

INSTITUTIONS, THE ENVIRONMENT AND DEVELOPMENT

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Abstract

This paper surveys the literature on the role of institutions in tackling environmental issues that affect developing countries with the aim of identifying areas that need further research. For issues of local natural resource management, the most important research problem is to understand what determines whether decentralization of management takes place. For issues at national and subnational scales, cross-country panel data on the stringency and effectiveness of environmental regulation is lacking. The collection of such data is essential if we are to make progress in understanding what makes for effective regulatory institutions. Research is also needed on when low-level equilibrium traps exist, in which regulatory agencies or those that provide environmental goods are under-funded and ineffective, but the public lacks confidence that an increase in fees or charges to improve performance will result in actually improved results. At international scales, research into the interaction between domestic lobbies and international agreements is needed.

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Introduction

Environmental problems may be classified by the scale of the relevant externalities. Some externalities are primarily local, for example, those concerning the management of resources like forests, pastures and inland fisheries, or local air and water pollution. Others are mainly regional or national like river and air pollution that is carried over longer distances. Still others, like ozone depletion and climate change, are global. Institutions that can address issues at these different scales are different in their genesis and structure. For example, community management that may work well for local commons under some circumstances is ineffective at larger scales, where state institutions are required.

This paper examines the evolution and performance of institutions that address environmental issues in developing countries at local, national, and international scales with a view to understanding the most important areas for research.

Community Management

There is a large literature examining small-scale common property resources like pastures, village forests, and local fisheries. The institutions that sometimes succeed in protecting these resources have been much studied. There is even an International Association for the Study of the Commons with annual conferences and a journal.

Theoretical literature

Economic theory has conceptualized the problem of the commons in simple terms as a game played by n persons, each of whom gets a benefit from harvesting a resource and imposes a cost on the others when she does so. Due to the externality, the Nash equilibrium of this static game is inefficient with harvest levels that are too high relative to a Pareto-optimum (Gordon 1954) (Dasgupta and Heal 1979). The conclusion, most famously expressed by a biologist, Garrett Hardin, in his 1968 paper in *Science*, was that commons should either be privatized or regulated by the state. With the publication of Elinor Ostrom's book *Governing the Commons* in 1990, a work that was instrumental in her being awarded a Nobel Prize, it became clear that commons in the real world were often successfully governed by their users, and

that Hardin's "tragedy" was by no means inevitable (Ostrom 1990). In commons such as forests, pastures, and some local fisheries, institutions to regulate extraction have evolved and many are successful in restraining excessive extraction. These institutions are often predicated on social norms and sanctions that ultimately depend on the ability of a community to sanction offenders.

Cooperation in the commons, once its ubiquity became clear, was first explained by economists in terms of dynamic games. Provided individuals do not discount the future too heavily, a subgame-perfect equilibrium in which players harvest the common resource at socially optimal levels exists. Such an equilibrium is sustained by the threat that if any individual harvests more than the equilibrium level, then others would do so too in subsequent periods. The notion of subgame perfection captures the idea that such threats are credible in the sense that they are in the interest of the individual to actually carry out should the eventuality arise. The main insight that this approach offers is that cooperation is highly dependent on continued interaction. Communities with too much mobility or anonymity are unlikely to succeed in cooperation. One problem with this approach is that actually observed cooperation everywhere relies on explicit or implicit punishments for over-extraction, not on over-extraction as a punishment.

Alternative approaches that rely on explicit punishments for over-extraction or other non-cooperation have appealed to evolutionary game theory (Sethi and Somanathan 1996) or evolved preferences for reciprocity (Sethi and Somanathan 2006). The predictions of Sethi and Somanathan (2006) are that cooperation will succeed when the returns from to cooperation are high, communication and monitoring costs are low and feasible punishments of opportunistic behavior, such as ostracism, are available at a cost that is not too high for those carrying them out. Although these are very intuitive, they do *not* follow from the standard model of agents as forward-looking rational actors. The model of Sethi and Somanathan (2006) allows the examination of how heterogeneities in returns from exploiting the commons, and in the power to inflict punishment, affect the prospects for cooperation. Asymmetries of power can actually promote cooperation in certain cases, by enabling punishment by the powerful that is strong enough to deter opportunism. This is consistent with many examples of cooperation that rely on leadership by local elites who also gain a disproportionate share of the benefits from cooperation.

Forest management as an example

The restraining force of social sanctions has eroded the world over for a variety of reasons – a rise in the return to harvesting with technical progress, a rise in resource prices when isolated communities are connected to external markets, a fall in the effectiveness of social sanctions with an increase in mobility, and in many cases, expropriation of common pool resources by states. This has destabilized social norms of restraint in harvesting (Jodha 1986) (Sethi and Somanathan 1996).

In some cases, states have responded to these difficulties by providing backing for community institutions, formalizing them and giving them the ability to raise taxes and levy fines. This has been the case, for example, in Uttarakhand in India in the colonial period (Somanathan 1991), and in Nepal in the last twenty-five years (Kanel 2008). In other cases, as in most of India, the state has been much more reluctant to cede powers to local bodies, despite an official rhetoric that favors this. This has a long history. The colonization of Asia and Africa by European countries in the nineteenth century led to more or less successful attempts by the conquering powers to seize control of forests from local populations. These led to nationalization and the creation of forest bureaucracies to administer forest resources so that the production of timber and other forest products could be sustained. The Indian Forest departments are the exemplar of this process but more or less similar structures were created in French colonial Africa as well (Baland and Platteau 1996). The Indian Forest departments were created to administer most of the country's forests and are in the control of state governments. Since Indian states are mostly of the size of large European countries, this is a highly centralized system that, even today, allows for very little local control.

Post-colonial states inherited these bureaucratic institutions and the resulting control of natural assets that became increasingly valuable as means of transport and labor availability improved. Not surprisingly, the incentive for local commons management was reduced and social norms governing resource use disrupted. For example, in the Indian central Himalaya, the system of traditional control of village forests by a council of elders was weakened to such an extent that by 1931 it prompted an official to write that “..the oak is melting away in Kumaun like an iceberg on the equator...” (Somanathan 1991).

In response to the obvious problems created by nationalization, there was a wave of decentralization of forest management across the developing world in the

1980's and 1990's, often encouraged by foreign donors. Participatory management became a buzzword. It has been estimated that over a quarter of forests in the developing world are now under indigenous or community management (Larson, Dahal, and others 2012). However, Larson et al's paper also reveals that in many countries in Latin America, Africa, and Asia, there is a tussle between state officials and local people over control of forests. This can be expected to lead to degradation and under-investment due to the uncertainty generated in property rights. (Of course, this applies to forests that are close to habitation. More remote forests may be managed by the state more effectively.)

A systematic review of statistical studies of the effects of community management of forests in less developed countries found only 42 studies, with more than two-thirds of these from Asia (Bowler et al. 2011). The authors' meta-analysis found that tree density and basal area were on average greater in community-managed forests than in forests under other or no management. There were too few studies to statistically analyze effects on species diversity or welfare outcomes. More informally, on the basis of case studies in the literature, Baland and Platteau (1996) concluded that the evidence suggested that centralized management did not lead to better outcomes. A study in India found that local management of forests cost an order of magnitude less than state management and delivered forest conservation that was at least as good (Somanathan, Prabhakar, and Mehta 2009). This suggests another potential advantage of local management – it is likely to be less expensive than centralized management that relies on bureaucracies that have high labor costs.

While there is a presumption that devolving powers to local bodies would lead to better outcomes for local communities, it is possible that the dominance of local elites could result in the poor becoming worse off. There seems to be no clear evidence of this. While it may be the case that the poor get fewer benefits from community forests than the non-poor (Adhikari 2005), it is not known how this compares to what happens when there is no devolution. An investigation of the impact of the Nepal community forestry program on poorer households was inconclusive (Datta 2011). In any case, it is to be expected that there would be considerable heterogeneity on this score, and it is unlikely that any general conclusions could be drawn.

Even though devolution may not always lead to better welfare outcomes, and the evidence concerning its effects is far from complete, the present state of our

understanding does suggest that in many circumstances, devolution would improve both efficiency and equity. The crucial question, therefore, is: *What leads states to devolve authority over natural resource management to local communities and authorities or households?* This is a question that is clearly related to broader questions concerning the nature of states.

Richer countries and more democratic countries tend to decentralize more (Arzaghi and Henderson 2005), but there is considerable variation. Moreover, it is not clear if the decentralization measure used in Arzaghi and Henderson (2005), which lumps provincial and local governments together, is a good measure of local autonomy. India and China, in different ways, do not fit this pattern. While India is quite democratic, and has strong provincial governments, local governments are very weak. In China, on the other hand, there is considerable autonomy given to local governments, perhaps because the authoritarian nature of the state limits political competition between levels of government. The relative autonomy of local governments means that centralization of authority over a particular sector, such as forests, is limited.

So far, we have treated common resources as exogenously given. But some of them could be privatized. This is the direction of tenure reforms in China's forestry sector. About 60% of China's forest area is collective, or village-controlled forest with the remaining being state owned (Yin, Yao, and Huo 2013). Tenurial reforms have taken place in collective forests. When the household responsibility system was introduced in 1978 for agricultural land, it was followed within a few years, by similar reforms in forest land. But in the case of forests, the reforms varied by province and were subject to constraints and partial reversals. The village authorities maintained controls over harvesting and thinning, timber was subject to heavy taxes, and the timber market in southern China was controlled, with farmers obliged to sell timber to the state at low prices. The situation in the north was different because there was little forest of value and the state was less concerned about ecological destruction. As a result, forest sector reforms went much further towards *de facto* privatization and free timber markets in the north.

There was a second wave of reforms in several provinces starting around 2003 which liberalized timber markets and reduced restrictions on households harvesting and thinning. This was followed by a large increase in timber harvests, a significant increase in the share of forestry in rural household incomes, and a large

increase in afforestation. While not all these can be attributed to the tenure reforms -- with increases in timber demand and prices playing an important role -- the increase in afforestation in particular is a sign that fears of unsustainable harvesting without replanting induced by greater freedom to individual households may be unjustified (Xu 2010).

This history and the contrast with other regions is a reminder of the fact that institutions to manage natural resources are heavily shaped by the larger institutional environment and cannot be analyzed in isolation. Paradoxically, it may well be the absence of private property in China that is favorable to effective privatization – it may be easier to distribute new *de facto* property rights on a more or less equal basis when there are no prior hierarchies in wealth and property ownership.

Perhaps the most interesting question for future research is what it is about governmental structure that makes it more likely that devolution of property rights over forests to local communities or households will take place. The two cases in the developing world where this has proceeded furthest appear to be China and Nepal, which have, or had, very different state structures at the time of their major forestry reforms.

The Nepalese case and its contrast with India is instructive because it suggests the importance of institutional inertia in determining the prospects for decentralization. During the century until 1950, Nepal was under the rule of hereditary prime ministers called the Ranas. In the Rana period, forests were managed by the village headman who was appointed by the government and controlled harvesting and extraction. The replacement of Rana rule by a democratic government led to nationalization of the forests in 1957, motivated by a desire to undercut the power of the headmen, who were a mainstay of Rana rule. However, there was no bureaucracy or effective control of forests to replace the headmen, and this, together with population growth, led to rapid deforestation and degradation. The government did form a Forest Department, modeled after the Indian one, but it was much smaller and did not have the resources to exert actual control over forests. By the late 1980s, it had become clear that nationalization was a failure, and the government, influenced by foreign donors, opted for legislation to establish community forest management (Mahat, Griffin, and Shepherd 1986). This process began in the early 1990s and community forests now cover 29% of the forest area. Another 19% are under various kinds of community and state co-management, while

perhaps another 30% are private forests (SANDEE and ICIMOD 2016). Thus, the only forests that are actually administered by the government are a few national parks and wildlife sanctuaries and remote forests in the mountains that are mostly inaccessible. In India, on the other hand, the vast majority of forests are administered and controlled by government bureaucracies, except in a few states. Although in both countries there was a shift in stated official policy towards decentralization at around the same time, implementation proceeded rapidly and comprehensively in Nepal, but made little progress in India. In the latter, there was an entrenched and powerful forest department that, together with state-level politicians, maintained control of the forests and the associated rents. Its counterpart in Nepal was much smaller, and had little by way of rents to fight for, the forests being much less productive due to its inability to maintain real control over them.

This discussion has been about forests. It should be noted that it does not generalize to fugitive resources like fisheries, wildlife, or groundwater. In those cases, it is much harder for local harvesters to discern the effect of their harvesting behavior on the stock, and this makes it much harder for them to self-regulate (Sethi and Somanathan 2006). While case studies of successful community management of forests are legion, success stories are notably absent in the case of fugitive resources. State regulation seems to be indispensable in these cases.

National and subnational issues and state institutions

Moving to slightly larger scales, even in small towns and cities, community-enforced norms of behavior are clearly insufficient for many environmental problems. Without the coercive power of a government, the residents of towns and cities will not be able to organize the necessary communication, monitoring, and deterrence necessary to curb problems like littering or road congestion.¹ The provision of clean water and sewage disposal are critical to avoid pollution by human waste leading to infectious disease. Yet these public goods are missing or very incomplete in most cities in low-income countries. This is the case with solid waste management and disposal as well. The provision of these public goods requires considerable physical investment in infrastructure, and this requires a state's power to tax. Accordingly, an understanding of these environmental problems is one of the principal issues of

¹ This is another reason why standard dynamic game models in which cooperation is sustained by threats of the withdrawal of cooperation provide unconvincing explanations of how social dilemmas are solved in the real world. These models predict that increasing group size does not destroy the existence cooperative equilibria (Pecorino 1999) (Haag and Lagunoff 2007).

development economics – why public goods are underprovided in low-income countries.

Another set of issues that manifest themselves at municipal scales are those of air and water pollution and congestion. These issues span multiple scales, however, and especially for the pollution issues, the locus of regulatory action is often at a higher level, that of the provincial or national government.

A natural starting point to examine how state institutions shape environmental regulation, and the determinants of their performance, is to look at cross-national data on environmental regulation. Unfortunately, these data are very sparse. Amazingly, there appears to be only one cross-country dataset on the stringency of environmental regulation and it is based on a single survey of governments conducted by the UN in 1990. Two different sets of researchers then coded the responses for some of the countries in the survey, so that an Environmental Policy Stringency index (EPS) is available for 54 countries (Pellegrini 2011). As we would expect, the EPS is increasing in income and education measures. Surprisingly, though, it is decreasing in urbanization, at least when other controls are included, as seen in Table 1 below. Obviously, these results must be interpreted with caution, given the non-random selection of countries and the likelihood of important omitted variables.

It is clear that a priority for future research is to collect much more comprehensive cross-country data on environmental regulation so that we may get at least a basic quantitative understanding of institutional performance in this domain. Such panel data would permit us to systematically examine the role of bureaucratic institutions, political factors, education, awareness, and other factors that influence the stringency of regulation.

Table 1

Dependent variable: EPS	(7)	(8)	(9)	(10)
$\ln Y_{1990}$	0.41*** (3.65)	0.37*** (3.67)	0.21* (2.01)	0.28* (1.99)
Index of Democracy	0.52*** (5.49)		0.35*** (3.52)	0.15 (1.46)
Corruption		-0.56*** (5.50)	-0.43*** (4.28)	-0.33*** (4.19)
Urbanization				-0.26** (2.65)
Schooling				0.32*** (3.57)
Dummy for Latin America				-0.10 (1.48)
Dummy for OECD				0.18 (1.52)
Dummy for South Asia				0.10* (1.82)
Adjusted R ²	0.74	0.76	0.81	0.89
Number of countries	54	54	54	51

*OLS estimation, with the Environmental Policy Stringency Index as a dependent variable. Coefficients are standardised. Superscripts *, **, *** correspond to a 10, 5, 1% level of significance, respectively. t statistics are in parentheses. The Ho of homoskedasticity, in the White test, was not rejected (i.e. $p > 0.10$) in any regression, apart from (7). Therefore the t statistics in (7) are calculated with robust standard errors.*

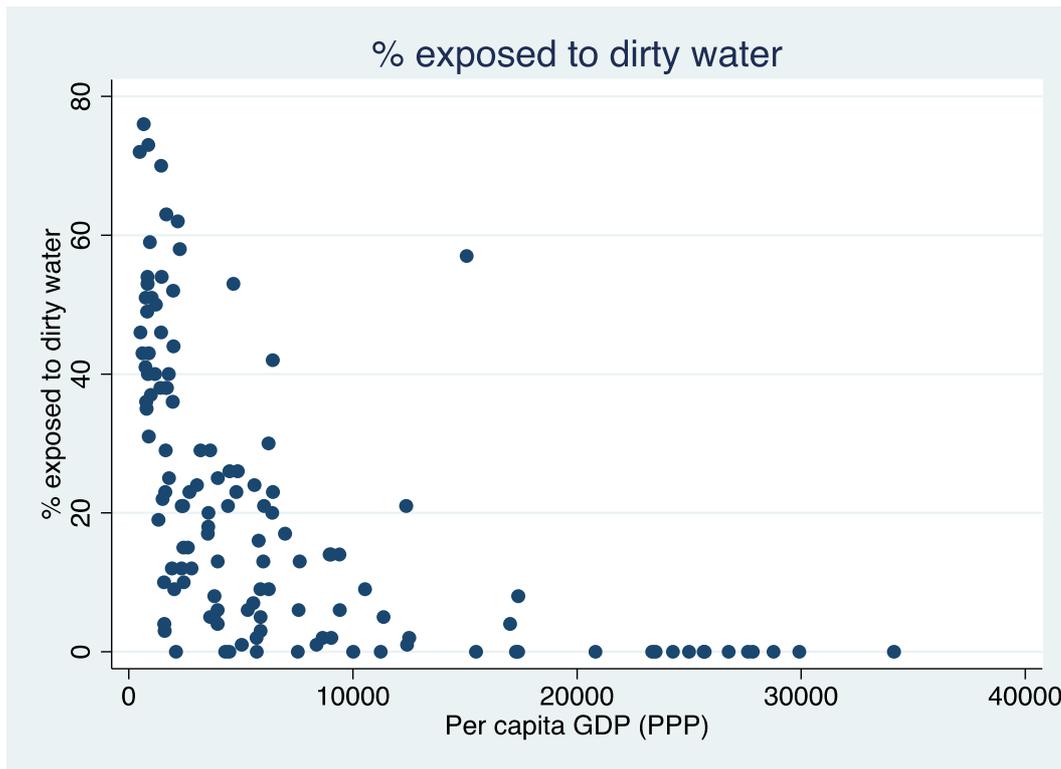
Source: Pellegrini (2011), Table 5.1.

Urban Water Supply: A case study

In the absence of more data, we must turn to case studies. I shall first take up the issue of the provision of clean water because it illustrates quite well some of the important themes and questions that appear for other environmental issues. It is obvious that the provision of an “improved” water supply is strongly increasing in per capita income as seen in Figure 1 below.² This is unsurprising because we expect the demand for environmental quality and protection from health risks to be normal goods.

Figure 1: Percent of population exposed to water from un-improved sources, 1998

² A water source is said to be improved if it is either piped or covered. It does not necessarily mean that it is potable.



Data Source: World Development Indicators

Figure 1 also shows that among poorer countries, there is considerable variation in the provision of water from “improved sources”. Clearly, there are other determinants of the supply of clean water. The question is: To what extent is this variation in the provision of improved water due to variation in the supply of good institutions as opposed to being driven by variation in the demand for safer water?

Some of the variation is, in fact, demand-driven. Analysis of survey data from urban India show that, controlling for wealth and other demographics, the more educated and those more exposed to news media are willing to pay more to reduce their exposure to unsafe water, as measured by in-home water purification expenditures (Jalan, Somanathan, and Chaudhuri 2009). A randomized controlled trial that provided information to households in a suburb of Delhi about their water quality also revealed that households who learnt that their water was potentially contaminated were willing to spend more to purify it (Jalan and Somanathan 2008).

Nevertheless, unlike per capita income, the level of awareness about environmental health risks is a factor that can be influenced by state institutions, even in the short run. The existence of regulatory institutions to control environmental pollution results in environmental monitoring. If the results are communicated to the

public, this raises awareness of health risks. In this way, the supply of environmental quality can have a feedback effect on the demand. The creation of regulatory institutions can thus have an important effect on the provision of environmental quality in the long run, even after the initial stimulus for their creation has disappeared.

An example of such a positive feedback cycle in a different domain is the conservation of tigers in India. Initial efforts at tiger conservation began with the creation of Tiger Reserves in the early 1970's. These were triggered by the concerns of elite domestic and foreign conservationists that tigers were endangered. The Prime Minister was sympathetic and, being in a dominant political position, was able to pass a wildlife conservation act (Rangarajan 2001). Of course, the Prime Minister changed, and so high-level political support for tiger conservation could well have gone with her. However, the tiger reserves soon became popular destinations for middle class tourism, so much so that the extinction of tigers from a single reserve in the early 2000's triggered a media outcry that forced the government to create a Tiger Task Force that included critics of the government (Somanathan 2010).

Returning to water supply, a much better measure of safe water supply than that in the World Bank database is whether there is 24-hour provision of piped water (Kumpel and Nelson 2015). Continuous, as opposed to intermittent, water supply guarantees that pipes are pressurized, and, therefore, not subject to contamination from leaks. Secondly, when provision is intermittent, households and other establishments are obliged to store water on the premises. This water is very likely to be contaminated during storage and handling. A study of an intervention to provide 24-hour water to a few neighborhoods in Hubli, an Indian city in the state of Karnataka found that nearly 32% of water samples were contaminated with *E. coli* in samples from areas with intermittent supply while only 0.7% were contaminated in areas with continuous supply (Kumpel and Nelson 2013).

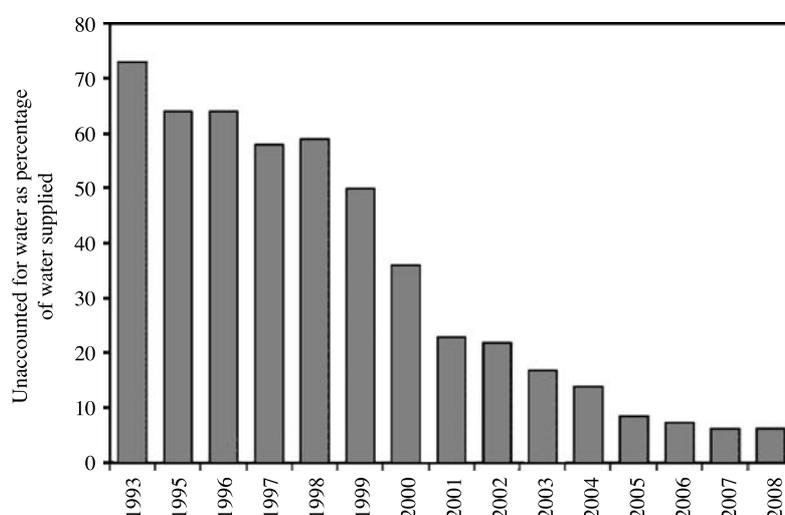
It may be thought that low-income countries would simply not have a demand for continuous piped water. The case of Phnom Penh provides a counter-example (Araral 2008), (Biswas and Tortajada 2010). The Phnom Penh Water Supply Authority (PPWSA) was completely dysfunctional after the civil war ended in Cambodia and the capital was gradually repopulated in the 1980s. In the early 1990s Cambodia had one of the highest infant mortality rates in the world. In 1992, the PPWSA had only 5 engineers. Most of the staff were not even capable of reading

meters. Most of the city got no water even if it was connected to the piped system. In 1993, unaccounted for water exceeded 70%. According to Biswas and Tortajada (2010):

“Not only were the staff demoralized, but they had good reason to be demoralized, being, as they were, faced with poor governance, below subsistence pay, lack of discipline, an absence of any incentives, and pervasive corruption. Lethargy, poor working practices and a ‘could not care less’ attitude to consumers were the norm. Therefore, the work culture had to be radically changed by enforcing strict disciplines in a sensitive, fair and transparent manner. This was a difficult task since the rest of the public sector employees in Cambodia were in a similar situation and behaved in a very similar manner. In fact, most public sector companies still continue to behave in a somewhat similar way at present.”

In 1993, a study by Tokyo Engineering & Nihon Suido consultants was commissioned by the Japan International Cooperation Agency at the request of Cambodia. In consultation with the PPWSA they developed a Master Plan that became a blueprint for the building of the system. From 1993 to 2000, the authority did pipe replacement and brought a drinkable water supply to the city centre. Revenue for the necessary additional expenditures had to be raised somehow. An important source of such revenue was the reduction in leakage and the improvement in billing, as seen in the rapid decline in unaccounted-for-water in Figure 2.

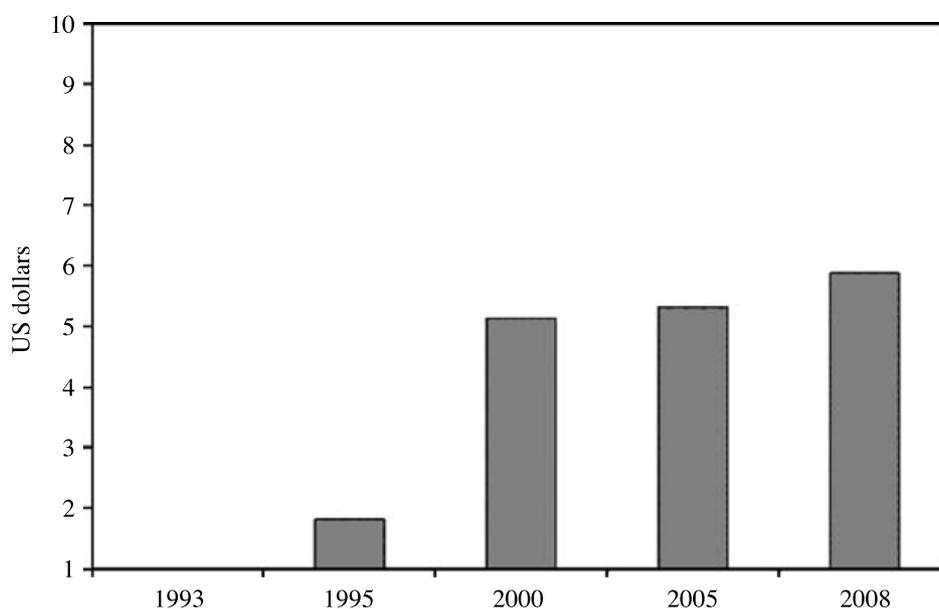
Figure 2: Unaccounted-for-water, Phnom Penh.



Source: Biswas and Tortajada (2010) from records of the Phnom Penh Water Supply Authority.

Improving the collection of existing tariffs, was not, however, sufficient. “One of the most difficult components of this strategy to implement was to increase the tariff of water so that all costs could be recovered without generating any social and political unrest. This was done by ensuring that its customers first witnessed and appreciated a much better quality of reliable service before the tariffs were increased.” The PPWSA got grants from the Japan International Cooperation Agency of \$25 million in 1995 and \$21 million in 1997. These were presumably crucial for improving service before raising tariffs. The PPWSA also received subsequent loans from the Asian Development Bank and the World Bank. The combination of improved collection and higher tariffs enabled the authority to cover its costs.

Figure 3: Average monthly household water bill.



Source: Biswas and Tortajada (2010) from records of the Phnom Penh Water Supply Authority.

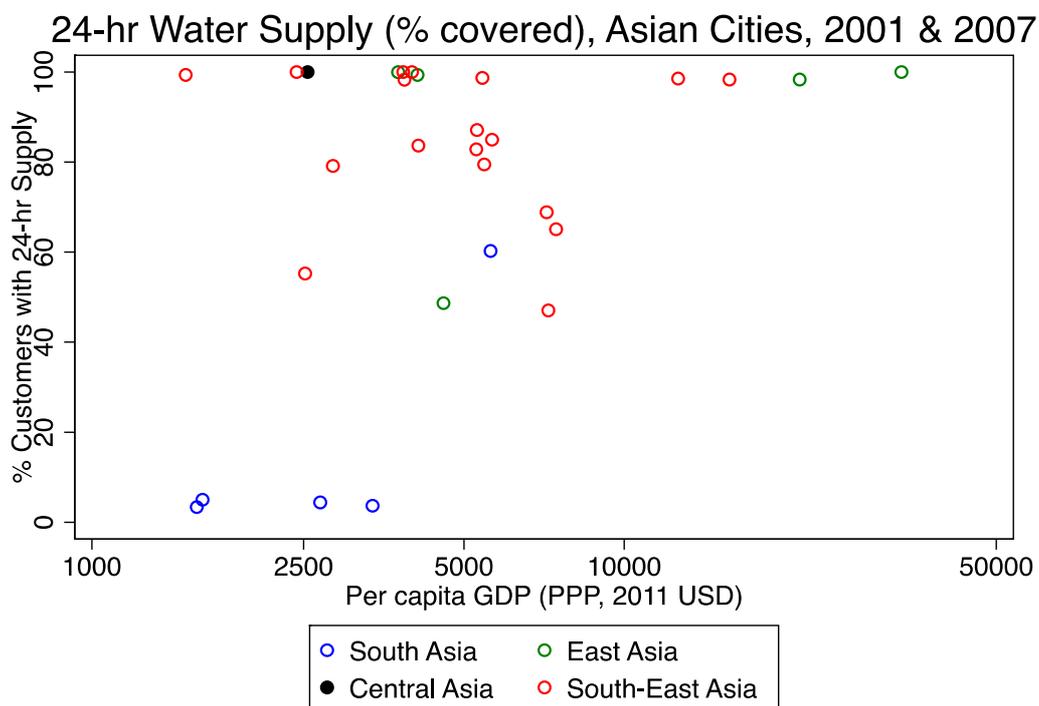
Before increasing tariffs, the authority conducted a survey of consumers to ascertain the various sources of water, what they paid for each, and whether they would be willing to pay more for water from the utility if service improved. The survey revealed, as is commonly the case in cities with an unreliable formal water supply, that consumers were paying private vendors far higher prices than the utility's existing tariff. Tariffs were raised in 1994, in 1997, and again in 2001.

The Phnom Penh experience suggests that the absence of a potable and reliable water supply in many countries in Asia (McIntosh 2003) and Africa (Schwartz 2008) may be an institutional failure rather than simply a consequence of a low demand for high-quality service stemming from low incomes. If there are other successes in low-income countries, then the hypothesis that it is institutional failure, and not low income, *per se*, that is the cause of unsafe and unreliable water supplies would be strengthened. As seen in Figure 4, there are, in fact, other examples of successful provision of 24-hour provision (McIntosh 2003), (McIntosh 2014).

Since the data are not a random sample of cities, nothing can be said about general relationships. But they do show that in addition to Phnom Penh (which appears twice), Tashkent, Chengdu, Shanghai, and three Vietnamese cities – Binh Duong, Hai Phong, and Ho Chi Minh City, all achieved complete 24-hour coverage in countries in which the per capita GDP was then below \$5000 (in 2011 PPP dollars). Near-complete coverage was also achieved in East Manila in 2007 when the Philippines had a per capita GDP of \$5200. Several Indonesian and Philippine cities achieved incomplete coverage, while all South Asian cities with the exception of Colombo had near-zero coverage. Even today, not a single Indian city has achieved a 24-hour water supply for a significant fraction of customers even though India's per capita GDP now exceeds \$5400.

As discussed above, part of the explanation for the failures in South Asia and Africa may be a lack of demand for high-quality supplies stemming from low education levels and awareness of health risks.

Figure 4



Source: McIntosh (2003, 2014) for water supply. WDI databases of the World Bank for country GDP.

However, this is unlikely to be the whole explanation. When water supplies are intermittent, households incur considerable costs to cope with the resulting situation. These include purchasing water from private vendors, storing and pumping water, and in-home purification to cope with the health risks. A study in Kathmandu found that these costs were, on average twice the water bill paid to the utility, while a contingent valuation exercise found the willingness to pay for reliable water to be still higher (Pattanayak et al. 2005). This implies that households are willing to pay more than the public providers are charging, so there is some scope to raise tariffs and use the revenue to improve services (McIntosh 2014).

Finally, another reason for under-provision of a safe water supply could be that it is blocked by politically powerful interests. It is useful to make a distinction between this political-economy explanation and one based on institutional or government failure. If institutional failure is the primary cause, a better understanding of policies that might help in getting out of a low-level equilibrium

trap is important. If it is vested interests, then examining institutions will not be of any practical importance until the politics changes. Urban water supply is an issue that does not involve polluters who will lose from government action, so that the political economy explanations are likely to be less important. To be sure, this too, cannot be said with certainty since the private provision of water supply by tankers has become a sizeable business in some cities, and it may be that action to improve the public supply is blocked by these interests.

Nevertheless, the Phnom Penh case study does suggest the presence of a low-level equilibrium trap in many low-income cities – citizens are not willing to pay the higher tariffs needed to finance improvements because their experience does not inspire confidence that the increased payments will deliver improvements. This suggests a possible way out – the utility could improve the water supply in small geographic areas, then raise tariffs in these areas, and then expand the geographic scope of the process.

Whether there is a low-level equilibrium trap is an important question for research. More systematic studies of how much more consumers are willing to pay for better service are needed. There are valuation studies that measure coping costs and/or stated preference methods that address this question (such as the one by Pattanayak et al (2005) mentioned above). A greater use of hedonic studies may also be helpful. A hedonic study in Bhutan that uses data from two rounds of the Bhutan Living Standards Survey finds that houses that are connected to piped water supply and sewage systems pay a substantial rental premium over those that are not, controlling for other measured characteristics including locality fixed effects (Dhendup and Tshering 2015). Since households can be expected to sort themselves into connected and unconnected houses according to their willingness to pay for services, the existence of a positive rental premium implies that there is scope to raise tariffs and use the revenue to expand coverage. What is needed is more such studies that address the issue of service quality, rather than simply measuring whether households are connected to the system.

The case study shows that while finances and physical investment are an important part of the story, an equally important part is the change in work culture and incentives within the utility that are tied up with service quality. An important aspect of the story is that the government published a decree in 1996 that

corporatized the PPWSA and gave it autonomy along with a structure of checks and balances (Biswas and Tortajada 2010), (McIntosh 2014). Such institutional changes may have long-lasting effects because they change the locus of decision-making. Taking action, an energy and time-consuming process for high-level administrators, is delegated to those who specialize in the particular issues.

Water supply is just an example of many environmental and development issues where such a low-level equilibrium trap may exist. Household air pollution is one of the most serious environmental issues in developing countries due to the use of solid fuels for cooking. It is listed as being the fourth-largest risk factor in the global burden of disease and the single largest risk factor in the disease burden in South Asia (Lim et al. 2012). One of the important routes to reducing it is to substitute electricity for solid fuels, but this requires a reliable electricity supply. In many low-income countries, a low-quality supply is a strong deterrent to the adoption of electricity for cooking, despite the appearance of inexpensive electric induction stoves and cookers of various kinds in developing countries in the last few years. Subsidized electric power leads to frequent blackouts, which in turn reduce the willingness to pay the higher tariffs needed to finance more reliable supplies.

Traffic congestion is a problem worldwide and is especially acute in the cities of developing countries with inadequate public transport, poor roads, and poor traffic management. Yet reducing it requires congestion charges that the public are unwilling to pay given the poor quality of transport infrastructure.

These sorts of problems are related to an inability to finance services of a reasonable quality, but, as noted earlier, they are not solely a financial issue, but are intimately related to the quality of institutions. Subsidized electric power, for example, may be accompanied by un-metered but rationed electricity provided to specific sectors like agriculture. Non-commercial allocation leads to a culture of theft and rent-seeking, while chronically loss-making public-sector utilities are unable to maintain staff morale and human capital. Blackouts that begin for financial reasons may persist due to a lack of qualified personnel (Ruet 2005). Similar considerations apply to traffic management and public transport.

When it comes to the regulation of industrial pollutants, it is clear that public awareness is essential to stimulate the formation of regulatory institutions that are capable of regulation. Historically, such formation has often begun with dramatic

incidents, such as the presence of deformed animals highlighted in the bestselling book *Silent Spring* (Carson 1962) that stimulated pollution legislation in the developed world. Background pollution levels, even though they may be high, are often invisible to the public. Once the institutions were created and financed, monitoring became a part of their role. To the extent that the results of monitoring were communicated to the public, this increased awareness and maintained a public demand for continued environmental improvements.

While a similar dynamic has been seen in developing countries, lower levels of education and income lead to lower public demand. There may also be less accountability as suggested by Pellegrini's results reported earlier. Where the functioning of regulatory institutions is less transparent, the monitoring they do may not be publicly available, thus cutting one of the links in the virtuous cycle. Thus, for these issues, the availability of information and the extent to which it results in regulatory responses is an important area for research.

Distributional issues are also likely to be important in determining which environmental problems are addressed. For example, it may be the case that water pollution is not addressed as much as air pollution because the rich can protect themselves from water pollution with home water purification but are much less able to avoid air pollution. The distributional implications of road congestion pricing are unclear. These issues need to be researched.

Global environmental issues and international institutions

Finally, there are the international environmental issues that affect economic development. Climate change is, of course, the most prominent, but there are others that are pertinent for development, especially in some countries – ocean fisheries, for example. There is an enormous game-theoretic literature that seeks to understand the provision of treaties – these are the principal institution in the international context – to solve the common-pool problem.

The main approach has been to assume that country governments in these negotiations attempt to maximize national welfare. Here, country welfare is defined as the total benefit to a country from abatement of emissions of greenhouse gases and other climate forcers minus the total costs of abatement to that country. Most of the literature adopts the approach initiated by Carraro and Siniscalco (1993) and Barrett (1994). The analysis falls into the area known as the non-cooperative

foundations of cooperative game theory. It is assumed that countries will adhere to a treaty once signed, but will sign only those treaties that leave them better off than not signing. A stable treaty is one such that the marginal signatory would do worse if it did not sign, and the marginal non-signatory would do worse if it signed. The papers then characterize the set of stable treaties and associated pollution and welfare outcomes that may obtain under these assumptions (Carraro and Siniscalco 1993) (Scott Barrett 1994). In the case of climate change, the results are generally pessimistic – the only feasible treaties are those that require the signatories to do very little, or those with very few signatories. Either way, little is accomplished.

This, however, is not the case with the problem of halting the damage to the ozone layer in the stratosphere arising from ozone-depleting chemicals such as halo-carbons. There are important differences between the two cases, and it has been argued that this is why the outcomes of negotiations predicted by the theory are different. In his book, *Environment and Statecraft*, Scott Barrett argues that the differences in actual outcomes align with the differences predicted by the theory (S. Barrett 2005). In the 1980's, when the Montreal Protocol was being negotiated, a single country, the United States, accounted for about 50% of the production and consumption of chloro-fluoro-carbons or CFCs, the largest category of ozone-depleting chemicals. In contrast, when the Kyoto Protocol was being negotiated in the late 1990's, the largest greenhouse gas emitter, at that time, the United States, accounted for only about 20% of global emissions.

The damage from a thinned ozone layer manifested itself directly in an increased rate of skin cancers, so that it was straightforward to calculate the damages in terms of increased death rates within the United States. Using an official estimate of the value of a statistical life, this was converted into a dollar figure that was two orders of magnitude higher than the abatement cost to the United States (S. Barrett 2005). This was an official estimate by the US Environmental Protection Agency. Thus, for the USA, and in all probability, for most industrial countries, the benefits from even a unilateral rapid phase-out of CFCs exceeded the costs by a wide margin. There was, however, no consensus on the economic damages from global warming and climate change. Even the global benefits of abatement, while positive, were small and did not justify significant abatement, according to the most widely cited author from the 1990s (Nordhaus 1993). The optimal carbon tax (the so-called social cost of carbon) estimated by Nordhaus was \$5/tCO₂. Other authors concluded the opposite with the social cost of carbon being hundreds of dollars per

ton of carbon dioxide (Cline 1992) (Azar and Sterner 1996). However, Nordhaus got most of the attention.

High net benefits and asymmetrically situated countries are both predicted to be favorable conditions for an effective treaty – one that achieves substantial global abatement. Asymmetry helps because it reduces the number of participants needed for effective global action. The Montreal Protocol achieved near universal participation and near complete abatement. But in the case of climate change, there was much less asymmetry and it was not so clear that the benefits of abatement exceeded the costs. The agreement that was negotiated at the end of the 1990s, the Kyoto Protocol, targeted only 5% of global emissions. It is for these reasons that Barrett concludes that the theory has some explanatory power.

Nevertheless, as we shall now see, the model of states as unitary decision-makers maximizing a national social welfare function is only of limited help in understanding the progress of climate negotiations, or of other issues like the depletion of ocean fisheries. A better understanding of international environmental agreements will have to consider how within-country politics affects environmental issues with international dimensions.

Before coming to climate change, let us first re-consider the Montreal Protocol of 1987 that restricted the production of ozone-depleting substances. In the mid-1970s, shortly after the prediction by chemists that CFCs would damage the ozone layer, the United States unilaterally restricted the production and sale of CFCs in aerosol cans. This reduced the profitability of investments in CFCs for US firms and made it attractive to conduct R&D to find substitutes. In 1975, Dupont Chemicals, the market leader in the US, had strongly argued against restricting CFCs, claiming that the costs of doing so would be huge. After this lobbying failed to prevent action, and the market for CFCs shrank, Dupont discovered inexpensive substitutes that it could profit from selling in the global market. It then reversed its previous stance and urged the US government to negotiate an effective agreement. This enabled US leadership in the negotiations with industry support (DeSombre 2000). It is clear that a proper understanding of why the Montreal Protocol was successful therefore requires an understanding of US domestic regulation and lobbying.

With regard to climate change, there are large un-internalized externalities from fossil fuel combustion in the form of local air pollution. For example, in the United States, despite air pollution regulation, excess deaths caused by air pollution

from coal-fired power plants are still at a high level. When these deaths were valued at the official value of a statistical life, it was found that the external cost of the plants exceeded their value-added (Muller, Mendelsohn, and Nordhaus 2011). The US government's estimates of domestic health damages from US emissions are more than three times its estimates of the global climate-related damages from the emissions (EPA 2014)(Table ES-7).

This situation is not confined to the United States. An IMF study asked what the optimal carbon price would be for each of the twenty highest emitters of energy-related greenhouse gases if they acted to internalize remaining *local* air pollution and road congestion externalities by taxing carbon dioxide emissions. That is, the price-setting would ignore the climate externality. It found that the emission-weighted average of nationally optimal carbon prices was \$58/ton of CO₂ (Parry, Veung, and Heine 2015). The current official US Environmental Protection Agency estimate of the optimal carbon price based on global climate damages is much lower: it is \$36/tCO₂. There was also considerable variation in nationally efficient carbon prices -- \$63/tCO₂ in China, \$36/tCO₂ in the US, \$93/tCO₂ in Poland, and in the hundreds for Saudi Arabia and Iran. Only Brazil had a negative price of -23\$/tCO₂, due to high petroleum taxation and a power sector that did not rely on coal.

If governments were acting to maximize national welfare as conventionally defined, then countries would not have such high un-internalized externalities. Greenhouse gas emissions would be considerably lower. For example, the US Energy Information Administration projected that if a carbon price of \$30/tCO₂ had been imposed in 2013, then greenhouse gas emissions from the US electric power sector would have declined by 40% within four years (Energy Information Administration 2013).³ Renewable technologies would have been deployed far more, creating new lobbies that would affect domestic policies and international agreements. The research agenda, therefore, has to incorporate a more sophisticated model of the interaction of domestic and international players in framing

³ This would be largely driven by older coal plants being shut down and replaced by gas and renewables instead of being upgraded to comply with new pollution regulations. It has been pointed out that most energy models, such as those of the US EIA, underestimate the response of emissions to a carbon tax, because they use price elasticities estimated from past data. However, renewable technologies are rapidly moving down a learning curve, a process that will accelerate with a carbon price. This response is not factored into the models (Kaufman 2016).

climate policies, and policies on other international environmental issues. It is necessary to model a two-level game – between domestic actors within countries with divergent interests regarding emissions, and the effect this has on negotiating strategies.

Discussion

At the local scale, where community management of natural resources is feasible, there is a considerable literature on what makes for cooperation by users. However, the discussion of forest management above shows that an arguably more relevant problem concerns the devolution of management to local communities by the state, or the lack thereof. One lesson from the case studies of China, India, and Nepal given here is that pre-existing institutions such as forest bureaucracies may be inimical to devolution because they create rents that politicians and bureaucrats prefer to retain. A second is that the nature of the state itself can be of considerable importance. The Chinese state is organized in tiers, with a central tier appointing provincial tiers that in turn appoint local tiers. This structure gives local heads of government considerable autonomy. In contrast, the Indian state has just two tiers, a central tier and a state tier, both elected. The local tier exists but has little autonomy. Instead, power is organized vertically within departments of the government within each state. Thus local decision-makers have little authority or autonomy to experiment. These are merely hypotheses suggested by the case studies given here. More research to confirm, disprove, or extend them is needed.

Coming to subnational and national scales, the greatest gap in the existing research is the lack of quantitative comparable cross-country data on the stringency and effectiveness of environmental regulations. Absent such data, we are really groping in the dark to understand the factors that drive the performance of regulatory institutions.

The case study of urban water supply given here strongly suggests that the failure to tackle environmental problems at these scales in low and lower-middle-income countries may reflect a low-level equilibrium trap. The performance of institutions is poor, so the public lacks confidence that increases in fees or other charges needed for upgradation will be well used, so performance continues to be poor. Research is needed to establish the extent to which this is actually the case, and what the willingness to pay of the public is for better service quality. Traditional

tools of environmental economics – valuation methods – need to be deployed much more extensively in order to answer these questions.

Another potentially important issue that needs to be researched is the role of state institutions in generating information about environmental quality that then feeds the demand for environmental improvements.

With regard to the international issues like global warming or the depletion of ocean fisheries, economists have concentrated their attention on models of states as unitary actors engaged in a game. It has been shown above that this is clearly inadequate for an understanding of the problem. What is needed are analyses of domestic lobbies and their influence on international negotiations as well as effects of actual and prospective agreements on the formation and strength of different lobbies within countries.

A few additional remarks are in order. First, the case studies described here suggest that there is a strong institutional inertia. Institutions are not easily established, and once they are, they often persist and have long-run effects, although, of course, they also evolve and change. This suggests that more research is needed on the *formation* of regulatory institutions. Second, there is an aspect of devolution that may be very important but has not been discussed. This is that the devolution of power to local authorities may lead to more *experimentation* – in the presence of suitable incentives to local authorities. The case of Chinese economic reforms is perhaps the most well-known example of this phenomenon, but it has also been seen with regard to joint forest management in India, for example. However, environmental performance does not appear to have benefited from decentralized governance in China. This is due to the nature of incentives provided to local officials by the central government.

Finally, it has to be said that some of the research that has been identified in this paper as much needed may not be easily publishable in economics journals. The methodological narrowness that characterizes the current state of academic economics is not very conducive to research into deep problems concerning institutions that are not easily amenable to neat identification strategies. For example, much of the literature cited in this paper comes from case studies that are never seen in economics. This is one reason why these gaps in research remain.

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