agencies, to be better placed to supply these common goods.

How is this level of coordination possible? Until comparatively recently, scholarly understanding of commons was hampered by a framework of analysis that relied on a crude binary between individual private property and public management (Field 1985). This reached a zenith with Hardin's (1968) famous article, 'The Tragedy of the Commons'. Ostrom relaxes the tragic assumption of individuals trapped in prisoners dilemmas, and suggests that many groups are sufficiently creative to solve social dilemmas by setting up complex arrangements that monitor and sanction the use of common resources (Axelrod, 2006; Ostrom et al., 2014: 167). Individuals have a propensity to form groups that foster social norms and organization because of the interdependence of their actions regarding natural resources (Ostrom, 1990: 39).

Durable rules and institutions (which can include property arrangements) emerge in social structures that provide feedback between one's own behavior and the expected choices of others (Ostrom et al., 1994: 319). Rather than necessarily being imposed externally, individuals produce both legal rules and informal norms whereby they can realize 'larger joint benefits when they observe many others follow the same strategy' (Ostrom, 1990: 39). Small groups can establish and enforce these rules because of the substantial marginal effect of individual compliance, and the fact that violators are identifiable (Ostrom et al. 2014, 181–93; T. L. Anderson and Hill 2004). When groups are socially cohesive, they do not necessarily need to take recourse to legal mechanisms, as social norms are effectively monitored and lead spontaneously to the effective governance of specific resources (Acheson 1998; Bradshaw and Lueck 2015, 2546; Ellickson 1986).

3. The contribution of market processes to successful commons institutions

3.1. Ostrom's approach

What do Ostrom's observations imply for establishing institutions that will best cope with mismatches in property? One interpretation of her work is that she identifies an alternative form of governance that stands apart from private property and state control. Understanding commons expands the strategies available to policymakers when coping with challenges to coordination. On this account, the well-rounded policymaker will insist on public provision for goods that are non-rival and non-excludable, a private property solution when they are rival and possible to exclude with the right framework, and commons-based solutions when called for by specific resource challenges. Thus Ostrom completes the policy toolkit by providing a third way (Block and Jankovic 2016).

However, on our account, the lesson from Ostrom is not so much the existence of a distinct third category. Her most significant insight is procedural. Her exploration of various commons institutions is not intended to create a new ideal-type to be copied elsewhere in order to solve property mismatches. The theory of the commons is a more general case against the top-down imposition of *any* legal regime – including commons (Ostrom 2010c; cf. Aligică and Boettke 2009; Moroni 2010). Within this view, Ostrom's focus is on endogenous rule-formation, whereby formal and informal property arrangements are emergent features of the social structure (rather than processes within exogenous rules) (Boettke 2018, 174). As Ostrom (1998, 2) explains: 'Field research... shows that individuals systematically engage in collective action to provide local public goods or manage common-pool resources without an external authority to offer inducements or impose sanctions.' A policymaker cannot know how to repair misallocations between property and the spaces they govern. Instead, the question is which processes support local communities that live in proximity of natural resources in finding their own solutions matched to their territory (Leeson and Harris 2018).

Ostrom identifies the value of spaces for public entrepreneurs to experiment within their circumstances and of communities to generate their own legal structures (Schneider, Teske, and Mintrom 1995; Schneider and Teske 1993). Communities are made up of individuals with unique knowledge and goals. Tailoring the level of governance to the level that reaches some homogeneity in goals and knowledge, brings political action closer to efficiency (Boettke, Coyne, and Leeson 2011). This appreciation of the commons as self-regulation does not mean theorists have nothing to contribute. Instead, the challenge for theorists is to figure out the conditions that are likely to help the successful emergence of commons (Buchanan 1959).

Under what conditions can bottom-up approach to institutional formation perform systematically better than an alternative where public officials, who derive their power from outside the community, take ultimate responsibility for the rules people must follow? Our alternative to public regulation needs some explanation: how bottom-up local decision processes can appropriately weigh the needs of the rest of society and, in turn,

disseminate better practices to other areas where governance challenges persist. How do we expect the successful experiments of public or community entrepreneurs in particular locations to scale up and spread (Chamlee-Wright, Haeffele-Balch, and Storr 2017)?

3.2. Private-property solutions to flood management

Looking through Demsetz' lens suggests that a lack of flood protection is not necessarily a market failure, but rather a failure of a market to exist. Realistic models would not ignore that private property leads to a mismatch in the governance of natural resources. However, the dynamism attributed to private property regimes could well lead to the "spatially efficient management" of natural resources as discussed in the new governance scholarship literature (Bradshaw and Leonard, 2019, this volume, p. 3). When we look at the legal structure surrounding flood management we observe property owners unaware of the extent of their rights, and a relatively greater reliance on public authorities. In Britain, riparian owners of waterways retain a common law duty to keep channels clear of debris. However, when it came to more pro-active approaches to flood management, landowners were uncertain as to what their legal powers and duties might be (House of Commons 2014, 7–8).

What might private-property solutions look like if property rights were more effectively codified? Absent the promise of collective interventions, practices such as flood-proofing individual homes and installing flood protection (like drainage ditches) on one's own land would become more popular. Equally, flood insurance would become more affordable, meaning policy holders accept property damage but spread its costs across their lifetime to make it more manageable. Through Coase's lens, this is only the beginning of a range of strategies that private actors can adopt. If property rights are sufficiently well-established then there are manifold bargaining opportunities when the gains from mutual cooperation are sufficiently high. These Coasean insights resonate with findings within the natural resource literature. As Bradshaw and Lueck (2015: 2544) explain:

'... private organizations can govern large landscapes without governmental control, but ... the factors necessary to promote private contracting are increasingly difficult to maintain because, over time, increased land fragmentation produces increased heterogeneity among landowners and administrative and legal regimes begin, and continue to, overlap... law has shaped the path of ownership by often dividing large-scale resources into fragmented parcels, which describes the conditions under which private organizations control large landscapes'.

When it comes to flood management, landowners could use private contracting to install flood channels throughout the plain in a way that provides for mutual defense. They could pay into a common fund to dredge rivers. In a broader commercial society, we might expect bargaining opportunities with specialists from outside the immediate region to emerge as well. For example, insurers might advise policy holders on how to manage drainage effectively based on their experience from other cases, and incentivize better practices with discounted premiums.

As with public provision, there are weaknesses to this contract approach too. The success of contractual solutions depends critically on the number of parties concerned and the homogeneity of their objectives (Bradshaw and Lueck 2015, 2544). Whether individuals at risk of flooding engage in contracts that successfully master spatial exigencies will depend on social and economic criteria that characterize the group. For example, a newly constructed town that hosts people that do not know each other, some with large residences that serve as holiday house while others live in small houses or own small fishing huts, might have difficulty coordinating pure contractual responses to flood risk. When the costs of the Demsetz solution are insurmountable, the Meade model is the more feasible, hence there is an interest in government control of flood risk (Bradshaw and Lueck 2015, 2545). Nevertheless, the idea that bottom-up solutions are a function of multiple variables, both formal and informal, is not only essential to the new governance scholarship, it is also at the heart of the legacy of Ostrom.

3.3. Pricing the commons

Leeson and Harris (2018) observe that governance decisions, for instance to privatize the commons, are successful when the decision-makers are residual claimants. Our additional theoretical contribution to the solution of mismatched property is that successful small-scale governance regimes are facilitated within societies that, on a higher level, are characterized by market processes. Market societies deliver an environment wherein communities can experience the costs and benefits of productive activities for

communities via trial and error learning. The effectiveness of innovative property regimes is discoverable through the wider presence of a market system that provides salient feedback by the realization of profit and loss (Boettke 2002; 2014; Hayek 1945; Kirzner 1996).

This does not imply that commons necessarily make use of market principles within their internal governance scheme, for example by privatizing parcels of natural resources. One reason for establishing the institution of a common is to introduce rules that restrict the use of market exchange in certain goods. Nevertheless, when commons are developing their communal property regimes, this discovery process is facilitated when these commons are nested within societies that have a price system. With a comparison, social groups like families and associates create particular property regimes, where rights to access and use are communal and group-rules apply to the management of specific resources. Our claim is that the higher-level presence of markets and price systems grants information that is essential for the choices individuals face when setting up their internal governance regimes (S. E. Anderson et al. 2019). At various levels, the presence of a price system is crucial for individuals engaging in bottom-up proprietary arrangements.

A community, a firm or a club will respond in its internal arrangements to the relative scarcity of a good, the former being revealed by public prices. When high-value common goods (for example, electricity supply) is under threat, communal governance will establish a more rapid and strict form of protection than in cases of goods with lower social value (for example, potato crops). If the community internally adopts collective property, it is essential for that community to know the value that the non-members attach to its goods. Commons can reach levels of efficiency because of trust and social control but – when trying to enhance the welfare of its members – it still needs information about the potential exchange value of the goods that are being collectively produced. The surrounding environment of a market, where a price signal attaches values to houses, land, crops, and electricity, enables commons to make effective choices when designing communal property regimes. The more stringent rules and norms revolving around goods with a high commercial value are likely to lead to monetary or in-kind benefits for the members of the community.

A hypothetical example can illustrate our perspective. Consider a neighborhood group that is thinking about establishing a communal garden. How precisely can they calculate the costs and benefits of a common institution? How could the neighbors decide on whether to fence each other out, or include each other in what will become the neighborhood garden? Skeptics of the primacy of private property have argued that property rights are not a costless good (Holmes and Sunstein 2000). And they are right: fencing costs money; granting access to non-property holders requires time; enforcement and use of a judicial system is expensive. However, the alternative is not free either: establishing and maintaining common goods involves investing time, effort, resources and local governance infrastructure with the expectation of a set of private returns for participants in the form of economic and other subjectively valued outputs. Even a quite simple question of private versus common gardens entails sophisticated economic calculation that involves knowledge of relevant scarcities and demands dispersed throughout society (Buchanan 1999, 38).

A system capable of providing this sort of information is the price mechanism supplied by a competitive market economy (Hayek 1945). This pricing mechanism can reveal the opportunity costs of private property and the potential gain of a common by enabling individuals to put a value on the time they need to grant others access, the fences they buy to exclude others, and the courses of action they could undertake with the money paid for defense and enforcement. Indeed, as the costs of privatization become apparent, the price mechanism will teach individuals the value of informal mechanisms like trust and social control when it comes to managing the goods in their proximity. Prices also reveal the costs of having the garden in the first place and thus make sure the entire exercise is made with prudence.

In this way, it is market pricing that enables individuals to step out of markets because the price signal reveals the opportunity costs associated with keeping things private (Buchanan 1965; 2001). Through this mechanism, as with firms and enterprises in other parts of the economy, communities are induced to be creative in developing schemes that other communities may choose to imitate if they turn out to be successful, while failed ones, where the benefits of participation turn out not to outweigh the costs, are abandoned and eventually reformed by more successful land users.

3.4. Appreciative theory

In making the claim that market processes can solve coordination problems in the midst of mismatched property rights to produce common goods, we are departing from defending their more established role in the provision of private goods. A skeptic might argue that we are expressing an overly optimistic application of market institutions. Even an unencumbered price system might fail to coordinate the actions of stakeholders that are trying to make difficult trade-offs in circumstances defined by specific, sometimes unique, territorial challenges. One mismatched property problem could be connected to another mismatch

hitherto unseen, perhaps operating at a larger scale or over a different natural boundary. The presence of price signals might not be able to overcome the coordination problem.

In answering the skeptic, we acknowledge that our claims about the contribution of a price system to protecting environmental goods present intrinsic complexities that resist formal, abstract proofs. What can be offered instead is something that market process economists term 'appreciative theory' (Boettke 2018, 107–8; Boettke and Coyne 2009, 12; Nelson and Winter 2004, 47). Rather than producing precise predictions about the outcomes of implementing institutional solutions, or prescriptions about how to definitively fix social challenges, this approach relies on broad observation, narratives and pattern prediction drawn from history and contemporary case studies (Furton and Martin 2018; Boettke, Coyne, and Leeson 2013). Avoiding attempts to prove an optimal solution, such a framework of analysis focuses on descriptive empirical comparisons of existing institutions, supplemented (when available) with contextualized quantitative data.

From this perspective, the question is not how a price system will identify and reconcile every property mismatch, but whether it offers the appropriate tools to incrementally ameliorate the causes of miscoordination. A comparison alongside a realistic account of political processes is useful here. One of the key advantages claimed in favor of public regulation is the capacity of states to discover and disseminate rational, scientific management techniques to solve optimally all the various problems that private actors produce. On an appreciative account, this optimism about the knowledge and motivation of actors within a centralized political process should be tempered (Furton and Martin 2019). Democratic decision processes are vulnerable to opportunism such that controlling majorities or well-organized minorities can channel public resources to support their private interests (Buchanan and Tullock 1999; Meadowcroft 2014). Political decisions can be subject to cycles whereby one party imposes a policy for a few years before a new majority coalition gains power and reverses it (Congleton 2003).

These issues are exacerbated when dealing with complex natural phenomena, including unpredictable floods where their risk and pattern of occurrence is highly variable. In one period, a government might conclude that flood protection is an essential public interest. In the next period, after private actors are committed to courses of action and investment, policymakers may conclude that the costs now outweigh the benefits, perhaps that the ecological costs were previously underweighted in the social calculus. As a result, people living and working on coasts and flood plains, already exposed to natural tides and downpours, become, in addition, subject to the uncontrollable fortunes of politics and policy. This makes private actors incapable of engaging in successful private planning to contain costs against the exigencies of nature. For these reasons, there is a compelling theoretical case for use of an open-ended market process that allows actors to incrementally, imperfectly, adjust to novel challenges and opportunities as they arise. There is no perfect solution but the presence of markets supports the reform of bad solutions in a way that is generally less likely for centralized government solutions. As Boettke (2018, 189) argues: 'The superiority of the market process lies not in its ability to produce optimal results, but rather in its ability to mobilize and effectively use knowledge that is dispersed throughout the economic system.'

3.5. Evidence

While our theoretical position can be proven definitively in neither a deductive nor empirical manner, it aligns with a growing and compelling evidence-base that illustrates the domains where our theory might apply. Several empirical contributions illustrate where price mechanisms can disperse and share knowledge crucial for institutional change in the provision of environmental goods. Leonard and Reagan (2019) show how, under a system where natural resources like water rights, wildlife or timber can be purchased, conservation groups can not only reveal, but act upon existing societal preferences for non-use and non-extractive management of these resources. S. E. Anderson et al. (2019) find that governance of natural resources adapts more strongly to the consequences of climate change when subject to relatively unencumbered price mechanisms. Within urban, coastal, and agricultural land markets, the presence of price mechanisms provides effective signals of the emerging costs of climate change. This encourages adjustments by private owners and public officials and technological innovations by entrepreneurs.

Cai et al. (2019, 9) use the example of forest management to show that public entrepreneurs will respond to the costs of common ownership within an environment that is characterized by robust market institutions. Conversely, where non-market zoning restrictions intervene with the price mechanism, communities are left increasingly unable to govern their housing markets, leading to exclusion of community members from access to shelter (Glaeser, Gyourko, and Saks 2005).

When it comes to water resources specifically, Dudley (1992, 769) finds that capacity-sharing in water reservoirs works better within an environment driven by pricing mechanisms, as 'water stored in the users'

shares of reservoir capacity to be transferred through the market confronts users with the full opportunity costs of water.' Komakech and van der Zaag (2011, 214) find that the emergence and functioning of governance via water committees in Tanzania is positively influenced by the presence of markets for agricultural produce.

This evidence is not probative. It merely tips the balance towards our claim that communities are better able to solve problems of mismatched property rights when pricing mechanisms are present. Our theoretical contribution is consonant with empirical research that shows how natural governance problems more generally can be overcome with the presence of price mechanisms and markets. While more empirical research is desirable, it is productive to extrapolate what the evidence so far suggests for explaining the challenges of flood management in Britain and prospects for reform.

4. Lessons from and for Britain

4.1. The decline (and hopeful rise) of local governance

Why are common goods in land a challenge to provide under existing legal frameworks in Britain? As in the rest of Europe, Britain emerged in the modern era as an integrated industrial and commercial society where traditional commons institutions tended to receive less legal recognition compared to public (state-owned) and private property (Gerber et al. 2008, 224). This binary approach to governance acted as a pincer that incrementally reduced the scope of commons institutions.

Details of local governance arrangements before the 20th century is limited despite evidence of sophisticated drainage schemes (Browne et al. 2016, 84). In the 1930s floodplain governance was standardized with nationally-recognized Internal Drainage Boards (IDBs) initially as farming cooperatives (E. Penning-Rowsell, Johnson, and Tunstall 2006, 324). IDBs levied both local landowners and local government authorities to pay for drainage activities. Their policies for most of their existence appear to have reflected closely the interests of local farmers and landowners. Thus they have a plausible claim to possess some of the polycentric properties that ameliorate the challenge of the mismatched property in land at risk of flooding.

Nevertheless, IDBs were not left alone to decide the appropriate trade-offs. There was a decisive turn towards public investment in the early 20th century (Scrase and Sheate 2005). Farmers had abandoned much floodplain land as it was uneconomic to drain with increasing labor costs but 'economic factors that were inhibiting this investment were seen as obstacles to be overcome rather than as signals that the market didn't want the produce' (Bowers 1998, 66). Overcoming local opposition, the government subsidized river drainage activities by replacing loans with grants, as well as supplying labor, first by using prisoners of war, and latterly paid laborers as part of unemployment relief schemes (Bowers 1998, 71). Because the land remained uneconomic to farm, it was not until farmers were subsidized to drain private land that the supposed benefits of river drainage were realized. However, there has never been a net social return to this policy (Bowers 1998, 80). Worse, by the 1980s, scholars were observing the damaging impact of drainage schemes on wetland habitats (Turner, Dent, and Hey 1983). The tide reversed leading the central government to diminish drainage in the face of local opposition. By the present day, of course, many people's lives are entangled with floodplain defense presumed to be a state competence.

IDBs are formally public authorities. They came under fresh scrutiny as part of the 'anti-government' politics of the 1980s. Thatcher's administration was keen to dismantle local government institutions that were seen as wasteful and replace them with privatized utilities. However, Thatcherism lacked a formula for handling common goods. Suspicion of local government ultimately implied greater reliance on central government. Coupling this with an increased role for the market led to the competencies and resources of the IDBs being largely taken over by private water companies and what eventually became the Environment Agency (Penning-Rowsell and Johnson 2015, 134). Nationalization in one political trend, followed by centralization alongside privatization in another, led to the devaluing of institutions that had plausible claims to utilize local knowledge and feedback regarding the costs and benefits of particular drainage strategies.

As a result, looking at the legal structure surrounding flood management by the 2010s, we observe property owners unaware of the extent of their rights, and a relatively greater reliance on public authorities. In Britain, riparian owners of waterways retain a common law duty to keep channels clear of debris. However, when it comes to more pro-active approaches to flood management, landowners have been uncertain as to what their legal powers and duties might be (House of Commons 2014, 7–8). In response to the failure of flood management in 2014, the Environment Agency permitted IDBs to perform more maintenance activities on rivers in their districts (House of Commons 2014, 9). This push towards polycentricity reflects Ostrom's (2010b) celebrated insights into what kind of institutions can best ameliorate natural resource challenges.

4.2. *The impact of land regulation and subsidy*

Our market-process perspective suggests that it is not just local institutions that matter but the capacity of those running them to access relevant information about values and scarcities throughout society. If the price mechanism is encumbered, then local decision-makers' capability to make well-informed choices will be reduced. In Britain, permissions to build and reconfigure real estate were effectively nationalized under the Town and Country Planning Act 1947 (Rydin 2003, 21). One likely consequence has been to constrain residential density in established urban areas (Dempsey, Brown, and Bramley 2012). This artificially raises the costs of housing and can make nearby floodplains marginally more attractive for developers than they would otherwise (Potter, Ludwig, and Beattie 2016).

Meanwhile, British farmers currently receive substantial subsidies through the European Union's Common Agricultural Policy (R. Howarth 2000). This means that both land-use decisions and farm incomes are de-coupled from underlying farm productivity (Bowers 1998; Rizov, Pokrivcak, and Ciaian 2013). Without the ordinarily presumed interest in maintaining intrinsic profitability, farmers may fail to contribute effectively to flood prevention or other environmental goals that impacts their output unless specifically incentivized by subsidy rules (Robinson 1991). If the farms were operating unsubsidized, the costs of flooding would figure more plainly in economic calculations when deciding where it is efficient to farm in a floodplain and what contributions to make to common flood defense. Indeed, European governments are currently in the perverse position of subsidizing relatively unproductive agriculture with one policy, while attempting to curb the resulting harm to the natural environment with another. These various schemes of regulation and subsidy plausibly combine to attenuate the capacity of the market process to furnish both private individuals and local communities with the appropriate knowledge and incentives to engage in common flood prevention without state support.

This situation helps explain the greater reliance on private goods (especially flood insurance) and public goods (especially early-warning systems) to alleviate flood risk in Britain, and less use of common goods (Geaves and Penning-Rowell 2016, 282; Johnson, Penning-Rowell, and Parker 2007, 383). This does not mean that physical protections are absent, only that they are often supplied through other, more indirect and likely less efficient, mechanisms than members of a local community cooperating and combining their own resources on the basis of their personal knowledge and experience. For example, a key driver of publicly funded provision of flood infrastructure is lobbying pressure from commercial insurers (Penning-Rowell and Pardoe 2012; Priest, Clark, and Treby 2005, 296).

5. Conclusion

In what circumstances can commons institutions ameliorate mismatches in property rights? We discuss this in the context of the pressing issue of flood management in the wake of climate change, using Britain's experience as an illustration. On our account, rendering local communities competent to solve specific cases of mismatched property rights is a promising direction for policy. Communities are able to employ their unique knowledge and goals to establish efficient schemes of property to solve the environmental challenges they face. These schemes are likely to include commons institutions in the case of flood management.

Moreover, decentralized public policy can be made more successful by addressing the general regulations and subsidies for particular land-uses that stymie the market process from helping property owners overcome mismatches in property. Price signals offer local actors the knowledge necessary for evaluating the real costs and benefits of different flood management strategies. As Christmas (2017) argues, this emphasis on local control through recognizing rights to private and communal property in nature does not mean that environmental values are ignored. Ultimately, it is through robust rights to nature that those who value the environment can more effectively protect it. Indeed, the price system grants information requisite for local communities to effectively execute their environmental goals.

Competing Interests

The authors have no competing interests to declare.

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How to cite this article: Cowen, N., & Delmotte, C. (2020). Ostrom, Floods and Mismatched Property Rights. *International Journal of the Commons*, 14(1), pp. 583–596. DOI: <https://doi.org/10.5334/ijc.983>

Submitted: 05 July 2019 **Accepted:** 11 June 2020 **Published:** 02 October 2020

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