

Resource Management and the Effects of Trade on Vulnerable Places and People

Lessons from Six Case Studies

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Abstract

Lessons from six case studies illustrate the complex relationships between international trade, vulnerable ecologies and the poor. The studies, taken from Africa, Asia and Latin America and conducted by local researchers, are set in places where the poor live in close proximity to ecologies that are important to global conservation efforts, and focus on the cascading consequences of trade policy for local livelihoods and environmental services. Collectively, the studies show how under-valued common resources are often poorly protected and consequently subject to shifting

economic incentives, including those that arise from trade. The studies provide examples where trade works to accelerate the use of natural resources and to exacerbate unsustainable dependencies by the poor, and other examples where trade has the opposite effect. An important conclusion is that local livelihood and technology choices have important consequences for how environmental resources are used and should be taken into account when designing policies to safeguard fragile ecologies.

This paper—a product of the Agriculture and Rural Development Team, Development Research Group—is part of a larger effort in the department to understand the relationships between trade, poverty and the environment. Policy Research Working Papers are also posted on the Web at <http://econ.worldbank.org>. The authors may be contacted at DLarson@worldbank.org and JNash1@worldbank.org. Financial support for the six case studies discussed in the paper was generously provided by the European Commission and the Netherlands Directorate-General of Development Cooperation. The authors would like to acknowledge the valuable insights and helpful suggestions provided on earlier drafts by Jonathan Cook, Owen Cylke, David Reed and Pamela Stedman-Edwards.

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Resource management and the effects of trade on vulnerable places and people: lessons from six case studies¹

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Introduction

The lowering of trade barriers is a visible point of policy change that is often associated with broader changes in the economy and a deeper set of policy reforms. In general, poor countries undertake trade reform because it carries the potential to lessen poverty through the increased opportunities that come with open markets and economic growth. Even so, when changes in trade policy have impact, they are likely to enhance the value of some activities and diminish the value of others. This, in turn, can have important consequences for how natural resources are used and for livelihoods, including those of the poor.

For this reason, trade policies and trade agreements are controversial. The scope for gains from new trade deals and the consequences of existing policies are scrutinized from policymakers, advocates, scientists and social scientists, and the scale of research devoted to these topics across a range of disciplines is large. At the same time, reported outcomes from trade reforms are varied and practical lessons from the literature are elusive. Moreover, when public debate over policy occurs, evidence put forward by advocates of different positions seems inconsistent and contradictory.

In this essay, we discuss findings from a collection of case studies jointly managed by the World Wildlife Fund and the World Bank. The case studies were carried out by local research teams and focus on the consequences of changes in trade policy on poor people living in places with important and sensitive ecologies. The case studies were motivated by a desire shared by both institutions and the local research teams to move the policy debate forward by bringing together accessible and tangible examples of the relationships between global markets, local economic activity and the local ecology. The full case studies are contained in an edited volume (Cook et al., forthcoming).

Taken together, the cases examined in the study suggest that the reason why generalizations about how trade, poverty and the environment relate are difficult to obtain lies in the very specific and local conditions affected by trade. The individual studies, taken from Africa, Asia and Latin America, are set in places where the poor live in close proximity to important and valuable natural resources and focus on the cascading consequences that trade has on the way people interact with the environment to earn their livelihood. The studies illustrate the significance of global markets for important ecologies and the poor who

depend on them. They also provide insights into how people can act collectively as stewards of natural resources.

For a number of reasons, the once remote areas in the case studies have become more closely tied with the global economy, and there are good reasons to expect that trade policies, acting through these strengthened links, will play an increasingly important role in environmental outcomes. At the same time, incentives from global markets filtered through national trade policies are just one of several determinants of how people interact with the environment. A key lesson from the case studies is that this relationship between global markets and local action is complex and that outcomes are difficult to anticipate, due at least partially to the location and situation specific nature of the relations. As evidence, the studies include examples where evolving economic practices work to mitigate the pressure of growing rural populations on limited soil, water and forest resources and also provide examples of how new export-tied demands can arise along with incentives to rapidly diminish important environmental resources, sometimes in irreversible ways. More to the point, the case studies suggest that important natural resources are often undervalued and poorly safeguarded. Consequently, how these resources are used is subject to shifting incentives that often go unchecked. One implication for policy is that restrictions on trade will rarely adequately safeguard important ecologies and, in some cases, can speed the degradation of natural resources.

A second key finding from the studies is that the local poor often depend heavily on natural resources and sometimes exploit them in unsustainable ways. In part, this is because access by individuals to forest, land, water and marine resources is difficult to police, which in the aggregate contributes to overuse. More fundamentally, however, the studies suggest that the problem is rooted in the condition that poor households are drawn to and become dependent on common-pool resources because they lack the private resources needed to support better livelihoods. For policy, finding equitable ways to protect vulnerable people who rely on vulnerable habitats poses a difficult challenge.

A third major finding from the studies is that differing ecologies give rise to distinctive sets of interdependent livelihoods and markets. As a practical consequence, decisions taken locally play an important role in how natural resources are used, which in turn has ramifications for income and for the environment. For this reason, policy solutions

that address the preservation of important natural resources as well as the needs of the local poor must have a component that reflects local conditions and practices. This can be problematic, since the institutions and knowledge base needed to do so may be weak or altogether missing.

1. Related literature

In this section we selectively review some of the recent literature on trade, poverty and resource management in order to provide a context for the case study findings. There are large literatures on the relationships between trade and poverty and also on the effects of trade on natural resources in the absence of well-defined property rights.⁴ And there is also a small but growing literature on the role of common resources in the livelihoods of the poor and how this is can be influenced by trade.⁵ Less developed in the literature is a broad conceptual framework that takes into account the incentives of households whose livelihood depends on open access to natural resources, the incentives for putting in place differing resource management regimes to limit access, and the effects of trade events on both sets of incentives. At the same time, recent theoretical models of resource management allow for the endogeneity of management regimes and are capable of a complex range of outcomes missing from earlier theory. Though households and firms play stock roles as agents with de facto rights to harvest natural resources, the models can replicate the heterogeneous outcomes from trade found in the case studies. Moreover, it is easy to see how the role of agents can be expanded within the context of these stylized models.

In resource management models where the regulatory regimes are static, predicted outcomes from trade events depend crucially on enforcement and the capacity of managing institutions to monitor access and long-run equilibrium outcomes tend to be bimodal. In particular, in models where the initial conditions include the protection of private and public property rights, trade liberalization reduces poverty and enhances overall welfare, inclusive of the environment. In contrast, when resource use is determined by the relative costs and benefits of extraction that accrue to individuals with weak protection afforded common

⁴ Winters, McCulloch and McKay (2004) review the literature on trade and poverty; Bulte and Barbier (2005) review the recent literature on trade and resource management.

⁵ See, for example, Lopez (1997, 1998).

resources, events such as trade liberalization can exacerbate incentives to harvest resources, pushing extraction rates to unsustainable levels with disastrous consequences for the resource stock and welfare. This can be true even when the models themselves are dynamic in other aspects.⁶ Under these circumstances, outcomes from trade liberalization are determined exclusively by the degree to which trade events increase or decrease resource prices.

Alternatively, outcomes from changes in trade regimes are ambiguous in models where the regulatory mechanisms are dynamic and endogenous, even when trade liberalization increases the resource price. For example, in a model of endogenous resource management by Copeland and Taylor (2009), an increase in the price of an exported resource simultaneously attracts agents who seek to exploit open-access resources and improves incentives to devote additional resources to activities that constraint resource access. Consequently, the model can generate a set of solutions in which low resource prices are associated with open access, while restrictions on access emerge at higher resource prices. The paper illustrates the conceptual findings with practical examples of how resource management regimes sometimes change and sometimes fail to change in response to new trade opportunities.⁷

The endogenous regime models are rooted in a substantive theoretical and empirical literature about the formation of formal and informal institutions that facilitate cooperative solutions to common pool resources (e.g. Olson, 1965; Wade, 1987; Bromley, 1992; Ostrom, 1992; Seabright, 1993). Included in this literature are studies that focus on how local conditions affect the incentives to take cooperative action, for example through their effects on the costs of negotiating or monitoring outcomes. In models of this type where the cost of cooperation is fixed, outcomes tend to be discrete, depending upon whether the fixed-cost hurdle can be cleared. However, when the costs of cooperation are variable, then a continuum of outcomes is feasible. For example, McCarthy, Sadoulet and de Janvry (2000) explore the consequences of variable costs in two-player and multi-player game settings in

⁶ See, for example, Brander and Taylor (1997) and Chichilnisky (1994). For the dynamic case see Fujiwara (2009).

⁷ Positive examples cited in the paper include Demsetz (1967) and Jones and Bixby (2003); negative outcomes are illustrated in Taylor (2007) and Vetemaa, Eschbaum and Saat (2006). Besely (1995) reviews the empirical evidence that property rights are pliable.

the context of common-property pastures shared by *ejido* members in Mexico. They show how the traditional governance structures of these collective farms combine with variable costs to affect environmental and sustainability outcomes.

Although, conceptually, it is possible to explain the wide variation in the environmental effects of trade under fairly simple household incentives, the case studies suggest a stronger dynamic link between access and poverty. Descriptively, the households that access natural resources in the case studies are poor in all forms of private assets, including human capital. Earlier studies suggest that, when this is so, common property serves as a substitute for private property in the livelihood strategies of the poor. Components of the strategies include activities in which households extract incomes from common property and often a reliance on common property as a substitute for insurance or precautionary wealth.⁸ Studies also suggest that households that access common resource pools are also self-selecting and that households without better alternative opportunities are attracted to open-access areas.⁹ Dynamically, the type of poverty associated with common pool resource use can lead to downward spiraling traps across generations, as poor households fail to invest in their children who continue to the use and degrade common pool resources.¹⁰

Policies that directly target the incentive structure of poor households as a mechanism to better manage natural resources are uncommon but some experimental programs are in place. Of particular interest are payment-for-environmental-services (PES) programs that pay smallholders to engage in conservation practices.¹¹ For example, Zhang, Tu and Mol (2008) analyze efforts in China to convert steeply sloped cropland to forests or grasslands by changing household incentives, a policy that is also discussed in the case study from China.

⁸ See Delacote (2009) for an overview. See also Bene et al. (2009), which discusses how fishing addresses cash needs among poor Congolese.

⁹ For example, see Cartier's (2009) description of the livelihoods of migrant artisanal ruby and sapphire miners in Madagascar.

¹⁰ See Ikefuji and Horii (2007) discussion of the dynamic relationships between education, incomes and environmental degradation.

¹¹ As background to their survey of 25 PES schemes in 15 countries, Mayrand and Paquin (2004) report finding more than 300 payment programs in 2004. For a discussion of design issues and practical outcomes see, Engel, Pagiola and Wunder (2008), Wunder (2008) and Alix-Garcia, de Janvry and Sadoulet (2008).

More often, policies affect household incentives indirectly or through general equilibrium effects.¹² General equilibrium effects and related growth effects are often used to explain the “environmental Kuznets curve” – an empirical relationship suggesting that environmental quality degrades during the early stages of development and subsequently improves. In his survey, Dinda (2004) considers the literature surrounding two potential mechanisms. In the first, the relationship is largely incidental and arises as the composition of a growing economy shifts from agriculture to manufacturing and then to services. The second mechanism is an expected endogenous regulatory mechanism in which stakeholder preferences shift with rising incomes to favor greater regulation of natural resources.

To conclude before moving to a description of the case studies, there have been significant advances in understanding the incentives that give rise to the success and failure of resource management regimes and the role that trade policy and the dynamics of growth play. To a large degree, the case studies described in the next section reinforce these findings. Still, from a policy perspective, less is known about whether it is possible to design successful local resource management approaches in places where existing conditions of poverty and high monitoring costs would seem to preclude the endogenous emergence of adequate management institutions. The case studies suggest that an important place to start is with a better understanding of how local household incentives and local technology choices affect local ecologies and the services they provide.

2. An overview of the case studies

The six case study sites are briefly described below. Each study deals with how the livelihoods of local population depend on nearby land, water and forestry resources and how change in trade policy affects that use. The case studies then go on to assess the consequences for the poor and for the core natural resources that they use. By design, the studies focus on areas where people are poor and where the local ecology is important to global conservation efforts.

¹² For example, Heath and Binswanger (1996) discuss how policies in Colombia unintentionally encouraged land degradation; Pascual and Martínez-Españeira (2009) model how low staple prices can result in spontaneous reforestation in Mexico without adverse welfare effects when there are alternative labor market opportunities.

China

The China study focuses on Pingbian County in Yunnan Province near China's southern border with Vietnam.¹³ The area is considered a biodiversity hot spot, and the World Wildlife Fund has placed Yunnan Province on its Global 200 list of eco-regions that are conservation priorities. The region is remote and mountainous and its ecosystems are relatively intact with clean water systems. Roughly a quarter of the county's 471,000 acres is protected as part of the Da Wei Shan Nature Reserve. The reserve's forests contain more than 3,000 plant species and more than 500 animal species.

About 62 percent of Pingbian's population of 147,000 belong to ethnic minorities, and the county is given a measure of autonomy for this reason. The Miao people, who are tied ethnically to the Hmong of northern Laos and Vietnam, comprise the largest group. The county is overwhelmingly agricultural and about 90 percent of the households earn their living by farming small plots of land. Despite recent gains, the county remains overwhelmingly poor; 61 percent of the population makes do with incomes less than US\$105 annually per capita and about half earn less than US\$76 per capita per year. The study focuses on the shifting composition of farm output, related changes in farming practices and the out-migration of farm labor following trade reforms taken prior to the start of China's WTO membership.

Vietnam

The Vietnam study centers on Ca Mau Province, which is situated on a low-lying peninsula between the South China Sea and the Gulf of Thailand.¹⁴ Ca Mau Province makes up about 13 percent of the Mekong River Delta. Its climate is sub-tropical climate with seasonal monsoons. The region once supported extensive mangrove forests but much of the land has been cleared for agriculture and is protected from flooding by a system of dykes. The delta has been modified to facilitate transport and a system of canals connecting natural rivers and estuaries now allows for passage from the South Sea of China to the Gulf of Thailand. Though reduced in size, Ca Mau's mangrove forest remains the largest in Vietnam and

¹³ This section draws on Daming, Jiang and Cochran (forthcoming).

¹⁴ This section draws on Thong, Mai et al. (forthcoming). For a good review of the spatial relationships between natural resources and poverty in Vietnam, see World Bank (forthcoming.)

provides a degree of protection against storms and its tidal ecology supports a wide variety of birds, reptiles, mollusks and crustaceans.

On average, incomes are low in Ca Mau, with about one-third of the province's 1.2 million people classified as poor in 1996. Most households in the province still depend on agriculture, fishing or forestry for their livelihoods. Traditionally, farming households have used the area's abundant water supplies for irrigated rice. In recent years, following the lead of national policies that promote export-led growth, local authorities have departed from their long-held emphasis on rice production, to encouraging shrimp production intended for export. The study examines the consequences of this policy shift on incomes and the local environment.

South Africa

The South African study site is a portion of the Incomati River basin, which also stretches into Mozambique and Swaziland.¹⁵ The Incomati River originates in South Africa, flows into Swaziland, reenters South Africa and flows into Mozambique, entering the Indian Ocean near Maputo. The river supports a rich set of ecologies in all three countries. The basin contains Kruger National Park, South Africa's large game reserve, located near the headwaters of the Incomati, and feeds a large estuary and mangrove forest at the mouth of the Incomati. The game reserve is home to cheetahs, giraffes, elephants, hippopotamus, lions, leopards, rhinoceros and zebra. Hundreds of species of resident and migratory birds dwell along the Incomati and its tributaries as well. The mangrove forest near Maputo protects against ocean storms and provides a breeding ground for shrimp and other important aquatic life. The Incomati River Basin is an important source of fresh water for the river basin's human population, providing water for drinking and for irrigating crops. Demand for the basin's water is high and current water use exceeds the Incomati River's annual runoff by more than 26 percent.

The economic focus of the study is on sugar production in the poor province of Mpumalanga, which abuts Kruger National Park. Household income in the province averages around \$257 per year, inequality rates are high, and life expectancy is under 50 years. The sugar industry employs nearly 70,000 people in the province where

¹⁵ This section draws on Lorentzen, Cartwright and Meth (forthcoming).

unemployment exceeds 33 percent. Sugar mills in Mpumalanga provide input and technical support to about 100 commercial farmers and 1,400 smallholder farmers. The study is forward looking and examines the effects of potential changes in the European Union's sugar regime that may well create opportunities for smallholder production to expand and the consequences for conservation and sustained development in the face of competing demands for the area's limited supply of fresh water.

Chile

The Chilean study has two areas of focus. One is the country's diverse forest ecology; the other is its rich coastal aquatic ecology. Chile is home to nearly one-third of the world's remaining large tracts of temperate forests (Global Forest Watch, 2002). Rates of endemism in Chile's forests are high and its temperate forests are included in the World Wildlife Fund's top conservation priorities. The forests contribute to global climate regulation and provide local benefits by reducing erosion and flooding, by providing catchments for fresh water and by preserving soil nutrients. Part of the study focuses on how the forestry industry has affected one of the richest zones of native forest and biodiversity in regions VIII to X. The other part focuses on the freshwater and estuarine ecosystems of southern Chile and the development of Chile's salmon industry.

In contrast to many of the studies that focus on household interactions with a specific natural resource, the Chile study looks at the longer-term structural changes that have given rise to regional differences in rates of economic growth and poverty reduction and in shifting sources of livelihood. Noting that, on average, rural poverty fell from 41 percent to 24 percent during the last decade of the 20th century, regional disparities emerged and have persisted, with incomes lagging especially in the study areas. The study focuses on the reasons for this and on the consequences for how the region's natural resources are used.

Madagascar

The Madagascar study has two components. The first focuses on traditional practices of maize cultivation and its affect on the Mikea Forest of southwest Madagascar. The second looks at the role of contract farming on the preservation of soil fertility, a long-standing resource management problem in Africa. The Mikea is a dry and spiny forest, rich in endemism and home to the radiated tortoise, the subdersert mesite and the white-footed

sportive lemur, none of which is found outside of the eco-region (Frontier-Madagascar, 2005). The area is a high priority for the World Wildlife Fund and other conservation organizations; however only 3.2 percent of Madagascar's spiny forest was protected at the start of this decade (WWF, 2000; Gorenflo et al., 2005). Local inhabitants are poor and livelihoods often rely on shifting maize cultivation characterized by low yields. The shifting cultivation practices have resulted in deforestation and the first part of the study examines how indirect and temporary incentives resulting from trade policy affected household incomes and rates of deforestation. More specifically, the study looks at how an EU program designed to stimulate livestock production in nearby Ile de la Réunion, an overseas department of France, led to a temporary surge in maize exports from Madagascar to Réunion and to an acceleration in the rate of forest clearing.

The second component of the study looks at how contracting for fresh vegetables destined for European markets affected the incomes and farming practices of 10,000 smallholders in the Madagascar highlands. Rates of erosion are high in this area, and finding ways to preserve soil fertility by adding organic matter is a priority. The study looks at how farm contracts, which were motivated by special EU trade provisions, affected smallholder use of organic compost on contracted and non-contracted crops.

India

The Indian study looks at the ecology of the Sunderbans and the livelihoods of its inhabitants in West Bengal.¹⁶ The Sunderbans is the world's largest delta covering 6.2 million acres in Bangladesh and India. Over a million acres of mangrove forest cover the Indian portion of the Sunderbans, of which about 40 percent is inundated. The climate in West Bengal is moderate with heavy rains during the monsoons, which typically begin in July and end in October. The water of the Sunderbans is brackish, but with seasonal and tidal variations. Two wildlife sanctuaries and the Tiger Reserve National Park are located in the Sunderbans. In addition to the tiger, the area is home to a number of rare and endangered animals, including the fishing cat, spotted deer, wild boar, Gangetic dolphin, water monitor, estuarine crocodile, river terrapin, Olive Ridley turtle, ground turtle, hawksbill turtle and king

¹⁶ This section draws on Chopra, Kumar and Kapuria (forthcoming).

(horseshoe) crab. The Tiger Reserve was designated a UNESCO World Heritage Site in 1987.

Many households living within the Sunderbans are economically disadvantaged. Almost 40 percent are from poor scheduled castes and about half of the region's 4.2 million people live below the poverty line. Literacy rates are below 35 percent and most communities lack safe drinking water and electricity. Most households (89 percent) rely on agriculture for income and most are either marginal farmers or landless laborers.

Traditionally, rice has been the region's major crop; however shrimp exports have grown rapidly in recent years and many in the region are involved in aquaculture. An estimated 150,000 people depend on shrimp larvae collection in the Indian Sunderbans (Central Inland Fisheries Research Institute, 1999 and 2000). Moreover, in spite of the prevalence of poverty in the region, people have been migrating there because of the rich natural resources. The study looks at how decisions taken by local and state governments contributed to the growth of an export-led shrimp industry in West Bengal and at the consequences for local livelihoods and the local ecology.

3. An overview of the trade events studied

The starting point for each of the case studies is a shift in the level or composition of trade that is of sufficient scale to affect the livelihood strategies of the local poor. As a practical matter, the research teams recognized that it is seldom possible to identify a single event and what is referred to in shorthand as "the trade event" is usually a sequence of policy decisions sometimes stretching over several years, or is, in some cases, a whole collection of (nearly) simultaneous actions. By way of example, while World Trade Organization (WTO) membership might be viewed as the driving trade event in both China and Vietnam, the case studies point out that the Doi Moi policies of Vietnam began in 1986 and that reform in China began with a partial liberalization of agriculture in 1978.

For purposes of the discussion, it is possible to use a two-way taxonomy of the cases, which constitutes (1) general trade liberalization of the country under study: Chile, China, India, Madagascar (horticulture), Vietnam; and (2) a trade event affecting mainly one product market: sugar in South Africa and maize Madagascar. But other classifications are possible. For example, the studies could be divided into those dealing with effects of external

trade events on the country under study: Madagascar (maize) and South Africa; and those dealing with the effect of a country's own trade policy decisions: all others. Yet another way to categorize the cases would be according to the drivers of the trade policy event: multilateral (WTO) agreements: China and Vietnam; unilateral policy decisions: Chile, India and Madagascar (horticulture); and policy actions external to the country under study: Madagascar (maize) and South Africa.

The latter way of looking at things may yield some interesting insights into the political economy of trade policy. But to a trade economist, the first classification scheme mentioned above is the most economically meaningful, since it basically differentiates those cases whose effects are on a general equilibrium (economy-wide) level from those whose effects are mainly partial equilibrium. Of course, in making this distinction we have to recognize that, in the real world, the division between these two classes of cases is not black and white. For example, even though new opportunities to export cash crops were direct trade-related drivers of change in China's Pingbian County, internal migration and the emergence of new domestic markets brought about by broader changes in the Chinese economy deeply affected livelihoods. And, as is suggested by the other taxonomies, each of the two categories includes examples of cases that differ in many ways from others in that category.

The trade events affecting mainly one product market are the most straightforward to conceptualize, since the linkages between the event and the specific market being studied are more direct. For example, the Madagascar maize study focuses on the effects of an external policy program in Europe that opened specific opportunities for maize exports while Madagascar was undergoing a more general process of trade policy reforms, which, in turn, amplified the impact of the market-specific policy. And the South Africa study modeled the potential impact on the sugar industry of a rise in sugar prices that would result from external trade liberalization. In these cases, the link between the event and the product market being studied is direct and linear: the event causes an increase or reduction in the demand and price of the product, without significantly affecting other markets.

In cases in which the trade event was general trade liberalization, the link with the market under study is more subtle. By "general trade liberalization" we mean a process of reducing barriers to trade more or less across the board, including import tariffs and non-

tariff barriers as well as export taxes and controls. This includes dismantling or at least relaxing foreign exchange controls. Trade reform of this kind was the cornerstone of reforms in Latin America in the 1980s and 1990s, as illustrated by the case study on Chile, and in developing transition economies following the breakup of the Soviet Union (Thomas et al. 1991). The policy objectives of this kind of reform are to increase the degree of competition and improve the efficiency of resource use in the economy (thereby raising the average level of income), and ultimately to increase the rate of growth and reduce poverty.

It is easy to see the connection between some of these policy actions and some of the intermediate objectives. Reducing import barriers obviously increases competition for domestic producers, reducing any monopolistic power they might have and putting pressure on them to become more efficient. Opening channels for imports of productive inputs and capital goods expands the set of available production technology for local industries, and liberalization that reduces domestic prices on consumer goods clearly benefits consumers directly.

Other links are less obvious, though no less important. Reducing import barriers encourages exports, but it does so indirectly. To the extent that increasing imports causes a reduction in the use of labor, capital and other resources by import-competing industries (either because the industries contract or because they are forced to become more efficient in resource use), these resources are released to be used by exporting industries and non-trade sectors. Another way to look at the process is that increased demand for imports causes an increase in the demand for foreign currency (which is necessary to buy imports), which bids up its price or domestic purchasing power – the “real exchange rate.” Since export industries generate foreign exchange, this real exchange rate effect benefits them. Of course, a country’s ability to take advantage of improved incentives and opportunities that may be opened by trade reform is conditioned by many other factors – some external, some under the government’s control and some a mixture. This will be discussed in more detail below.

All the cases identified here as general trade reforms are ones in which the government has consciously adopted a policy of fostering increased integration with the global economy and export-led growth through reduction of import barriers. China and Vietnam did this in anticipation of accession to the WTO, Madagascar accomplished it as

part of a structural adjustment program, and Chile and India took unilateral actions. In some cases, the policy measures also entailed explicit policies to support exports. For example, Madagascar allowed exporters to operate under a special policy regime that exempted them from certain regulatory restrictions and local taxes. Chile, on the other hand, relied very little on special treatment for exporters (other than some very general and small-scale support), relying instead on the impetus coming from reducing government interventions (including import barriers and tariffs) to boost exports. Since all case studies focus on specific products, they begin from the implicit assumption that the general equilibrium effects of these overall reforms work their way through the system and eventually have an impact on these particular markets.

As noted above, the macroeconomic real exchange rate effect of general trade liberalization also tempers the impact of product-specific liberalization. When foreign exchange in effect becomes more expensive, this raises the price of imports, all other things being constant, and benefits import-competing productive sectors. But, of course, in a general trade reform, all other things are not constant; tariffs are being reduced and non-tariff barriers relaxed, which tends to increase competitive pressure on producers of these products. In the face of these two offsetting effects, not all import-competing producers will feel an equal reduction in their incentives, and some may even benefit, if their sector is liberalized much less than others. So it is expected, for example, that a reduction of 40 percent in tariffs on corn as part of a general trade reform will not reduce the real domestic price of corn by 40 percent, but rather by something less, since some of the tariff reduction is counterbalanced by the real exchange rate effect. If, on the other hand, the tariff is reduced by 40 percent with no liberalization in other products, then one would expect that corn producers would indeed see prices decline by the full 40 percent.

The potential linkages between trade on the one hand and growth and poverty reduction on the other are many and complex, but the underlying intuition rests on two concepts fundamental to the modern theory of international trade – comparative advantage and factor price equalization. The first of these is the idea that when two countries trade freely, each will be relatively more efficient in producing the kinds of goods that intensively use the factors (e.g., labor, land, capital) that are relatively abundant (and therefore cheaper) in that country. Trade will therefore lead each to specialize in doing what it does best. The

second concept follows from the first. Because the intensive use of a factor increases demand for it, and so too its price, increased trade will cause the relative price of each factor to rise in the country in which it is most abundant. So, to take the simplest example, a country with a lot of labor and little land might produce vegetables – which require labor-intensive cultivation – most efficiently, while a country with a lot of land and not many people might specialize in wheat. Trade between the two would increase the demand for labor in the first (where labor is cheaper), raising its price relative to the price of land. Conversely, in the second country (where land is cheaper), the price of land relative to labor would rise. The factor prices would therefore tend to “equalize.”

Transfer of technology through foreign direct investment (FDI) or imported inputs can also be channels through which trade liberalization improves productive efficiency, as was the case in our studies of Chile, Madagascar, Vietnam and China. Other studies have also found this effect to be important. For example, transfer of agricultural technology “embodied” in inputs has sometimes been blocked by regulatory requirements on seed, fertilizer or machinery imports, with adverse effects on farmers (Gisselquist, Pray and Nash, 2002).

Applying these concepts to developing countries, one would expect that since labor – especially unskilled labor – is abundant and cheap, these countries would tend to specialize in products that use a lot of this labor, which in the end would raise incomes of low-wage laborers and thereby reduce poverty. In the real world, of course, things are not so simple, and there are many intermediate steps between changes in the incentive structure triggered by trade policy reform and the consequent effects on growth and poverty reduction. Many of the most important lessons from this project and other research on the effects of trade reform concern the institutional and legal framework necessary to make sure that this trade-poverty linkage works well. It should also be recognized that the labor intensity of a product is not measured only by the direct labor use – for example, labor used on-farm in growing an agricultural commodity -- but also by labor required to distribute inputs, process the primary product and bring it to market. This was underscored by several of our case studies (more below).

Similar considerations apply to the linkage between trade and environment. Traditional trade theory would predict that countries that have a relative abundance of

natural resources – true of many developing countries – would specialize in goods that use these intensively. The problem, however, is that often natural resources and environmental services are free goods with uncontrolled access. With no pricing mechanism to guide decisions, overexploitation is the likely result. In some cases, this may be done by the poor, creating a trade-off (in the short run at least) between poverty reduction and environmental damage. In the long run, at least some of these short-term win-lose trade-offs may turn into lose-lose situations, as environmental degradation kills the goose that temporarily laid golden eggs, leaving the poor even poorer. Again, many of the lessons of the project concern how to use institutions to prevent or mitigate this kind of adverse outcome.

For a trade event to result in behavioral changes in the markets for particular products, two basic requirements are (1) that the event be translated into changes in incentives for producers and consumers in that market; and (2) that conditions exist that allow these producers and consumers to respond. This study was not designed to examine in detail the transmission of trade policy reforms to changes in domestic prices, but it can be inferred from the fact that most case studies found significant producer response that the transmission mechanism generally functioned as expected.¹⁷ The case studies focused on the second link in the chain, i.e., from changes in incentives to economic response.

4. Outcomes from the case studies

The case studies were chosen partially because there appeared *ex ante* to be a relationship between trade-tied industries and resources drawn from vulnerable habitats. For this reason there is an emphasis on areas that have experienced export-led growth. Not surprisingly then, there is a tendency among the case studies to find that the trade events have worked to reduce poverty, while at the same time have placed additional demands on the resources that support fragile ecologies. Because of this selection process, the case studies are not in any sense a random sample of trade reform episodes and do not offer a balanced view of whether the environmental impact of trade on poverty or on the environment is generally positive or negative. They do, however, highlight instances where the need to find

¹⁷ The transmission mechanism has been examined in previous studies, such as Mundlak and Larson, 1992, or Baffes and Gardner, 2003.

sustainable solutions is most pressing and illustrate the ways in which trade effects may manifest themselves and the factors that influence this.

At this point it is also useful to say something about how outcomes are measured in the case studies. At the outset of the project, the study teams sought to develop comprehensive quantitative measures for trade, human welfare and the environment. For trade, emblematic measures included border tariffs and equivalents for subsidies or quantitative restrictions; for the environment, efforts were made to document the full and varied types of services provided by the studied ecology and to measure changes over time; and human welfare measures were sought that would supplement evidence on income. As a practical matter, the study teams often had to settle for more circumscribed measures. As will be discussed later, this speaks to the need for more comprehensive measures of important ecologies and the people who depend on them for their livelihoods.

Environment

The case studies illustrate two primary reasons why the fragile ecologies studied are undervalued and overused. The first has to do with externalities – benefits or costs that accrue to those who do not manage the resources. In most of the case studies, the studied ecologies generate non-market services that benefit local communities and, in some cases, provide global public goods. At the same time, mechanisms for valuing core resources and paying for their preservation are often lacking. Instead, market incentives, based on a partial valuing of the resource, determine use. A second, related issue has to do with difficulties associated with policing the use of natural resources. As a practical matter, firms and households were able to exploit many of the natural resources identified in the case studies with minimal restrictions, giving rise to overuse.

As discussed, many of the case studies focus on places that environmental scientists and the broader environmental community consider valuable and at risk. In several instances these environments provide the habitat for rare and diverse plant and animal populations and contribute significantly to the planet's biodiversity. For example, as mentioned, the Da Wei Shan Nature Reserve, the setting for the China study, is home to thousands of plant species and hundreds of animal species and the parks of the Sunderbans in India provide a sanctuary for rare wild tigers, dolphins, wild boar and estuarine crocodiles. The reserves provide ancillary services as well. The reserves in Da Wei Shan serve as catchments for

drinking water supplied to nearby municipalities and the forests there stabilize steep slopes that are prone to erosion. And the estuaries of the Sunderbans provide natural hatcheries for shrimp and other harvested sea life.

Still, as will be discussed later, the costs of maintaining the core environmental resources upon which global and local public benefits depend are not broadly shared. For example, farmers or fishermen operating in the mangrove forests of Vietnam or India are not directly rewarded for adopting approaches that preserve the rich biodiversity of the regions. Of course, were the full range of environmental services well known and their relationships with livelihood choices understood, it might be possible to devise resource management schemes that provide incentives for farmers and local communities to manage and maintain common-pool resources such as forests and estuaries at appropriate levels.

In practice, the natural resources at the center of the case studies are undervalued and under-protected and their overuse is well documented. The studies from Chile, China, and Madagascar all provide examples of how easy access to untitled forest lands leads to diminished ecologies. In the studies from India and Vietnam, commonly owned mangrove estuaries were converted over time for private use. In the South Africa case, the common property relevant to the study is water. Sugar is a thirsty crop that requires irrigation in the Incomati region. The authors suggest that, were water priced at its opportunity cost (i.e., its value to other users), it is doubtful that sugar would be grown in this area at all. And if it were, more water-efficient cultivation techniques would be employed. As a virtually free good, large quantities of water are used on a low-value crop, to the great detriment of the ecosystem and downstream users.

In most of the case studies, the problem of common resources is a long-standing one, and fundamental problems exist separately from the studied trade events. For example, the steady decline in the spiny forests of Madagascar or the loss of native forests in Chile occurred over time in response to growing demographic pressures and shifting cultivation.

Even so, because access to these common resources is largely unfettered, additional demands to serve export markets can accelerate their depletion. This is well illustrated in the case study from Madagascar, where land ownership is informal and use rights are conveyed by clearing or otherwise using the land. The authors of the study suggest that 10 percent of deforestation in the study area could be attributed to a temporary demand for maize exports.

Additional examples include an overharvesting of traditional plants and animals for domestic and export markets in Pingbian, China; by-catch losses of larval fishes and shellfish associated with the harvesting of wild prawn seed in the Sunderbans of West Bengal, India; the loss and fragmentation of mangrove habitat in Ca Mau, Vietnam, also partly associated with shrimp exports; and the potential loss of habitat from reduced river flows in the Incomati River Basin of South Africa, should sugar exports increase.

A similar problem arises when common resources can be polluted without penalty or cost. As in the earlier examples, trade does not lie at the root of the pollution problem; however, trade can give rise to incentives that result in increased pollution. Examples include the spread of disease through shared water resources in Ca Mau and the consequences of accumulated waste from caged salmon in Chile.

While trade liberalization can increase incentives for unsustainable exploitation of the resource base, some of the worst examples uncovered in the studies were caused by policies that created incentives against trade, generally in the cause of food self-sufficiency. The severest losses of the Madagascar spiny forest were in the anti-trade period of the 1970s and 1980s and were tied to the government's support for rice, which also encouraged slash-and-burn cultivation.¹⁸ Likewise, in Vietnam, particularly in the south, much of the lost mangrove area was initially cleared for rice cultivation or for charcoal, firewood and building materials in a period when government policy was striving for self-sufficiency. Similarly, in Pingbian, long-standing incentives to grow land-intensive crops on marginal and steeply sloped lands, which created severe erosion problems, were reversed as internal trade and external trade with Vietnam and Laos developed. Instead, farmers shifted their production to supply emerging markets for fruit and vegetables. Protection may also be largely responsible for the overuse of water for sugar production in the Incomati region, since it is doubtful that, without a protected domestic market, sugar would be grown there. It is nonetheless true

¹⁸ Citing earlier research by the World Bank (2003), Minton et al. (p. 10, 2006) note that "It is estimated that Madagascar lost about 12 million ha of forest between 1960 and 2000, effectively reducing forest cover by 50% in just 40 years.... The severest losses took place during the 1970s and early 1980s during the height of the socialist revolution when the practice of slash-and-burn agriculture was actively encouraged in order to produce more rice to feed the growing urban population. Since the mid 1980s, Madagascar has therefore been the focus of international conservation efforts with international development organizations providing loan and assistance programs explicitly aimed at environmental objectives."

however, that global liberalization could exacerbate this problem by raising world sugar prices. In contrast, regional trade liberalization, which would grant more access to South Africa's market for lower-cost producers in neighboring countries, would reduce domestic prices and discourage sugar production.

Importantly, even as the case studies focused on direct links between trade and resource use, several authors note that some of the most significant impacts were secondary effects tied to a shifting of labor resources from agriculture to other sectors. As is discussed next, such general equilibrium effects are closely tied to economic growth and poverty reduction; however, important effects on the environment were noted as well. For example, in China, an out-migration of labor helped ease pressures to convert additional lands and harvest fuel from public forests. In contrast, migrants were attracted to study areas in Madagascar and Vietnam, placing additional strains on those ecologies. Moreover, the authors predict that the entry of new industrial activity in Pingbian will give rise to problems associated with water and air pollution.

Poverty

As the previous discussion indicates, the case studies provided several examples of how trade policy, in combination with other policies and events, can increase employment opportunities locally and in other parts of the economy. Consistent with this, most case studies reported general national declines in poverty levels during the study periods as well as local improvements. For example, rapid economic growth across China was matched in Pingbian, where economic growth led to significant declines in poverty. Similarly, economic growth in Vietnam was matched with improved incomes and declining poverty in Ca Mau. In the maize-growing areas of southwest Madagascar, declines in poverty were less pronounced, but evidence suggests that poverty fell more rapidly there than in other parts of the province.

Even so, the studies suggest that not everyone benefited from economic growth. In Chile, significant reductions in rural poverty nationwide mask remaining regional differences. Moreover, even where poverty reductions have been significant, absolute poverty levels remain high. For example, the authors note that poverty levels in Pingbian and southwest Madagascar remain at 61 percent and 73 percent, respectively.

Generally, the studies suggest that differences in household access to assets, such as capital and land, partly determined the degree to which families were able to take advantage of economic opportunities. For example, the studies from India and Vietnam found that farmers with access to land benefited directly from new shrimp export markets. Moreover, those with better access to capital were able to take advantage of more profitable production technologies. In contrast, benefits for unskilled landless workers were less direct and came from employment in soil preparation for ponds, sludge removal, caring for shrimp, processing companies and transportation. Nevertheless, the Vietnam study noted that more than half the households in a survey of the region said this kind of aquaculture-related income was increasingly important to them. In Madagascar, a select group of households with landholdings near the Export Processing Zone were the primary beneficiaries of farm contracts linked to exports.

Importantly, the studies suggest that access to natural resources mattered as well. For example, in Pingbian, rainfall and soil conditions determined the extent to which households could convert to more profitable crops. In South Africa, the authors note that access to land and water resources largely determines livelihood strategies and income among the poor in Incomati. The case studies also suggest that, to a degree, poor households were able to supplement incomes limited by access to private assets by drawing on natural common-pool assets. For example, in India, a large number of poor landless households generated income by harvesting wild prawn larvae. In Pingbian, some households earned a portion of their livelihood from harvesting herbal plants from surrounding forests. In Vietnam, households with limited access to capital relied more heavily on tidal flows and natural food sources to raise shrimp for sale into export markets.

The study on Chile, which covered a much longer time period, illustrates how the links between trade and income can also evolve with time. The Chile study found that growth was at first driven by export-oriented primary production, but over time it became increasingly driven by resource-based manufacturing, processing and upstream service and input supply, with increased value added. This is consistent with a study of agricultural growth in Chile, which found that the biggest poverty impacts came not from farming itself, but from the development of these related upstream and downstream activities (Valdés and Foster, 2003).

Trade, local livelihood choices and environmental consequences

As mentioned, the case studies feature uncommon ecologies that support diverse habitats. As the case study authors emphasize, these same ecologies, in combination with a variety of factors, including markets for traded goods, give rise to local livelihoods. Importantly, the case studies find that it is the interaction between the local ecology and livelihood choices that largely determines how broad changes in trade or other policies translate into a given set of outcomes for vulnerable ecologies and households. Said differently, trade events shape poverty and environmental outcomes by influencing production decisions and livelihood choices.

In particular, as suggested in the previous section, many households that live in close proximity to important ecologies craft livelihoods by drawing on the same resources that support valuable habitats and other local environmental services. They do so in combination with other private and public assets, such as household labor, capital and public infrastructure. Because households differ in their range of accessible assets, different livelihood strategies and different production choices will emerge, even in the same community. In turn, different livelihood choices will have different consequences for income and will also place differing demands on local ecologies.

A good example is found in the Vietnam study, alluded to above. The authors point out that a variety of farming methods are used to raise shrimp in Ca Mau, but note that many poor farmers, who lack the capital to build shrimp ponds, choose an extensive farming method that relies partly on food sources and tidal flows provided by local estuaries. In contrast, many wealthier farmers with better access to credit employ more input-intensive production methods that are also more profitable. Just as each approach has different economic consequences, each approach places different strains on the local ecology. For example, the extensive systems operate using open sluices and shared water systems. Consequently, pollution sources, while generally low, are shared among all producers and local estuaries. The same is true of disease, and so the risk of epidemic is high. In contrast, more intensive production systems provide better contamination controls but also employ higher chemical concentrations that can spill into local estuaries. Moreover, pond sludge accumulates more quickly when intensive methods are used, resulting in problems related to blocked drainage systems and higher levels of water pollution.

The other side of the same coin is that, because household and firm dependence on natural resources differ, policy changes that limit access to overused natural resources will have greater effect on some firms and households than others. This can create a quandary for policy makers when a large number of dependent households are poor. In such cases, even though in the long run it is in the interest of the poor who depend on ecological services to preserve them, taking steps to better safeguard natural resources can, in the short run, adversely impact the livelihoods of those least able to adjust. By way of example, the authors of the South Africa study argue that, while sugar firms are geographically diversified in South Africa, smallholder producers are not and would be hard hit by a policy that more appropriately prices scarce water resources in the Incomati River Basin. Similarly, the study from India notes that the poor without land and resources who harvest wild shrimp larvae in the Sunderbans also depend most on access to estuarine resources.

5. How can policy condition outcomes?

As discussed, the consequences of trade reform for specific ecologies and for the poor can be driven by a combination of international and national market outcomes and also by decisions taken by local communities, firms and households. Indeed, it is this large set of determinants and the complex way in which they interact that makes outcomes hard to predict. Even so, lessons drawn from the case studies indicate that predicting the outcomes from trade policy changes is less crucial than putting in place safeguards that protect vulnerable ecologies and households from a wide range of adverse outcomes and finding policies that broaden participation in economic opportunities.

As the previous discussion suggests, understanding how the physical features of the studies' ecologies combine with market incentives and local livelihoods to affect poverty and the environment is crucial for the formulation of policy. At the same time, not all determinants are mutable and responsive to the instruments available to policy makers. In this section we focus on four areas suggested by the case studies whereby policy can influence poverty and environmental outcomes related to trade. These focus on (1) how market institutions determine the range of new economic opportunities stemming from trade reform; (2) how government programs that provide public goods can complement economic opportunities arising from trade and lower the hurdles that preclude participation by the poor; (3) the role institutions can play in building knowledge about important natural

resources, the services they provide and their relationship with the livelihoods of the poor; and (4) resource management approaches and the role institutions play in safeguarding vulnerable ecologies and people.

Market institutions

Overall, factor market institutions seem to be especially important in transforming the potentially beneficial economic impacts of trade reform into actual growth and poverty reduction on the ground.¹⁹ In turn, governments play an important role in establishing the legal framework upon which markets depend. Governments and informal institutions can also introduce programs to help markets work better. The case studies provide several examples.

Good legal frameworks for labor and land markets reduced barriers to factor mobility and underpinned Chile's growth. This case stressed the "importance of migration to translate economic growth into poverty reduction" and found that those without mobility were at a significant disadvantage. Chile's legal framework facilitated the movement of labor and land resources, which allowed the smooth transfer of resources from contracting to expanding industries and areas. Labor mobility is particularly important to help equilibrate wages and ensure that benefits are not confined to areas or activities that are direct beneficiaries of trade reform. Fluid labor markets are also important to enable industrial restructuring that is necessitated by reform. Chile's forestry industry, for example, was a heavily protected, inefficient producer before the reforms, but with some restructuring it was able to transform itself into a competitive exporter.

In China also, ancillary policies improved labor market mobility. The government helped organize migrant workers and enacted policies to retain property rights for migrants, so they could leave their villages temporarily without fear that their property would be taken away. This encouraged off-farm employment and diversification of income sources, helping to spread the benefits of trade reforms even to very remote areas and reducing income inequality. India's shrimp farming development, which brought large economic benefits to

¹⁹ By institutions, we mean the formal and informal economic rules of the game (North, 1990). Institutions that permit broad economic participation, enforce contracts, protect property and speed the dissemination of information are expected to be particularly important.

one of the poorest areas in India, was facilitated by a fluid land rental market. Failed market institutions were noted as well; in South Africa, researchers conclude that ongoing weakness in the land tenure system there creates uncertainty and thereby reduces farmers' ability to invest and diversify out of sugar. The Chile study reports that the failure to resolve land-use disputes in the forestry sector led to conflicts among indigenous people.

The studies also noted the importance of traditional and informal market institutions. For example, in India, traditional middlemen, known as *arattidars*, helped organize and finance dispersed markets for wild prawn seed. In a similar way, informal cultural ties between the Miao people of Pingbian and the Hmong people of Laos and Vietnam facilitated the creation of new markets once trade barriers had been removed.

The case studies suggest that international institutions and their influence on international markets are important as well – for better or worse. Some of the positive drivers have already been mentioned. International consumer pressure transmitted to Chilean producers through global value chains was instrumental in upgrading environmental standards for exports. Free trade agreements also had this effect. Contract farming arrangements set up through direct investment provided both capital and technology and were environmentally friendly and effective in reducing poverty in Madagascar and China. Contracts to deliver vegetables to European supermarkets from Madagascar address employment practices and hygiene standards. Foreign direct investment also played a key role in Chile. Other drivers have been part of the problem, rather than the solution. High and changing standards (sanitary and phytosanitary, labeling requirements) present challenges for shrimp producers in India and farmers in China. US anti-dumping duties have heavily penalized Vietnamese shrimp farmers.

Some of these international institutions are driven by government policy, but many are market-driven. One lesson coming out of recent research (Jaffee, 2005) is that while standards are sometimes used by governments as protectionist non-tariff trade barriers (in principle subject to challenge under WTO rules), relatively strict standards in global markets related to quality, labor or environmental standards are often driven by the private sector (not subject to challenge under WTO rules). These can serve as constructive catalysts for change, although producers faced with standards-related barriers should weigh the costs and benefits associated with participating in different market segments before embarking upon

programs to upgrade production standards. In some cases, producers may have profitable opportunities to service the domestic market, the regional market or market segments in industrialized countries that impose less stringent standards or allow more time to implement certain measures. Similar considerations should apply to governments' decisions to make necessary public sector investments. But, in any case, experience demonstrates that it is much better to actively plan ahead, rather than respond to crises.

Targeted programs and public investment

While broad changes in policy and broad support for institutions and markets are often crucial for creating new economic opportunities, the case studies illustrate how targeted policies and investments can extend the reach of market incentives and complement private investment. This is especially true of programs designed to lower entry hurdles. In general, the most effective programs identified in the case studies focused on information and technology dissemination or on the provision of particular types of services and infrastructure.

The case studies from Chile, China, India and Vietnam illustrate how private entrepreneurs are often the first to identify new economic opportunities, making use of informal networks for information and investment capital. Subsequently, state and local governments recognized the potential of new trade opportunities as a vehicle for growth and moved to disseminate information about markets and about production technologies. In the case of Chile, the government trade group, ProChile, helped with market identification and product promotion overseas. In India and Vietnam, the provincial government sponsored technical research programs and provided extension services. In some cases, private firms provided information on production technologies and other extension services through contracts. The already-mentioned case of vegetable exports in Madagascar is one example; another example from the South African study is services provided to smallholder sugar producers by the Tsb sugar mill.

In some cases, state or local governments also invested in transportation or irrigation systems. For example, the Vietnam case study explains that the decision to ease restrictions on converting rice land was coupled with investments in irrigation systems and hatcheries as well as extension services. In South Africa, the Nkomati Irrigation Expansion Program provided irrigation infrastructure investment for smallholder farmers. In India, the state

government established a development agency specifically charged with assisting shrimp farmers.

At the same time, programs that are poorly designed can be wasteful of public resources and can encourage unsustainable activities. For example, the development agency in West Bengal not only invested in public services, such as irrigation and road systems, training and extension, but also took on additional tasks such as distributing fishing nets and providing housing, which might have been left to the private market or supported through targeted instruments designed to benefit poor households regardless of their participation in the shrimp industry.

Institutions and knowledge building

As discussed, natural resources of the type covered by the case studies provide a range of environmental services. In cases where the benefits of these services accrue exclusively to individuals or cohesive groups, markets can be relied upon to properly value and preserve the underlying resources. In other instances, when natural resources provide benefits to a larger community, markets alone are insufficient and alternative methods for preserving core resources must be devised. Doing so, however, requires understanding of the full range of services provided by the resources and how they can be sustained. At an international level, this entails identifying the role the local resource plays in the global ecology. Locally, an understanding is needed of services provided to local communities as well as the ways in which the welfare of the local households and firms depends on the local ecology. This effort includes understanding especially the incentives and constraints households face and the consequences of household choices for incomes and for the local environment.

Public resources for conservation are limited and the case studies generally find that international and national groups, both government and non-government, have been effective in identifying priority areas. The case studies illustrate how past efforts to use science-based criteria to determine where best to focus conservation efforts have affected national and international policies regarding how core natural resources are protected. It is noteworthy that national and state governments have moved to provide some measure of protection to all of the ecologies in the study. Past research establishing priorities for conservation also influences subsequent research by scientists and social scientists. A case in

point is the selection of case studies reported in this essay, which highlight ecologies that are considered vulnerable and important by conservationists.

Another aspect of knowledge building has to do with the construction of basic measures that can be used to quantify existing conditions, changes over time and the relationships between policy and outcomes. To conduct their analysis, the authors of the case studies looked to find measures of human welfare, of environmental impact and of the relationship between the two. Their stocktaking suggests that the state of these measures is uneven and sometimes weak, especially with regard to environmental measures over time. For this reason, many of the research teams found it difficult to fully quantify changes in core natural resources over time or in the services that they provide. For the same reason, the research teams found that broader measures of human welfare that take into account the consequences of air or water pollution were hard to determine. Very broadly, the researchers were generally able to document changes in income and poverty over time by drawing on national and regional surveys. Moreover, economic data on local production and income sources were sometimes available; for example, time-series data in China

Less available was information that would allow the researchers to quantify the types of provisioning services provided by the studied ecologies and to measure changes in those services over time and their impact on human welfare. For example, while environmental services such as the provision of drinking water or biodiversity from the Da Wei Shan Nature Reserve in Pingbian are noted, baseline measures from which the authors could draw comparisons are lacking. In India and Madagascar, for example, focus groups and surveys were used to provide broader measures of human welfare, but comparisons over time were based on recall and subject to error. For this reason, many of the conclusions about environmental degradation over time are based on deforestation maps. In their efforts to evaluate the environmental impact of increasing sugar production in Mpumalanga, the research team from South Africa concluded that “little is known about ecological thresholds and reversibility of environmental damage in Incomati.”

Managing vulnerable ecologies

The case studies describe several mechanisms currently in place to manage natural resources. At a fundamental level, these systems are intended to properly value the broad range of services that ecologies provide and to preserve the core resources that provide those

services. As discussed, one key aspect of preserving those resources is to limit access to common-pool resources in a way that precludes a tragedy of the commons. In principle, one way to do this is to charge an appropriate price for the use of the resource to “internalize the externality,” but as discussed earlier, examples of this in developing countries are rare in practice and experimental in nature. The authors of the India case study mention this possibility but conclude that it would be impractical given current institutional shortcomings.

Another approach to managing natural resources is to grant some form of ownership over a common-property resource – thereby creating an incentive for the owner to conserve it. In the traditional systems identified by the case studies, group ownership is implied and group leaders are obligated to ensure that resources are used in a sustainable way. Examples from the studies include the role of traditional authorities in Madagascar and India. Still, these informal arrangements can be fragile. In particular, evidence from Madagascar suggests that some types of internal migration can result in reduced social cohesion that undermines traditional institutions.

A more common approach is to create formal institutions that provide title or other use rights. Conceptually, such rights could be granted to groups rather than individuals; this was the idea behind the Gelose program in Madagascar. More commonly, resource management approaches identified in the case studies involved private use rights, usually in connection with restrictions on how the resources can be used. In the case of some natural resources, private ownership can go a long way to solve the problem of overuse. An example is the contract-farming case study from Madagascar, which illustrates how private ownership creates incentives for farmers to adopt practices that preserve soil fertility. More generally, positive or negative externalities are sometimes associated with the private use of natural resources, which has motivated restrictions on their use. Often, regulations are intended to stem specific pollution problems. For example, the study from South Africa notes that sugar mills are required to cool water used in processing before returning it to rivers in order to stem thermal pollution in natural habitats; in India, the Supreme Court intervened to limit particular technical approaches to shrimp farming because of adverse environmental consequences. In Ca Mau, the government stepped in to ban the use of certain types of antibiotics in shrimp production.

However, because ecological systems of the type studied are complex, their preservation usually requires more than restricting certain forms of private use. One approach, well illustrated by the case studies, is to establish a mix of private use areas combined with public areas held in reserve. This method of juxtaposing wildlife preserves and buffer areas is illustrated in the case studies from India where parts of the Sunderbans are set aside as preserves, with restrictions on how adjacent land is used. In Vietnam, households were assigned 7.4 to 24.7 acres of mangrove forestland under the condition that 70 percent of the forest was to remain intact. The studies suggest that the success of mixed-use strategies depends significantly on the institutions, formal and informal, charged with policing differentiated use. For example, the authors of the study in Vietnam suggest that restrictions on use were not well designed or fully enforced.

As discussed, when the poor have come to depend on natural resources, tightening access to common resources can impose a cost on already vulnerable households. One solution illustrated by the case studies is to couple restrictions on use with compensation combined with efforts to provide an alternative livelihood. For example, the China case study documents two programs designed to reforest slopes through cash buyouts and resettlement programs; the case study from Chile also examines incentives for private firms to plant trees on new lands or lands that were formerly forested. Similarly, the Vietnam study notes that a resettlement program was used to reclaim 39,500 acres of mangrove forest.

As the examples above illustrate, resource management strategies rely heavily on a combination of social norms and formal rules and on organizations charged with enforcing them. In many instances, it falls to national and local governments to create and support these institutions, and the case studies provide examples of practical difficulties that frequently arise.

For one, institutional arrangements of all types tend to lag behind economic and environmental events – an outcome consistent with endogenous regime models. For example, in Chile a general legal framework for fisheries and aquaculture did not appear until 1991, despite rapid growth in the subsector during the previous 10 years, and significant environment regulations were not in place until 1996. Likewise, forestry regulations and programs to protect fragile soils and the rehabilitate degraded land in Chile were not enacted until 1998. Once in place, the study authors conclude that the institutions have operated

fairly effectively and that the environmental impact of Chile's forestry and salmon sectors has been relatively neutral. The institutional arrangements have developed along different models – more self-regulation in the salmon industry, for example – and while the authors suggest that some of the institutions (CONAF, the forestry regulator, is mentioned) could be improved, they conclude that the institutions are performing their intended role in general. Similarly, the authors of the Vietnam study note that mangrove forests in Ca Mau were afforded protection only after significant loss had already occurred. Moreover, they note that while governments of various levels provided early assistance to expand shrimp production, the pollution consequences were largely unanticipated, and relevant regulations have been introduced in a catch-up manner.

In other cases, the institutions charged with enforcement or implementation are missing or have been under funded. For example, the Madagascar team notes governance problems with the Gelose program. Moreover, the team notes that only 3 percent of Madagascar's spiny forest is protected, despite its importance as a habitat for endangered plants and fauna.

More fundamentally, however, most of the management systems described in the case studies are partial and reactive. This is not surprising, since lessons from the case studies suggest that the tasks required to put in place a comprehensive system are challenging. For one, the job of measuring the full range of services and the role they play in the lives of vulnerable households is incomplete, as is the job of building quantitative baselines to measure progress. Moreover, the number of stakeholders is large for the type of ecologies studied. Resolving competing objectives and implementing any resolution is likely to involve a large number of local and nonlocal institutions, some of which must be built up from scratch. Consequently, the potential for coordination failures is high.

The case study from the Incomati River Basin illustrates the large set of stakeholders that are often associated with important natural resources and the complex task of consultation, policy formulation and implementation. To a degree, the task of managing the Incomati Basin's water resources was helped along because of previous international efforts to establish best practices. A set of guiding principles were articulated in the 1992 International Conference on Water and Environment and South Africa's 1998 National Water Act drew on these. Still, under the national legislation, it was necessary to establish a

hierarchy among a diverse set of users of urban and rural users, with a portion of water set aside as an environmental reserve. In parallel, a network of 19 catchment management agencies was created to reach agreement on how water resources from each catchment should be used. In practice, the authors suggest that representation on key advisory committees largely drives licensing decisions, a process that the authors argue favors status-quo outcomes that are inefficient and inequitable. In particular, they argue that South Africa's three-tiered structure that spreads the tasks of policy making and policy implementation among national, provincial and local stakeholders is impractical because of weakness among local institutions and agencies.

6. What stands in the way of better policy?

The case studies provide further evidence that some of the world's most biologically diverse ecologies are being used in unsustainable ways. Further, the studies suggest the reason for this has to do in part with a range of non-marketed services provided by ecologies that make natural resources difficult to properly value and to secure. When trade events occur, the weakness of existing protections is often revealed as new demands for market-related services are added. In the same way, the weak protections have given rise to livelihoods that rely on ecologies in unsustainable ways. For the poor, this dependency is especially crucial because, lacking private assets, they depend more on common-pool assets. At the same time, broad policies related to trade or to poverty reduction are unlikely to realign incentives or adequately safeguard vulnerable ecologies. Instead, the studies suggest that strong institutions that operate locally and that find support across a wide range of stakeholders are needed to manage fragile ecologies and the livelihoods that depend on them. This task of building such institutions is challenging, but the studies indicate areas that should be priorities for policy makers and conservationists.

Most basic is the need to build a better understanding of the services natural resources provide, the livelihoods of those that depend on them and what is required to sustain them. Especially important for this are improved measures of ecological services that do not enter markets, including such services as water purification or the provision of biologically diverse habitats. This is a first step in arriving at sensible resource management solutions and such measures are also essential to assess the success or failure of current and future policies. As the case studies point out, it is also important to develop information

about the livelihoods of people living in and near vulnerable places and the consequences of choices for incomes and for the environment. In particular, the case studies point out the value of understanding the consequences of alternative production technologies and barriers the poor might face in choosing among them.

A second task, which builds on the first, is to create and strengthen institutions that match the range of global and local market and non-market services associated with key ecologies. In the case of market, the case studies point out that strong market institutions and more targeted public programs and investments can help poor households participate in new economic opportunities when they arise. In the case of non-market services, the studies provide several examples of how partial steps, such as contract farming or regulations on specific production technologies, can be useful and important for conservation. Even so, the case studies suggest that in most instances holistic resource management schemes are needed to adequately protect core environmental resources. One frequently noted obstacle stems from weakness in the types of local institutions required for an integrated management scheme. Such institutions are especially important, since many of the trade-offs among management and production choices play out contentiously at the local levels. Moreover, some of the most costly and difficult tasks, such as policing and monitoring common natural resources, often fall to local governments and organizations. For this reason, the successful implementation of policy is often crucially linked to the strength of institutions with a local presence.

This suggests a third key task of finding ways to share the costs of creating and disseminating knowledge, of building institutions and of providing safety nets for vulnerable households that are hurt by changes in trade or resource management policies. As the case studies explain, local ecologies often benefit larger communities in many ways. This is true for local municipalities that benefit from the provision of fresh water and for those in the global community that value biodiversity. Still, to a large degree, the costs of institution building and policy implementation fall to local governments and organizations. Similarly, misaligned incentives and the inadequate protection given common pool resources permits and sometimes encourages poor households to take up livelihood choices that degrade local ecologies. The case studies provide successful examples of programs that help households transition to sustainable practices, but such programs generally depend on financing from a

central government or the international community. Finding and funding ways to encourage livelihood choices that are sustainable has great potential to address the vulnerabilities of households and ecologies.

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