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Introduction

1.1. About the book

This book is about the valuation of environmental services in South Asia. It brings together, for the first time, multiple case studies on valuation undertaken by economists and environmental scientists from Bangladesh, India, Pakistan, Nepal and Sri Lanka under the aegis of the South Asian Network for Development and Environmental Economics (SANDEE). The book provides an over-view of different environmental problems in South Asia and examines how economic valuation techniques can be used to assess these problems. It seeks to offer robust evidence of the monetary benefits of resource conservation and the costs of a decline in environmental quality as South Asian economies grow rapidly.

As elsewhere, markets for many environmental goods are absent in South Asia and the prices of these resources are unknown. Therefore, the chapters in this book discuss various methods for generating information on the prices of environmental goods and services. Another feature of the book is its exposition of the use of environmental and economic data and analytical techniques under circumstances when data are difficult to obtain. Thus, the book seeks to address some of the challenges of valuing environmental changes that are unique to developing countries. The book is also designed to serve as a work book for students and practitioners of environmental valuation. Each chapter offers a description of an environmental problem and the valuation strategy used. This is followed by a discussion of methods of estimation and results.

1.2. Environmental valuation in South Asia

Environmental resources constitute the core of life supporting systems on earth. They offer a number of services for human well-being, which are ordinarily not accounted for in regular market transactions. Many of these services are public goods or external benefits from conserving resources. In other cases, human activity results in pollution, with tangible costs that need to be accounted and assessed. Because the benefits from environmental services and costs of pollution are not always immediately obvious or because they are not priced and exchanged, they tend to be ignored with serious consequences for human health, income and well-being.

Economists consider the problem of valuing environmental services as a result of market failure and have tried to develop special tools and methods of valuation. In fact, valuation of environmental services now occupies a central place in the environmental economics literature. Its increased prominence is largely because it provides information that can be used for (a) designing policies for the sustainable use of environmental resources, (b) making investment choices with a due consideration given to environmental impacts and risks of projects, and (c) accurately measuring a country's Gross Domestic Product/Net National Product (GDP/NNP) after accounting for the contribution of natural resources.

In the developed world, valuation has entered the mainstream of policy and legal frameworks. Numerous valuation exercises are routinely undertaken to make policy choices about air quality standards or to settle legal disputes about oil spills or wetland loss, for example. Developing countries in Asia, Africa and Latin America, especially the emerging economies of China, India, Brazil and Russia, are now witnessing environmental degradation of formidable proportions. However, in these countries, there are fewer assessments of the true value of environmental services. While there are now requests from parliamentarians and the judiciary for evaluations of the price of environmental goods and services, there are very few studies that can be readily presented for public review. Thus, there is an urgent need to undertake environmental valuation exercises in these regions of the world. Such studies can identify the importance of environmental conservation as a path for sustainable development. Well done studies can also reduce methodological uncertainties about how to undertake this kind of research in the developing world.

Recognition of the need for environmental valuation came rather late to South Asia with some empirical studies start appearing only during the late 1990s. The initial cohort of studies included books that value water quality (surface and ground water) – prominent amongst these are Markandya and Murty (2000) on cleaning the Ganges, and Murty, Mishra and James (1999) on the economics of water pollution. Another dominant trend included studies focused on bio-diversity conservation and eco-tourism[1]. Interestingly, valuation in South Asia initially saw a number of contingent valuation studies[2]. The enthusiasm found in West for contingent valuation clearly had an influence on the first set of valuation studies done in the region. There was also interest in estimating pollution abatement cost functions in order to assess the possibility of using economic instruments such as taxes to reduce pollution[3].

In more recent years, there has been an upsurge in studies that have examined the health impacts of water and air pollution[4]. A good part of this literature took its cue from an earlier study done by (Cropper et al., 1997) on the health benefits of air pollution control in Delhi. Another strand of this literature, responding to demand from development agencies such as the World Bank, used valuation methods to examine willingness to pay for water service delivery[5].

The above is the context for the chapters presented in this book. Whereas most of the previous valuation studies in the region have been from India, this book is unique in that it brings together studies from across South Asia. Another area of interest in organizing this book was to see how varied valuation numbers may be across South Asia. Interestingly, as will be shown later, the valuation numbers for similar issues are comparable in the different countries. This suggests that the benefit transfer approach which applies valuation numbers from one country to another, can be used. This book can also contribute as a teaching tool. Many colleges and universities now teach environmental economics. Thus, the varied chapters in the book can serve as examples of how to apply a valuation method to

[1] Some of these are Hadker et al. (1997), Murty and Menkhaus (1998), Chopra (2004), and Santa Kumar, Haque and Bhattacharya (2005).

[2] World Bank (1993), Misra (1997), Hadker (1997), Venkatachalam (2000), Markandya and Murty (2000).

[3] Mehta (1995), Pandey (1998), Murty, James and Mishra (1999), and Murty and Kumar (2004).

[4] Kumar and Rao (2001), Lvovsky et al. (2002), Murty, Gulati and Chettri (2003), Dasgupta (2004), Goldar et al. (2005), and Gupta (2008).

[5] Chowdhury (1999), Whittington et al. (2002), and McKenzie and Ray (2004).

different contexts, what kinds of data are required, and what challenges are likely to be faced.

1.3. Valuation methods

Environmental economists describe environmental values as use values, option values and non-use values. The literature further categorizes the methods for measuring these values as revealed and stated preference methods. Revealed preference methods provide methodologies for estimating environmental values in the context of consumers and producers making consumption and production choices in market. Stated preference methods rely on values that are expressed by consumers and producers in the context of hypothetical markets scenarios. Chapters 2 and 3 of the book provide a succinct review of these methods.

Environmental degradation has unfortunately become a by-product or an externality associated with economic development. Most often, the many environmental externalities of production in agriculture and industry are ignored. Several case studies presented in this book examine the costs of these ignored externalities. A common approach taken is to estimate production functions, treating the environment as an input in the production of a marketable good. Any decline in the quality of the environmental input is expected to affect output. Because several case studies use this approach, we have dedicated an entire chapter (Chapter 3) to describe this method in detail.

Two chapters in this book use the production function approach to analyze externalities related to shrimp farming. Chapter 4 shows how shrimp production affects paddy cultivation in southern India, while Chapter 5 examines the effect of lagoon water pollution on shrimp production in Sri Lanka. These studies value the external costs of shrimp farming, which contributes to water and soil salinity, thereby leading to a decline in fish or rice yields.

An interesting variant of the production function method is used in estimating the contribution of pesticides to vegetable farming in Nepal (Chapter 6). Here the story is slightly different. Pesticides are used as damage control agents – they don't increase or decrease output directly. Rather, increased use of pesticides is expected to decrease the impact of pests and thus indirectly contribute to reducing yield losses. This case study shows that pesticides are used in quantities larger than optimal in

vegetable farming in Nepal. Thus, reducing pesticide use is likely to be both economically efficient and environmentally appropriate.

Chapters 7 and 8 focus on the regulating services of eco-systems. Chapter 7 aims to measure the benefits of forest re-generation by examining the links between stream flow, agricultural water use and economic returns to agriculture in the Western Ghats. The counter-intuitive results from this case study are discussed in greater detail later. Chapter 8 estimates storm protection benefits from conserving mangroves in the north-eastern coast of India. Both these chapters provide examples of techniques for estimating eco-system services.

Two chapters use the travel cost method to estimate demand functions for recreation. The travel cost method is a well-honed technique that uses the costs that visitors bear in traveling to a recreational site for estimating the demand curve for recreation. Chapter 9 discusses urban parks near Islamabad, Pakistan and Chapter 10 examines a remote rural protected area in the Indian Sunderban. While the Pakistan chapter follows the individual travel cost approach, the Indian study uses the zonal travel cost approach because of infrequent multiple visits to the site.

There are several studies in this book that estimate health production functions. Conceptually, health is an outcome that is a result of exposure to pollution. Health status is also affected by a number of other variables such as income, health stock, conditions of living or lifestyle, and adaptive behaviour. Environmental economic studies that seek to understand the health impacts of pollution generally follow two approaches. The first approach is to estimate a full health production function using a systems approach because many household decisions are inter-related. This approach jointly estimates a dose-response function, which provides an estimate of probability of a person falling sick due to exposure to pollution, along with a mitigating or medical costs function and an avertive expenditures function. This allows researchers to establish an individual agent's Marginal Willingness to Pay (MWTP) to reduce pollution.[6] A second linked approach is to estimate the dose-response function and a mitigating cost function separately and use the estimates from these regressions to obtain the MWTP. Several studies (Chapters 11 to 15) in this book follow this approach to estimate the health effects of indoor and outdoor air pollution and arsenic contamination of water.

[6] MWTP should also include the disutility from sickness but this factor is often ignored because of difficulties in estimation.

Another methodological technique illustrated in this book is the use of the Hedonic Price approach. This method evaluates changes in the value of an environmental good by assessing changes in the prices of a marketed good or service in a surrogate market. Chapter 16 in this book examines housing markets and prices in Delhi and Kolkata to estimate the benefits from reducing air pollution. Chapter 17 uses wage data from industrial workers to estimate the value of statistical life. The interesting issue here is whether the markets of linked goods are sufficiently robust to allow one to estimate the value of environmental changes. Our case studies suggest that this is indeed true and the hedonic approach can be applied to developing countries.

Finally, Chapter 18 illustrates the use of the Contingent Valuation Method (CVM). In contingent valuation, the preferences of economic agents and their willingness to pay for environmental changes are directly gauged by asking survey questions. This stated preference method is particularly useful when revealed preference methods are unavailable. This Chapter provides a step-by-step account of the procedures used to implement a contingent valuation survey in the context of a water supply and sanitation project in Sri Lanka.

In the following sections, some of the findings of the case studies in this book are discussed. An attempt is made to show how these valuation studies can be used by placing them amidst the environmental challenges faced by South Asia.

1.4. Implementing full cost pricing in agrarian settings

Agrarian losses from ignoring the environment are a key problem faced in South Asia. The food production and quality of our environment are closely linked. As a result, loss in production due to deteriorating environmental conditions might lead to increased poverty. During the last decades, economic growth has lead to significant poverty reduction – 16 per cent in Bangladesh (1999–2004) and around 17 per cent in India (1984 –2004)[7]. Part of this reduction in poverty can be attributed to agrarian changes and the green revolution. However, even as the importance of improved agriculture is recognized, there are many counter examples of environmental damage as a result of over-zealous agricultural practices, for example, pesticide pollution, forest degradation and water use. One of

[7] Planning Commission, Government of India.

the main reasons why such environmental problems are faced is because of a complete failure to account for the price of the environment.

The failure to undertake 'full cost' pricing is well illustrated by two SANDEE research studies that have looked at shrimp farming in India and Sri Lanka. The shrimp industry is a very lucrative industry and brings in considerable foreign exchange. In India, it brings in about two billion US $ in a regular year. However, depending on how intensively the farming is done, it can cause surface and ground water pollution and salinization of agricultural lands.

The first study reported in Chapter 4 examines the salinization of paddy lands by adjacent shrimp farms in South India. Soil data shows that soil salinity was in the normal range before shrimp farms arrived 15 years ago. By examining two similar villages one closer to shrimp farms than the other, the study has shown that the costs to farmers from the salinization externality ranges from INR 1000 to INR 5000 per hectare – a significant cost because the average returns to paddy in this area are about INR 6000 per hectare.

In Sri Lanka, the situation is somewhat different. Shrimping is a major industry in the Dutch canal lagoon with over 1300 farms occupying various tracts. Unfortunately, they have had many episodes in the last decade of disease outbreaks – the main reason is that the pollution created in the lagoon by the waste discharged by the farms themselves, has a negative feedback impact on the farms. The study reported in Chapter 5 shows that reduction in lagoon pollution to safe levels would increase yields by about seven per cent. So in the former case, it is a direct one-sided externality and in the later case, we have a reciprocal externality with an open access coordination problem.

The question is how can these be rectified? The two obvious courses are government and community action. In terms of government action, there are laws in India that limit the type and geographic prevalence of shrimp farming, however, these laws are not always well implemented. In Sri Lanka, a project to clean up the basin has been in the books for years but the question is should the public sector subsidize the private sector for its own inaction? Arguably, an effluent tax would be a way forward if the regulatory framework to impose such a tax exists.

In terms of community action, in the Indian case study, a second nearby village escaped the impact of the shrimp farms because villagers coalesced together under a farmers' organization. There are many attempts to

scale up such community-based efforts through watershed management programmes in South Asia. This example suggests that such efforts are critically needed for managing agrarian areas where full cost pricing is difficult to implement.

1.5. Accounting for linked ecological and social systems

Any environmental resource transformed into a flow that is valuable to us is a service that ecosystems provide. Ecosystems provide many valuable services to human beings. Arguably, the entire life support system that we are dependent on for the continuation of the human species is an eco-system service. However, this over-arching service is better understood if further categorized. Some commonly identified eco-system services are – climate regulation, pollination, pest control, ground and surface water maintenance, filtering and water purification, biodiversity provision, food and shade provision, waste absorption and so on (Millennium Ecosystem Assessment, 2005).

Scientific understanding of eco-systems services has grown over time. However, the long time it has taken to get to the current understanding of climate change and its determinants suggests that the complexities of ecological and bio-physical interactions are enormous. Measuring changes in eco-system services, valuing these changes, and establishing the right institutions to regulate these changes are looming challenges.

This book provides two good examples of the complex nature of ecological interactions, especially when overlaid with human enterprise. The first example is provided by a study in Chapter 7. This study examines the hydrological services provided by forests in the Western Ghats of southern India. In the study area, there is an interesting water management strategy that has been used for many years. Here, agriculture is either rainfed or irrigated through the use of water from storage tanks. For example, in the study village, if the tank fills up during the Rabi/Summer season, water is released and farmers grow paddy. If the tank does not fill up, none of the farmers get water and they switch to a rainfed crop.

Chapter 7 compares run-off/rain ratio in two nearby forests and concludes that the ratio is much higher in un-conserved and relatively degraded forests and less in dense and conserved forests. Therefore, conservation of forests means less water for surface or tank irrigation and more water for ground water or well irrigation. Farmers could potentially be better

off by conserving the forest if they used ground-water for irrigation. But, because of the unique and collective way decisions are made to use surface water for growing crops, more forests would actually mean a significant reduction in average expected annual income to farmers. So, here is an interesting situation, where the local institutional arrangement for water management works in harmony with degraded forests.

The second example in Chapter 8 looks at the cyclone of 1999 that killed around 10,000 people along the coast of Orissa. In this chapter, Saudamini Das asks if the presence of mangroves provided any storm protection to households and their assets during the storm. By combining GIS data with census information, she examines the mangrove mediated effects on residential property in Kendrapada district of Orissa and concludes that mangrove forests, by reducing the velocity of storm surge, offered protection. In the absence of mangroves, the number of houses that fully collapsed would have increased by some 23 per cent.

Das's work suggests that the mangrove forests can act as a natural barrier during storms. This assessment is important because climate change is likely to increase the frequency and intensity of storms in South Asia. So should mangroves be conserved in Orissa? While, the opportunity costs of land are higher than the protective value mangroves provide to residential property, the overall protective values of mangroves are high enough to promote conservation.

The sustainable development challenges are here clear – a) careful economic analyses of the multiple services of forests is needed – even in the case of Chapter 7, the conclusion is not to allow forests to degrade but to recognize that there are some costs associated with conservation; b) the data needs for undertaking this kind of analyses are immense and methods inter-disciplinary. Therefore it is required to teach ourselves, more so than before, the language of scientists; and c) as evident in so many instances, the institutional arrangement matters tremendously. This is obvious in the case of hydrological services in the Western Ghats. In the case of the mangroves in Orissa, it is interesting that much of the degradation of mangroves took place after 1952, when new Government rules transferred mangrove forests from local *Zamindars* (the feudal landowners) to the government. Moving forward to fix this problem will require both public investments in mangrove restoration and new public-private arrangements to get communities involved in mangrove conservation.

1.6. Improved health outcomes

The ambient air and water pollution in South Asia on an average is much higher than safe standards. The World Health Organization (WHO) standard for annual PM_{10} concentration, small particles that can enter the respiratory system, is 50 μg/m^3. However, in Dhaka, the annual average PM_{10} concentration was estimated to be 133 μg/m^3 in 2003 (World Bank 2006) and this number was 194 μg/m^3 in Karachi in 2003 (World Bank 2006). In India, in 2007, over 50 per cent of 304 monitoring stations registered PM_{10} concentrations higher than the levels prescribed by the National Air Quality Standards (CPCB, 2008). In fact, 51 per cent of the residential stations had PM_{10} levels that were considered 'critical'; interestingly only 14 per cent of the industrial stations were in the critical status. In terms of water pollution, organic pollutants tend to be the most important source of pollution. In India alone, some one million children are estimated to die annually as a result of water related diseases such as diarrhoea (Parikh et al., 1999). Thus, reducing pollution of surface and ground water and indoor and outdoor air pollution is a huge environmental challenge for policy makers.

A number of studies reported in this book are eye opening in terms of the magnitude of damage pollution causes and the challenges the governments and communities face in reducing pollution. The studies suggest that the costs of outdoor air pollution per person per year in terms of morbidity effects are approximately INR 100 in India (Chapter 11) and LKR 699 in Sri Lanka (Chapter 14). To get a better understanding of these numbers, it is useful to compare these to annual income. The annual per capita income in Sri Lanka was LKR 77,556 per year in 2006–2007 (HIES, 2008). Thus, conservatively, the costs of air pollution are close to one percent of per capita income in Sri Lanka. In Kanpur, the per capita income in the sample studied was approximately INR 15000 per year. This places morbidity costs of ambient air pollution in the same range of less than one percent of per capita annual income. Chapter 16 estimates the total annual damages, including morbidity and mortality effects, from air pollution in the cities of Delhi and Kolkata to be INR 54,833 and INR 37,026 million respectively.[8] The Kanpur study in Chapter 11 estimates that the annual health damages from morbidity effects alone for people in this city as INR 310 million per

[8] Reducing air pollution to meet current safe standards would provide a representative household an annual benefit of INR 23,354 (US $486.54) in Delhi and INR 11,727 (US $244.31) in Kolkata.