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The economics of environmental change and pollution management – issues and approaches from South Asia

PARTHA DASGUPTA
Faculty of Economics and Politics, Austin Robinson Building, Sidgwick Avenue, Cambridge, CB3 9DD, UK.

PRIYA SHYAMSUNDAR
1818 H. Street NW, World Bank, Washington DC 20433, USA.
Email: Pshyamsundar@worldbank.org

KARL-GÖRAN MÄLER
The Beijer Institute, The Royal Swedish Academy of Sciences, P.O. Box 50005, SE-104 05 Stockholm, Sweden.

1. Introduction

This special issue focuses on environmental problems related to poverty and economic growth in South Asia and seeks to illustrate the types of economic analyses that can be undertaken to address these problems. The idea for this issue emerged at the inauguration of the South Asian Network of Development and Environmental Economics (SANDEE).[1] The papers presented at SANDEE's inaugural conference demonstrated the need for a tighter connection between environmental and development economics. The study of environmental change in poor countries benefits a great deal from well-established theoretical and empirical investigations of externalities and valuation of non-market goods, the staple of environmental economics as taught in the West. However, it is also closely tied to questions about institutions and why they succeed or fail. The spatial nature of dependence of the poor on local resources also matters. Further, the study of environmental change and of institutions cannot be divorced from policies and economic reforms in poor countries. These are some of the topics discussed in this collection.

[1] SANDEE is a regional network with a mandate to strengthen capacity in the field of environment and development economics. It is hosted by IUCN the World Conservation Union in Kathmandu, Nepal and was founded with the support of the Beijer Institute for Ecological Economics, Sweden. It has been generously supported by the Swedish Agency for International Development Cooperation, Department for International Development, UK, the MacArthur Foundation and the Ford Foundation. Further details are available on www.sandeeonline.org.

We originally conceived this special issue to communicate the interesting and important work being undertaken in different countries in the Indian sub-continent. While our initial set of papers went beyond India, some of these manuscripts had to be dropped as they were not ready for publication. We have instead added two articles (a) by Purnamita Dasgupta and (b) by Rita Pandey and Geetesh Bhardwaj. Notably absent in the papers included are studies that investigate institutional questions. We try to fill this gap by discussing institutions and communitarian management in our introduction. We hope to facilitate the publication of studies from other countries in South Asia in future issues of *Environment and Development Economics*.

2. Policy reform versus institutional change

Over the last two decades economic development in poor countries has focused on 'getting policies right'. Any policy reform causes perturbations to an economy. To say this is easy enough; it is altogether more difficult to identify the perturbations. Any system, human or otherwise, responds when perturbed. A policy change can create all sorts of effects rippling through unnoticed by those who are not affected, for the reason that there may be no public signals accompanying them. Tracing the ripples requires an understanding of market and non-market interactions and institutions.

In earlier days social scientists searched for policies that enable people to avoid getting caught in poverty traps. However, today the focus is on identifying the character of institutions where such traps are a rarity. This shift has arisen because of an increased sensitivity toward the role of incentives. Institutions determine the structure of incentives, and the latter help to shape individual and group decisions. For example, if there is no suitable and credible punishment for breaking agreements, people would not necessarily have the incentive to abide by them. If this is generally recognized, they would not enter into transactions with one another in the first place, and mutually beneficial relationships would not be initiated. If policies that read well often come to nothing because of dysfunctional institutions, the study of policies or institutions on their own is not sufficient: neither good policies nor sound institutions can be plucked from the air. There is mutual influence here, and the task before the social scientist is to study it.

Economists have traditionally studied markets; political scientists, the state; anthropologists and sociologists, interpersonal networks; and ecologists and other natural scientists, the dynamics and functions of ecosystems. Only in recent years has each group begun to peer into the others' publications to see if they can better understand the links connecting their particular areas of interest. The emerging understanding about the interplay of institutions and of the importance of the resource base for human welfare is rich in possibilities. Of particular interest are non-market institutions and the way they interact with markets in poor countries. A few social scientists were led to study this field in the course of a search for links between rural poverty and the local natural resource base in poor countries. The literature that has emerged on poverty and natural resources is not so much a new theory, but a new perspective on how poor people live and the kinds of reforms governments ought to initiate in order to help

people live better. Dasgupta (1993), Dasgupta and Mäler (1997, 2003), recent review and policy documents by Duraiappah (1998) and DFID *et al.* (2002), and much of the work emerging through SANDEE,[2] are explorations into this set of questions.

3. The significance of non-market interactions

Large numbers of economic interactions occur through non-market channels. Transactions involving environmental and ecosystem services are examples of such non-market interactions (see, for example, the essays in Dasgupta and Mäler, 1997). One class of non-market institutions involves communitarian management of local common-property resources, or local commons for short. In poor countries the local commons include grazing lands, threshing grounds, inland and coastal fisheries, rivers and canals, woodlands, forests, village tanks, and ponds. Hardin's invention of the admirable metaphor, 'the tragedy of the commons', has done much to create public understanding of the problems that arise when property rights to resources are inadequate to manage the commons. However, in many places and in many periods, communitarian management practices have protected people from the 'tragedy of the commons'. In other places and at other times, such practices have failed to take off, or have broken down in the face of changing circumstances. A task of social scientists is to explain the differing outcomes in terms of economic 'fundamentals'. It has been taken up with relish: the study of common-property resources has been one of the biggest growth industries in environmental and development economics for some time.[3]

Market interactions are generally sustained by the legal power of the states. An important question for understanding environmental change is: How are non-market interactions sustained? Four mechanisms come to mind. First, innumerable transactions take place because the people involved care about one another and trust one another to carry out their obligations. The household best exemplifies institutions based on care and affection.

Secondly, there can be an external enforcer of agreements, which is not the state. It could be that an agreement is translated into an explicit contract and enforced by an established structure of power and authority. In rural communities the structure of power and authority are in some cases vested in tribal elders, in others in dominant landowners, village elders, chieftains, and priests.[4] On occasion there are attempts to make rural communities

[2] There are several forthcoming working papers on this broad issue – see for example Adhikari (2003), Balasubramanian and Selvaraj (2003), and Ghate (2003).

[3] For early work on the subject, see Dasgupta and Heal (1979, Ch. 3), Jodha (1986), McKean (1986, 1992), Feder and Noronha (1987), McCay and Acheson (1987), Wade (1988), Chopra, Kadekodi, and Murty (1990), Feeny *et al.* (1990), and Ostrom (1990).

[4] The question why such a structure of local authority as may exist is accepted by people is a higher-order one, akin to the question why people accept the authority of the state. The answer is that general acceptance itself is self-enforcing behaviour: when a sufficiently large number of others accept the structure of authority, each

mini-republics in certain spheres of life. For example, village Panchayats in India try to assume this form. The idea is to elect officials, who are entrusted with the power to settle disputes, enforce contracts (be they codified or only tacit), communicate with higher levels of state authority, and so forth. Robert Wade's account of local enforcement of water allocation in rural South India describes such a mechanism in detail (Wade, 1988). Wade studies 41 villages and finds that downstream villages (those facing an acute scarcity of water) regulate water used for irrigation through an elaborate set of rules, enforced by fines. Wade reports that elected village Panchayats appoint agents who allocate water among farmers' fields, protect crops from grazing animals, collect levies, and impose fines.

Where people encounter one another repeatedly in similar situations, agreements can be honoured even if people are not disposed to be honest, and even if an authority is not available to enforce agreements. This mechanism, where people are engaged in long-term relationships (among people who do not necessarily care for one another personally), is an ingredient in theories of social capital. It is the third mechanism by which non-market interactions are sustained. The enforcement mechanism underlying such relationships involves credible threats for non-cooperation to someone who breaks an agreement. The theory underlying the mechanism is well presented in Fudenberg and Tirole (1991).

Long-term relationships in transactions involving land, labour, and credit have recently been studied by economists and political scientists with the same care and rigour they used to invest in the study of markets and the state.[5] There is now, for example, a considerable body of work on how people cope with resource scarcity when there are no formal markets for exchanging goods and services across time, space, and circumstances, and when the state is ineffective. The literature offers us a way to understand how people, both individually and collectively, respond to policy changes when they are involved in long-term relationships. It tells us why institutions that are sustained by long-term relationships are fragile in the face of growing markets. Management of local commons has frequently been based on long-term relationships, and this has been the source of its vulnerability under changing socio-economic circumstances (Dasgupta, 2001a). Commons management is an important subject in India and it is unfortunate that we were unable to include any specific studies related to this topic in this issue. However, this is a well-established area of research (within and outside SANDEE) and there should be more papers in future issues of *EDE*.

4. Externalities as a form of non-market interactions

The fourth basis for non-market interactions is a perverse one, being reliant on an absence of well-defined property rights. The theory of economic externalities explores the consequences of their absence. Externalities are the side effects that occur when people undertake activities without mutual

has an incentive to accept it, the personal cost of non-compliance (a stiff jail sentence) being too high.

[5] See the pioneering empirical work of Rudra (1982, 1984) and the essays in Hoff *et al.* (1993) and Dasgupta and Serageldin (2000).

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agreement. Externalities do not lead to institutional failure, they are a form of institutional failure – environmental problems are frequently symptoms of such failure. It is useful to classify externalities into two categories: unidirectional and reciprocal (Dasgupta, 1982). Damage inflicted by upstream deforestation on downstream farmers without compensation is an example of the former. The famous 'tragedy of the commons' is a metaphor for the latter. Carbon emissions into the atmosphere, unregulated fishing in the open-sea, and pollution of rivers (see Markandya and Murty in this issue) are examples of the tragedy.[6]

The traditional literature on environmental and resource economics has studied ways to internalize externalities where agreements are enforced by the state. (Pigou, 1920; Mäler, 1974; Baumol and Oates, 1975). In this special issue, the paper by Markandya and Murty discusses the issue of negative externalities in the context of the much-revered river Ganga in India. This is a classic story of the 'tragedy of the commons' and an attempt by a third party, the state, to eventually clean-up the mess. In the late 1980s and the 1990s the Indian government spent over Rs 7 billion in capital costs and Rs. 480 million in operations and maintenance costs (in 1995–96 prices) on the Ganga Action Plan – this was in effect a massive operation with several states financing the plan. Using a variety of valuation techniques, Markandya and Murty estimate the benefits resulting from the Ganga Action Plan to different stakeholders, including users, non-users, farmers, fishermen, unskilled labor etc. Markandya and Murty show that improving the Ganga's environmental quality was definitely socially beneficial, and even more so if income distribution is taken into account.

5. Understanding ecosystem dynamics

Chopra and Adhikari's paper in this issue focuses on a popular and well-visited lake in Northern India. They describe the dynamic connections between economic and ecological systems and argue that careful modeling of wetlands requires understanding both current changes in efforts to harvest from wetlands and slower changes in ecological health (which are not obvious in the short term). In their model, upstream agricultural water use along with rainfall have an impact on downstream water flows into the wetland and the biomass supported by the wetland. The lake generates both tourism income and income from grasses collected by local residents and this income is affected by changes in the lake's ecological health. Chopra and Adhikari simulate a variety of policy scenarios to understand the effects of these inter-connections over a 23 year period. This paper is a good example of how exogenous changes can affect natural wetlands and how income generated from natural resources can be quite significantly changed by shocks to eco-system health.

The paper adds to our understanding of the economics of complex eco-systems. Ecologists have long argued that the constituents of eco-systems interact with each other and their external environment in ways that involve

[6] Gordon (1954) was the first to analyse the implications of free entry (i.e., open access) into a resource base. Scott (1955) is an original study on the effects of free entry into fisheries and Milliman (1956) on the effects on groundwater.

feedback loops and thresholds. If enough damage is inflicted on an ecosystem, whose ability to function is conditional on it being above some threshold, the consequences can be irreversible. This of course results in irreversible impacts on the people who depend on the resource. In the case of the rich, the change in natural assets (whether irreversible or slower degradation) may not matter too much because they can find alternative sources of income. However, for the poor, location and availability of local resources matters – they cannot typically substitute away their dependence on local resources by finding alternative jobs, alternative goods, or alternative locations to move to without huge transaction costs (Dasgupta and Mäler, 2003). Thus, in poor countries, it is particularly important to study and scrutinize the ways and mechanisms through which economic systems interact with nature.

6. Pollution and health risks

Increasingly, traditional problems of poverty and loss of natural resources in poor countries are being supplemented by 'new' problems of pollution and health. One of the many side effects of economic development is large-scale pollution of air and water. Regulatory institutions in most developing countries have simply not adapted fast enough to match the decline in environmental quality that has accompanied economic and demographic growth. The World Bank estimates that 'environmental health' risks, or, health risks associated with poor environmental conditions, make up about 18 per cent of the total burden of disease borne in less developed countries (a number that is much higher than the same for industrialized market economies) (Lvovsky, 2001: table 1). The two most important ways in which environmental quality has a negative impact on health is through water and air pollution. Water pollution is a source of diseases such as diarrhoea, malaria and cholera. Both indoor and outdoor air pollution are reason for concern, because of their contribution to respiratory tract infections.

For purposes of poverty reduction, it becomes important to consider how the environmental health of poor people can be assessed. What costs associated with ill-health are environment related? What are the benefits of improved air or water quality relative to the costs of required investments? Do the poor disproportionately bear the health costs of environmental degradation, i.e., is environmental quality a relatively major determinant of the health of the poor? We do know that their low nutritional status makes the poor more vulnerable to any form of illness, and the poor are less able to take defensive or corrective action to protect themselves. We also know poor countries are affected more than rich countries by such problems (Gwatkin and Guillot, 1999; Lvovsky, 2001). There is considerable scope for rich empirical work in this area – the paper by Purnamita Dasgupta is in this tradition.

Dasgupta's work focuses on one metropolis in India and identifies the health damages suffered as a result of poor water quality. She concentrates on diarrhoeal diseases as a manifestation of poor water supply and estimates the costs of ill-health using a health production function approach. She first estimates the predicted probability of illness in a household and then calculates the economic losses households incur as a result of

sickness. Dasgupta's carefully undertaken empirical study uses primary household data as well as laboratory-tested water samples. Her work confirms hypothesized negative linkages between per capita income and piped water supply and the probability of observed illness. Lack of disposal facilities for solid waste is also significant in explaining the probability of disease occurrence. Dasgupta estimates the annual cost of illness to the average household in her sample to be approximately Rs. 1094 or approximately 9 per cent of the reported mean annual income of her survey sample. These numbers clearly illustrate why it is critical to continue to invest in clean water in the developing world.

7. Environmental laws, institutional change and economic instruments

The puzzles that confront us as we try to understand environmental changes and their implications are innumerable. We are involved in teaching and research in environmental economics in South Asia and are struck by the many interesting and challenging problems that researchers raise based on their understanding of reality on the ground. While each problem is unique, because it is from a specific part of the region and faced by a unique group of rural households or tribal farmers or urban settlers, many of these problems relate to some form of non-market interaction and institutional failure. Some of these interactions and failures can be fixed by strengthening local institutions, but many need to be addressed with provincial, national or international policies. Predicting what policies and institutional fixes will result in improving the environment and which will simply result in other problems is not that easy. Thus, it appears to us that there is no substitute for sound and enforceable environmental standards and laws.

Enforcement of laws of course brings us back squarely to the need for good institutions, both local and at higher levels of government. Fortunately, there is much on-going research in this area and considerable policy experimentation as well. For instance, in both Nepal and India, forest management has moved toward strengthening community-oriented institutions, a far cry from the traditional state-controlled systems (Adhikari, 2003; Khare *et al.*, 2000). Several recent studies emerging from the South Asia region (Mukhopadhyay, 2003; Ghate, 2003; Balasubramanian and Selvaraj, 2003) highlight the role of strong local institutions in stemming environmental degradation and make a case for state support for such institutions. Issues that need further exploration are local inequalities and their implications for poor households within decentralized settings (Adhikari, 2003), and incentive structures that enable bureaucracies to sustain local institutions.

Environmental economics in the USA and Europe has contributed a rich array of market-based instruments to the tool-kit available to policy makers in the West. While environmental policies in developing countries are primarily regulatory, the policy milieu is now more open to a larger number of tools and there are indeed a wide variety of instruments that poor countries can use to stem degradation (Sterner, 2003). An emerging area for research is analyses of different economic instruments and how they may work in developing-country contexts. Two papers in this issue focus specifically on policy instruments and their implementation.

Rita Pandey's very practical paper demonstrates that there are a number of policy options, some technical and some fiscal, that can be used to control air pollution in Delhi. She identifies conversion of petrol and diesel vehicles to compressed natural gas as win–win options for consumers since they decrease pollution and save costs. For two-wheelers (which are a dominant form of transportation), she estimates that it is cheaper to retrofit them with catalytic converters rather than substitute four-stroke engines for two-stroke engines. In order to induce consumers to adopt some of the more expensive technical options, Pandey identifies a set of taxes and subsidies. She makes a particularly strong case for levying emission charges on diesel fueled cars.

The paper by Pandey and Bhardwaj is of special interest since it discusses the possibility of using emissions trading. The paper attempts to design an intra-firm emission trading scheme for suspended particulate matter (SPM) at the Bokaro Steel plant, a large integrated plant in Bihar, India. The authors identify different sources of SPM emissions within the plant and estimate marginal abatement costs for each source, given over-arching regulatory standards on ambient air quality that have to be met. The authors estimate cost-savings associated with a trading system where some sources emit more while others reduce their emissions. Relative to the existing regulatory system, the authors are able to clearly demonstrate that it is more cost-effective to adopt emissions trading.

8. Conclusion

Countries in South Asia currently face tremendous challenges in managing economic growth, human development, and environmental change. Over the last decade, South Asia, with an average GDP growth rate of 5 per cent, was the second fastest growing developing region in the world. However, the region is also home to 40 per cent of the world's poor (World Bank, 2001). South Asia also faces several serious natural resource degradation and pollution problems, which influence poverty and growth outcomes. Recent estimates that include the loss in natural capital in wealth calculations show that net wealth per capita has actually declined over the last few decades in this region. Between 1970 and 1993, net wealth per capita declined by an annual average of 2.6 per cent in Bangladesh, 3 per cent in Nepal, and 1.9 per cent in Pakistan. It stayed at a constant 0 per cent in India (Dasgupta, 2001b: Chapter 10, Table 7).

There are a number of economists and several excellent institutions working on environmental and natural resource problems in South Asia. SANDEE tries to facilitate their work by supporting research, training, and policy analyses related to economic development, poverty reduction, and environmental change. We hope that this will contribute to learning, cross-border sharing, and real solutions to South Asia's environmental problems.

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