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Natural Capital, Ecological Scarcity and Rural Poverty

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Abstract

Much of the rural poor—who are growing in number—are concentrated in ecologically fragile and remote areas. The key ecological scarcity problem facing such poor households is a vicious cycle of declining livelihoods, increased ecological degradation and loss of resource commons, and declining ecosystem services on which the poor depend. In addition, developing economies with high concentrations of their populations on fragile lands and in remote areas not only display high rates of rural poverty, but also are some of the poorest countries in the world today. Policies to eradicate poverty therefore need to be targeted at the poor where they live, especially the rural poor clustered in fragile environments and remote areas. The specific elements of such a strategy include involving the poor in payment for ecosystem services schemes and other measures that enhance the environments on which the poor depend; targeting investments directly to improving the livelihoods of the rural poor, thus reducing their dependence on exploiting environmental resources; tackling the lack of access of the rural poor in less favored areas to well-functioning and affordable markets for credit, insurance, and land; and reducing the high transportation and transaction costs that prohibit the poorest households in remote areas from engaging in off-farm employment and limit smallholder participation in national and global markets.

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Introduction

Much discussion is occurring in the international community about policy strategies for promoting a transition to a green economy, or "green growth" (Barbier and Markandya 2012; Hallegatte et al. 2011; OECD 2011; UNEP 2011). A typical definition is that "green growth means fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies" (OECD 2011, p. 9). However, if such a goal is to have relevance for low and middle-income economies, it must also be compatible with the most important development objective for these countries, which is poverty alleviation (Dercon 2011). But in developing economies many of the rural poor – who are growing in number – are increasingly concentrated in ecologically fragile and remote areas (Barbier 2010). This particular structural feature of underdevelopment remains a paramount obstacle to any transition to sustained economic growth – green or otherwise – for much of the developing world.

The purpose of this paper is to argue the case for a new strategy for overcoming the pervasive problem of ecological scarcity and poverty in many rural areas of developing economies. To make the case for such a strategy, the paper first reviews the evidence on the location of the rural poor, and especially their concentration in ecologically fragile and remote areas. Economies with large shares of their population in such locations not only have high incidence of rural poverty but also are generally poorer. This evidence suggests that tackling this structural problem of the geographical clustering of impoverished households in marginal and remote areas with poorly integrated and functioning markets should become more of a focus for development policies.

However, management of natural capital is not sufficient for eradicating persistent rural poverty in developing economies. To understand why, the paper explores the typical conditions of the "asset-less" poor in remote and ecologically fragile areas. The poorest rural households have very few productive assets, except land and unskilled labor, yet permanent migration is rare. Given the lack of ownership of assets, and the tendency of poor households in remote areas to stay where they are located, their livelihoods are often dependent on exploiting the surrounding environment and its ecological services for survival. But if access to outside markets and jobs is inadequate, the land available is unproductive, and the surrounding environment becomes degraded, then income opportunities remain poor and the surplus available for investing in land improvement or other asset acquisition also are negligible. In short, these poor households are prone to a poverty-environment trap (Barbier 2010).

Overcoming such constraints and alleviating rural poverty will require a much more robust strategy than simply reliance on improvements to natural capital as an effective pathway

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out of poverty. Specific policies need to be targeted at the poor where they live, especially the rural poor clustered in fragile environments and remote areas. This will require a variety of measures including involving the poor in these areas in payment for ecosystem services, targeting investments directly to the rural poor, reducing their dependence on exploiting environmental resources, and tackling their lack of access to affordable credit, insurance, land, and transport. Where possible, efforts should be made to boost rural employment opportunities, especially for those poor households dependent on outside labor employment. These measures can complement other actions to improve livelihoods by increasing economic mobility, including physical or institutional migration out of low-return agriculture and the informal sector.

Ecological scarcity and poverty in poor economies

From an economic perspective, ecological scarcity has been defined as the loss of myriad benefits, or "services", as ecosystems are exploited for human use and activity (Barbier 1989, pp. 96-7; see also Barbier 2011, ch. 9). Certainly, at a global level, ecosystems and their services are in decline. An important indicator of the growing ecological scarcity worldwide was provided by the Millennium Ecosystem Assessment (MA 2005), which found that over 60% of the world's major ecosystem goods and services were degraded or used unsustainably. Some important benefits to humankind fall in this category, including fresh water, capture fisheries, water purification and waste treatment, wild foods, genetic resources, bio-chemicals, wood fuel, pollination, spiritual, religious and aesthetic values, and the regulation of regional and local climate, erosion, pests and natural hazards.

For many developing economies, ecological scarcity also is manifesting itself in another way – it is contributing to the economic vulnerability of the rural poor. Increasing ecological scarcity is disproportionately affecting the world's poor in rural areas, who depend critically on many ecosystem goods and services for their livelihoods (Barbier 2005 and 2010; MA 2005; TEEB 2010; Wunder 2008). As shown below, many of the world's rural poor continue to be concentrated in the less ecologically favored and remote areas of developing regions, and their livelihoods are intricately linked with exploiting fragile environments and ecosystems (Barbier 2005 and 2010; Bird et al 2002 and 2010; Comprehensive Assessment of Water Management in Agriculture 2007; CPRC 2004; Dercon 2009; Fan and Chan-Kang 2004; Sunderlin et al. 2008; World Bank 2003 and 2008). Such conditions often result in *spatial poverty traps* – geographic pockets of poverty, marginalization and disadvantage (Barrett 2008; Bird et al. 2002 and 2010; Jalan and Ravallion 1997 and 2002; Kanbur and Venables 2005). The clustering of poor rural populations in less-favored areas and fragile environments that are located far from market centers is also likely to continue into the foreseeable future, given current global rural population and poverty trends (Chen and Ravillon 2007; Dercon 2009; Population Division of the United Nations 2008).

Since 1950, the estimated population in developing economies on "fragile lands" prone to land degradation has doubled (World Bank 2003). These fragile environments consist of upland areas, forest systems and drylands that suffer from low agricultural productivity, and areas that present significant constraints for intensive agriculture. Today, nearly 1.3 billion people – almost a fifth of the world's population – live in such areas in developing regions (Barbier 2011, Table 9.10). Other estimates suggest that poor people in developing countries are predominantly found in areas with the greatest potential for land and water degradation; i.e., land with highly

weathered soils, steep slopes, inadequate or excess rainfall, and high temperatures (Comprehensive Assessment of Water Management in Agriculture 2007). About 630 million of the rural poor live on these unfavorable lands in the developing world, whereas just under 320 million of the poor have access to favored lands (Comprehensive Assessment of Water Management in Agriculture 2007, Table 15.1).

Figure 1 further illustrates that rural poverty is correlated with the fraction of the population in developing countries found in degradable and poor quality lands. As the figure indicates, for a sample of 92 low and middle-income economies, the incidence of rural poverty rises with the share of the total population concentrated on fragile lands. Although the average poverty rate across all economies is 45.3%, the rate falls to 36.4% for those countries with less than 20% of their population in fragile environments. For those with more than 50% of their populations in marginal areas, however, the incidence of rural poverty rises to 50% or more.

The tendency for the rural poor to be clustered in more marginal environments prone to land degradation and poor productivity is also supported by studies at the regional and country level, although important differences exist within and between countries. Such a "poverty-environment nexus" appears to be prevalent in three of the poorest countries in Southeast Asia – Cambodia, Laos and Vietnam (Dasgupta et al. 2005; Minot and Baulch 2002). In Cambodia, the core poor in rural areas appear to be located in areas that are already heavily deforested, although poor populations tend also to be more concentrated in the lowlands rather than steeply sloped lands. In Laos, the poorest rural provinces in the north and northeast also have the highest incidence of poverty, with poor households located mainly in forested areas and the highlands. In Vietnam, large poor populations confined to steep slopes exist in the provinces comprising the Northern and Central Highlands, but extensive rural poverty is also found along the North Central Coast and the Red River Delta.

Despite its robust growth and reduction of poverty overall, China has seen rural poverty persist and concentrate geographically in the relatively poor agricultural areas of the west and southwest (Gustafsson and Zhong 2000; Jalan and Ravallion 2002; Olivia et al. 2011; Ravallion and Chen 2007). In general, households living in the lowlands and plains are less poverty prone than those living in hilly and mountainous regions, which contain less productive and more degradable land. As poverty declines in coastal and lowland areas, the rural poor are increasingly found in upland areas. There are still more than 100 million rural poor in China living on less than $1 per day, and most of them live in western, inland China in mountainous areas with low rainfall or on marginal lands with low agricultural potential (Olivia et al. 2011). For example, the proportion of China's rural poor living in the mountains increased from less than one-third in 1988 to a majority in 1995 (Gustafsson and Zhong 2000).

A study of the spatial pattern of rural poverty in Bangladesh concludes that "the pockets of high poverty incidence generally coincide with the ecologically poor areas" (Kam et al. 2005, p. 564). Overall, four such areas could be considered poverty "hot spots" in Bangladesh: the low-lying depression area in the north east; the drought-drought prone upland area in the north west; several flood-prone subdistricts fringing major rivers; and several of the subdisticts in the south eastern hilly regions. A similar poverty mapping exercise in Sri Lanka reveals that regions with lack of availability of water and poor quality land are most associated with high rural poverty and food insecurity (Amarasinghe et al. 2005). Poverty mapping in Syria indicates that rural areas with shallow soils or unfavorable topography, such as steep slopes, generally display lower regional income levels (Szonyi et al 2010). In Mexico, the rural poor are also concentrated

in particular regions, especially those with marginal lands (Bellon et al. 2005). Poverty is especially concentrated in mountainous regions in central, southern and northwest Mexico. As the authors note, "these 'islands' of poverty exhibit specific circumstances such as the presence of indigenous populations, higher rainfall, steep slopes, erodible soils and lack of access to services", reflecting that these areas are both ecologically fragile and remote (Bellon et al. 2005, p. 489).

Much of Africa's population, and its rural poor, are located in ecologically fragile regions of landlocked, resource-scarce countries (Collier 2007; Fan and Chan-Kung 2004). But even in coastal African economies, the rural poor continue to be clustered in marginal environments. For example, in Kenya locations with poor quality soil, a high percentage of steep land and variable rainfall have much higher poverty levels among populations compared to areas with more favorable land and environmental conditions (Okwi et al. 2007; Radeny and Bulte 2011). Throughout Uganda, crop income is positively associated with soil fertility (Yamano and Kijima 2010). In Rwanda, even resource-poor households with low quality land that are located close to markets tend to have the lowest levels of income and consumption expenditures (Ansoms and McKay 2010).

The rural poor of developing economies also tend to be concentrated in remote areas, locations with poor market access and that require five or more hours to reach a market town of 5,000 or more (see Figure 2). Around 430 million people in developing countries live in such distant rural areas, and nearly half (49%) of these populations are located in less favored areas, which are semi and semi-arid regions characterized by frequent moisture stress that limits agricultural production (World Bank 2008). As indicated in Figure 2, developing countries that have a larger share of their rural populations located in remote rural areas also display higher rural poverty rates. Across 91 developing countries, the average (median) share of rural population in remote areas is 26.9% (19.0%), whereas the average (median) share of rural population in poverty is 45.2% (46.5%%).

Often, the remote areas containing the rural poor are also fragile environments with marginal lands for agriculture. According to Dercon (2006, p. 23), in Ethiopia, "the poor contain mainly households with poor endowments in terms of poor land, far from towns or with poor road infrastructure." Similarly, the western, inland and mountainous regions of China where the rural poor tend to be located are also remote regions that lack integration with major markets (Olivia et al. 2011). Remoteness is also a factor in the land-use poverty traps found in Amazonia, where isolated, subsistence-based shifting cultivation systems can lead to farmers failing to invest in perennial cash crops and forest fallows (Coomes et al. 2011). In Tanzania, rural poverty appears closely related to access to regional urban centers and markets rather than distance to roads or to the capital, Dar es Salaam (Minot 2007). In Rwanda rural households in remote rural areas are isolated from major markets and lack public services, and are among the poorest, attain low education levels and accumulate little farm capital (Ansoms and McKay 2010). In Uganda, distance to the nearest urban center and the poor quality of roads appear to negatively affect crop income (Yamano and Kijima 2010). Overall, the lack of integration of the rural poor in remote areas in regional and national markets is a major barrier preventing many smallholders to "break out of the semi-subsistence poverty trap that appears to ensnare much of rural Africa" (Barrett 2008, p. 300).

Developing economies with high concentrations of their populations on fragile lands and in remote areas not only display high rates of rural poverty but also are some of the poorest

countries in the world today. As indicated in Figure 3, for a sample of 104 low and middle-income economies, real GDP per capita declines sharply with the share of the population in fragile environments. For all economies, the average GDP per capita is $1,952, but for those economies with less than 20% of their populations on fragile lands, real GDP per capita more than doubles to $3,961. In contrast, for those economies with 50% or more of the population in fragile lands, GDP per capita falls to $822 or less. According to the World Bank (2012), the low-income, or poorest, economies of the world are those in which 2009 Gross National Income per capita was $995 or less. Similarly, as Figure 4 indicates, developing economies with a large share of their rural populations located in remote areas tend to be relatively poor. Across 104 countries, the average (median) share of rural population in remote areas is 26.9% (18.7%), and the average (median) share of real GDP per capita is $2,075 ($1,100).

The relationship between GDP per capita, rural poverty and the share of populations concentrated in fragile and remote areas is summarized in Table 1. The table includes 89 developing economies that have, on average, at least 20% of their populations located on fragile lands and 30% of their rural populations in remote areas. Across all economies, the average real GDP per capita is $1, 613 and the rural poverty rate is 47.3%. In addition, several important trends emerge from the table. First, more than half (48) of the countries are low-income economies with real GDP per capita of less than $1,000. Second, none of the economies with GDP per capita greater than $4,000 have more than 50% of their populations located in fragile areas. Finally, the table confirms that lower-income economies generally have more of their populations concentrated in fragile and remote rural areas and higher rural poverty rates.

The rural poor will continue to be clustered on marginal lands, fragile environments and remote areas, given current global rural population and poverty trends. First, despite rapid global urbanization, the rural population of developing regions continues to grow, albeit at a slower rate in recent years. From 1950 to 1975, annual rural population growth in these regions was 1.8%, and from 1975 to 2007 it was just over 1.0% (Population Division of the United Nations 2008). Second, the vast majority of the world's poor still live in rural areas, even allowing for the higher cost of living facing the poor in urban areas. In general, about twice as many poor people live in rural than in urban areas in the developing world (Chen and Ravallion 2007). Around 30% of the rural population in developing economies survives on less than $1 a day and 70% lives on less than US$2 a day, yet the respective poverty rates in urban areas are less than half of these rural rates (Chen and Ravallion 2007).

The "asset-less" poor and the environment

Because the rural poor of developing economies are often concentrated in ecologically fragile and remote locations, these areas can become significant poverty traps. To understand why, it is important to identify the typical conditions facing the "asset-less" poor in such regions that influence their use of available natural capital.

The poorest rural households in developing economies have very few productive assets (Banerjeee and Duflo 2007). First, land is one of the few productive assets owned by the rural poor, and almost all households engage in some form of agriculture, but the size of landholdings tends to be very small. Second, poor rural households tend to rely on selling their only other asset, unskilled labor. Agriculture is generally not the mainstay of most these households; instead, they generally obtain most of their income from off-farm work as agricultural laborers or

in unskilled paid work or occupations outside of agriculture. However, when households do engage in outside employment, they tend to migrate only temporarily and for short distances. Permanent migration over long distances for work is rare for most poor rural households (Banerjee and Duflo 2007). Thus, given the lack of ownership of assets by the rural poor, and their tendency to stay where they are located, it is not surprising that the livelihoods of the "asset-less" poor are often the most dependent on their surrounding natural environments.

The scale of this dependence may be very extensive in some developing regions. For example, in Southern Malawi households derive 30 percent of their income on average from exploiting "common" forests (Fisher 2004). Households that are especially lacking in land, education, and goat holdings are more reliant on "low return" forest activities, such as sales of "forest-based" crafts (bamboo baskets and mats, grass brooms, and wood-fired pots), roof thatching and brick-burning, sales of prepared foods and drink, sales of firewood and bamboo, and traditional medicines. Similarly, in both Cameroon and South Africa, the poorest households used more non-timber forest products, such as fuelwood, wild fruits, edible herbs and grass hand brushes, per capita than wealthier households (Gbetnkom 2008; Shackleton and Shackleton 2006). Such findings appear to be consistent with studies of income diversification across Africa, which show that the "asset-less" poor diversify into low-return activities based on exploiting common property environmental resources, but with little hope of escaping the "poverty trap" (Barrett et al. 2001; Dercon 1998).

This link between asset poverty, lack of income opportunities and resource extraction as insurance may be very significant in many tropical forest regions, where the livelihoods of the poor often depend on the extraction of biological resources in fragile environments (Adhikari 2005; Coomes et al. 2011; McSweeney 2005; Shone and Caviglia-Harris 2006; Pattanayak and Sills 2001; Sunderlin et al. 2008; Takasaki et al. 2004; Vedeld et al. 2004; Wunder 2001). For example, Vedeld et al. (2004) conduct a meta-analysis of 54 case studies globally of rural communities that live in or near tropical forests, and find that on average 22% of household income in these communities depends on forest resources. However, the proportion of forest income was significantly higher for poorer households (32%) compared to the nonpoor (17%). Similarly, López-Feldman and Wilen (2008) find that non-timber forest product use is mainly conducted by households in Chiapas, Mexico with low opportunity costs of time and fewer income generation opportunities. And, in Palawan (the Philippines), hunting pressure on fauna was shown to be inversely related to farm size and agricultural productivity, but positively correlated with labor availability (Shively 1997).

The state of the local environment may also affect how the poor utilize their resources, and in turn, their livelihood strategies. In India, Narain et al. (2008) find that, in villages surrounded by good quality forests, the poorest households depend on forest resources for as much as 41% of their income compared to 23% for the richest households. In areas where the forests are in a poor state, both the rich and poor's use common resources decline, but more so for the poor; both types of households depend on forests for only around 9 to 14% of their income. In West Bengal, almost 10% of the time of the average household is spent on gathering fuel, either for use at home or for sale (Banerjee and Duflo 2007). In general, throughout many tropical forested regions, there appears to be a relatively high dependence on forests for livelihoods in areas of high forest cover and high poverty, as poor households depend on the forests for both supporting their economic livelihoods and as a source of new land (Coomes et al. 2011; Sunderlin et al. 2008).

The range of choices and tradeoffs available to the poor, and their dependence on the surrounding environment, is also affected by their access to key markets, such as for land, labor, credit as well as goods and services, as well as the quality and state of the surrounding environment on which their livelihoods depend (Barbier 2005; Barrett 2004; Carter and Barrett 2006; Caviglia-Harris 2004; Dasgupta 1993 and 2003; Gray and Mosley 2005; Pattanayak et al. 2003; Reardon and Vosti 1995; Scherr 2000; World Bank 2008). As summarized by Dasgupta (1993, p. 475) "in rural communities of poor countries a great many markets of significance (e.g. credit, capital, and insurance) are missing, and a number of commodities of vital importance for household production (potable water, sources of fuel and fodder, and so forth) are available only at considerable time and labour cost." In the absence of local labor markets capable of absorbing all the poor and landless households looking for work, or well-functioning rural credit markets to lend needed capital, the landless and near landless in rural communities fall back on the use of common-property and open access resources for their income and nutritional needs. Because of missing or inaccessible markets, therefore, the "asset-less" poor often depend on exploiting the surrounding environment and its ecological services for survival (Barbier 2010). This is especially the case in remote rural areas, where local markets are isolated from larger regional and national markets and essential public services are lacking (Barrett 2008).

Lack of assets and access to key markets may also constrain the ability of poor households to adopt technologies to improve their farming systems and livelihoods. In conducting a meta-analysis based on 120 cases of agricultural and forestry technology by smallholders across the developing world, Pattanayak et al. (2003) find that credit, savings, prices, market constraints, and access to extension and training, as well as tenure and plot characteristics, such as soil quality and landholding size, are important determinants of adoption behavior. Not surprisingly, the result is low adoption rates for sustainable agricultural and forestry technologies among poor smallholders, especially those with lower quality soils. In Mozambique, market access through an adequate road network and transport services is crucial in determining the successful adoption of improved agricultural technologies, and may even compensate for the disadvantages of marginal environments, such as poor rainfall (Cunguara and Darnhofer 2011). In Nepal and Ethiopia, the lack of vital infrastructure, such as roads, irrigation and infrastructure, severely constrains the ability of poor farmers in remote and environmentally fragile areas to adopt new technologies and increase agricultural incomes (Dercon et al. 2009; Dillon et al. 2011).

The asset-less poor are also highly vulnerable to natural disaster shocks, such as droughts, hurricanes, tsunamis, floods and other extreme events (Badola and Hussein 2005; Barbier 2008; Carter et al. 2007; Das and Vincent 2009; Laso Bayas et al. 2011; McSweeney 2005; Takasaki et al. 2004). On the other hand, positive income shocks and targeted programs to the poor can reduce pressure on natural resources (Fisher and Shively 2005). For example, two studies based on the 1999 cyclone that struck Orissa, India, found that mangroves significantly reduced the number of deaths as well as damages to property, livestock, agriculture, fisheries and other assets (Badola and Hussain 2005; Das and Vincent 2009). Statistical analysis indicates that there would have been 1.72 additional deaths per village within 10 km of the coast if the mangrove width along shorelines had been reduced to zero (Das and Vincent 2009). Losses incurred per household were greatest ($154) in a village that was protected by an embankment but had no mangroves compared to losses per household ($33) in a village protected only by mangrove forests (Badola and Hussain 2005). However, evidence from Thailand indicates that poor coastal households are less willing to participate in mangrove replanting schemes, even

though they are aware of the storm protection benefits of mangroves, because of the high opportunity cost of their labor and lack of community control over the management of the restored mangroves (Barbier 2008). In many developing regions, poor households rely on natural resources not for protection against storms and other environmental shocks but as insurance and coping strategies for avoiding the income and subsistence losses associated with such disasters (Carter et al. 2007; McSweeney 2005).

Given that poor rural households engage in some agriculture, and are highly dependent on outside employment for income, their livelihood strategies across these activities must be inter-dependent. In particular, as the "natural" assets and land available to them degrade or disappear, the rural poor are likely to search for more paid work to increase their earnings from outside jobs. Such environmental degradation effectively lowers the “reservation wage” of the poor for accepting paid work, as households are forced to look for additional work to make up the lost income (Barbier 2007; Dasgupta 1993; Jansen et al. 2006; Pascual and Barbier 2006 and 2007).

For example, Barbier (2007) finds that mangrove deforestation is likely to increase the probability that both males and females from coastal communities in Thailand participate in outside work, but the number of hours worked in outside employment by males decline with any mangrove loss while the number of hours worked by females rise. Households appear to be highly dependent on males continuing to work on the physically demanding mangrove-dependent activities, such as fishing and collecting products, and as mangrove resources decline, even more male labor will be devoted to exploiting them to maintain the mangrove-based income and subsistence required by the households. In contrast, females are more likely to be sent out for paid employment to earn needed cash income as local mangrove resources decline. In contrast, in the Yucatán, Mexico, in response to increased population density and declining soil fertility, only the better off households are able to devote more labor to off-farm employment; in contrast, the poorer households allocate even more labor to shifting cultivation, thus perpetuating problems of shortened fallows and declining yields (Pascual and Barbier 2006 and 2007). On the other hand, in the rainfed upland areas of Honduras, favorable rainfall during the secondary season lowers the probability that a household's income-earning strategy focuses on off-farm work, probably because it makes own farm vegetable production more profitable (Jansen et al. 2006).

Evidence from the Philippines confirms that higher wages for off-farm employment can draw away smallholder labor that would otherwise be used for clearing more forests for on-farm agricultural production (Coxhead et al. 2002; Shively and Fisher 2004). However, poorer households in remote locations are the least likely to participate in off-farm employment, as they face higher transaction and transportation costs (Shively and Fisher 2004). Bluffstone (1995) finds similar results in Nepal; higher wages reduce smallholder deforestation, but only if there are paid employment opportunities available in remote areas. Non-farm employment and improved wages in Honduras has also been associated with investments to improve cropland quality in Honduras and improved resource conditions in Uganda (Pender 2004). In El Salvador, as the employment opportunities and income per capita of agricultural wage owners declined, they relied increasingly on cultivating land for subsistence production. But rising income growth also enables poor and near poor households to acquire more land for cultivation, as a precaution against possible future income losses (González-Vega et al. 2004). In Honduras, there is concern that the 30-50% decline in real wages over the past decade has shifted upland households to

income strategies emphasizing hillside cropland expansion and resource degradation that has worsened rural poverty (Jansen et al. 2006). Similarly, in the Yucatán, because they have limited access to off-farm employment, the least poor households tend to over-supply labor to shifting cultivation and thus clear too much forest land (Pascual and Barbier 2007).

Although higher nonfarm income may discourage cropland expansion and deforestation, it does not necessarily follow that households will invest more in conserving and improving existing land. For example, Holden et al. (2004) found that, in the Ethiopian highlands, better access to low-wage nonfarm employment improved substantially the income of households, but because it also reduced farming activities and food production, increased nonfarm income also undermined the incentives for soil conservation. Similarly, Pascual and Barbier (2007) find evidence that the poorest households in the Yucatán have a backward-bending supply curve for off-farm labor. As real wage rates rise, these households actually decrease their supply of labor to outside employment and increase clearing forests for shifting cultivation. In contrast, richer households respond to higher real wages but supplying more labor to outside work, thus reducing shifting cultivation and deforestation. In Malawi, the factors reducing forest pressure included favorable returns to non-forest employment, secondary education of the household head, and wealth (Fisher et al. 2005).

Poverty traps

Because the "asset-less" poor tend to be concentrated in less-favored rural areas and fragile environments that are located far from market centers, such populations are highly vulnerable to poverty traps. A *poverty trap* is characterized by self-reinforcing patterns of chronic or persistent poverty (Barrett and Swallow 2006). Such patterns have been characterized in terms of the lack of nutritional status and the capacity for work by the poor (Dasgupta 1993, 1997 and 2003), or an asset-based approach to characterizing long-term structural poverty (Carter and Barrett 2006; Carter et al. 2007).

As a result, two types of poverty traps can ensue. First, poor households located in fragile environments are vulnerable to a *poverty-environment trap*, which is a self-reinforcing pattern of over-allocation of household labor to production from marginal agricultural land and resource commons, low and even declining labor productivity in these activities, and consumption falling to subsistence levels (Barbier 2010). Second, if the asset-less poor are also located in remote areas, then the geographical isolation of these rural communities and local markets can reinforce conditions that create a *spatial poverty trap*. As described by Barrett (2008), this geographical isolation raises substantially the costs of agricultural commerce and crop production in remote markets, distorts or insulates these markets from economy-wide policy changes, and thus discourages smallholder market participation.

For example, to illustrate the poverty-environment trap, Barbier (2010) considers a representative rural household living in a less favored area for agricultural production, i.e. upland areas, converted forest lands and drylands that suffer from low agricultural productivity, land degradation and lack of irrigation and other inputs for intensive agriculture. The household also lacks access to formal or well-functioning markets for credit, capital, land and insurance. Thus, members of the household may participate in two broad types of economic activity: i) production activities that rely on the natural resource endowment available to the household, including any

common-property resources or land for agriculture and, if they choose, ii) outside paid employment.

This household labor allocation choice of the poor rural household is shown in Figure 5a. The horizontal axis depicts the total labor allocated by the household to both production activities and outside employment, with L representing total household labor, l_0 labor allocated to production activities, l^w labor devoted to paid work, and $L - l_0 - l^w$ is the remaining unallocated household labor, which can be broadly categorized as "leisure".[2] For a given quantity and quality of the natural resource endowment available to the household, N_0, the marginal value to the household of allocating labor to its own production activities, $VMP_l(N_0)$, is downward sloping because of the decreasing marginal productivity of labor, whereas the marginal cost of this allocation in terms of foregone leisure, MC_l, is upward sloping because of decreasing marginal utility of leisure. Where these two curves intersect determines the reservation wage w^R of the household, which is the value of its labor that just ensures that the optimal hours engaged in paid work is zero.

This existence of a reservation wage is important to the household labor allocation decision, as the household will only engage in outside employment if the market wage received exceeds the household's reservation wage. If the wage for paid work is less than or equal to the reservation wage, then the household will not participate in the labor market. For example, as shown in Figure 5a, if the market wage w for hiring labor is equal to the reservation wage, then the household would not allocate any labor to outside employment, $l^w = 0$. Instead, l_R household labor would be involved in production activities and the remaining $L - l^R$ labor would be devoted to leisure. On the other hand, as shown in Figure 5a, if the household is offered a wage rate in outside employment higher than its reservation wage, $w > w^R$, then the household would reduce both its labor allocated to production activities and to leisure in order to engage in outside employment. The household will devote l_0 labor to production activities, l^w to paid work, and $L - l_0 - l^w$ to leisure.

However, for its production activities, the household relies on agriculture and collecting or harvesting products from resource commons. As we have seen, agriculture on marginal lands is prone to land degradation, and many resource commons are subject to overexploitation due to uncontrolled access or under threat from development activities. Such impacts will eventually cause the quantity and quality of the natural resource endowment available to the household to decline, from N_0 to N_1 (see Figure 5a). The result is a fall in labor productivity, and thus also in the household's reservation wage. The household will now allocate only l_1 labor to its own production activities, and much more labor will be devoted to outside employment. Leisure will be unaffected.

But in less favored areas there will be many poor households facing problems of environmental degradation from farming marginal lands and exploiting natural resources found in the commons or open access locations. If there are large numbers of households seeking outside employment, the supply of labor for paid work could exceed demand. The market wage for hired labor will decline. For some households, the wage rate will fall to the level of the

[2] In this context, "leisure" includes all other uses of household labor, such as rest, educational activities, looking after the elderly or children of the household, chores, food preparation, etc.

reservation wage or even lower. These households would now stop seeking outside employment opportunities and instead allocate all of their labor to production activities and leisure. The danger for these households is that, if this process degenerates into a vicious cycle, then the dynamics of a poverty-environment trap may ensue (see Figure 5b). The vicious cycle of the poverty-environment trap can be even worse for the household if the land and environmental degradation problems are widespread in the region and affect many households. In that case, the large numbers of households seeking outside employment will force down the market wage to subsistence levels very quickly. As shown in Figure 5b, the vicious cycle can easily lead to such a downward spiral. Falling wages for outside work will force the household to reallocate more of its labor back to production activities. This is clearly a sub-optimal labor allocation, as it is devoting excess labor to production and resource extraction. There is a further danger to the household, however. By putting too much labor into production activities, the household is likely to overexploit further common resources and degrade its marginal lands for agriculture. As indicated by Figure 5b, the result is even further declines in the labor productivity of the household in agricultural and resource activities, continuing misallocation of labor, and a deepening poverty-environment trap.

Examples of this type of poverty-environment trap are noted, for example, by Pascual and Barbier (2007), who find that it is the least poor households in the Yucatán, Mexico that tend to over-supply labor to shifting cultivation, thus causing more deforestation. Similarly, Coomes et al. (2011) identify a "land-use" poverty trap for shifting cultivators in the Amazon, whereby insufficient initial land holdings induce land use patterns that trap households in low agricultural productivity as well as further forest conversion. Caviglia-Harris (2004) also document in Amazonia the relationship between low-productivity agroforestry systems, forest clearing and poverty. In Rwanda, resource-poor households even in fertile areas are very dependent on subsistence production, and when can find outside employment, receive the lowest median pay per hour (Ansoms and McKay 2010). Similar poverty trap relationships have been found between declining productivity, outside employment and poverty for the resource-poor households in El Salvador; Ethiopia, Honduras, India, Malawi, the Philippines and Thailand (Barbier 2007; Coxhead et al. 2002; González-Vega et al. 2004; Holden et al. 2004; Jansen et al. 2006; Narain et al. 2008; Shively and Fisher 2004).

When the asset-less poor are located in ecologically fragile area located far from major urban centers and markets, the poverty-environment trap can also be reinforced by a spatial poverty trap (Barrett 2008; Bird et al. 2002 and 2010; Jalan and Ravallion 1997 and 2002; Kanbur and Venables 2005). In such cases, the geographic isolation of poor rural communities dependent on much smaller and remote local markets discourages widespread smallholder participation in markets, reduces outside employment opportunities for the asset-less poor, and thus fosters the prevalence of poverty in the remote region. Adapting the analysis of Barrett (2008), Figure 6 illustrates this type of poverty trap that emerges from the concentration of poor rural communities in remote regions with isolated markets.

As argued Barrett (2008), the key characteristic of remote regions is that, although they may contain active markets that exchange local produce, the geographical isolation of these markets limits their integration with larger regional, national or even global markets. In effect, there is a substantial transaction cost in the form of inter-market costs of commerce that afflicts local, remote markets. For example, as shown in Figure 6, suppose that P^B is the border-equivalent price for an agricultural product prevailing in the major markets of a developing

economy. However, because of the transaction cost of commerce, τ, the actual price prevailing in a geographically isolated local market is much higher, $P^R = P^B + \tau\left(G^R, Q^R\right)$. This transaction cost is influenced by the availability and quality of public infrastructure and services in the remote region, G^R, such as roads, extension services, communications and so forth, and also by the scale of the local market, Q^R. Because larger markets have lower inter-commerce costs, τ declines as local market transactions increase in size.

Figure 6 depicts the market equilibrium in a small, remote market with poor access to public infrastructure and services. The resulting large transaction cost of inter-market commerce ensures that the market is restricted to local demand and supply and that the resulting price is well above P^B. Consequently, the substantial transaction cost acts a as a barrier both to the integration of the remote rural market with major agricultural markets and to the transmission of price changes from economy-wide policies to the isolated region; "hence the frequent ineffectiveness of trade, exchange rate and other macro level policies in stimulating either smallholder market participation or significant improvements in rural producers' welfare" (Barrett 2008, p. 304).

By restricting smallholder market participation in the remote region, such a spatial poverty trap also reinforces the dynamics of the household poverty-environment trap (see Figure 5). If small, isolated markets constrain the commercial opportunities and returns of smallholders capable of becoming net sellers of agricultural products, then these households will have lower returns to their land holdings and also be discouraged from hiring additional agricultural labor. Less returns to land will discourage the smallholders from investing in improvements to their land that boost agricultural productivity and make it less vulnerable to soil erosion and other forms of land degradation. Less hiring of agricultural labor will further depress the off-farm employment opportunities and wages on which local resource-poor households depend. The result is that the type of poverty-environment dynamics depicted in Figure 5b is more likely to occur.

Toward a new poverty eradication strategy

To summarize, a distinct geographic pattern of natural resource use and rural poverty has emerged in developing economies. Many low and middle-income economies display a high concentration of large segment of the population in fragile environments and in remote areas with poor market access, and rural poverty. Moreover, there appears to be a correlation of this pattern of resource use with poor economic performance: those developing countries that are highly resource dependent and whose populations are concentrated in fragile environments and remote areas tend not only to have high incidence of rural poverty but also are some of the poorest economies in the world.

To eradicate such persistent problems of geographically concentrated rural poverty in developing economies will require a new poverty eradication strategy. Such a targeted strategy for the rural poor in remote and less favored areas will require the following components:

- Provide financing directly, through involving the poor in payment for ecosystem services schemes and similar incentive mechanisms that enhance the environments on which the poor depend.

- Target investments directly to improving the livelihoods of the rural poor, especially their existing agricultural and resource production activities, thus reducing their dependence on exploiting environmental resources.
- Improve access of the rural poor in less favored and remote areas to well-functioning and affordable markets for credit, insurance and land.
- Reduce the high transportation and transaction costs that prohibit the poorest households in remote areas to engage in off-farm employment and to integrate with larger markets.
- Provide effective institutions and governance in support of poor communities' use of common pool resources.

If policies are to be targeted to improve both rural livelihoods and protect the fragile environments on which many poor people depend, such a strategy must take into many important factors influencing households' behavior, including lack of income opportunities or access to key markets for land, labor and credit, and the availability and quality of natural resources, including land, to exploit (Barbier 2010). Nevertheless, there are several ways in which a strategy could be developed to target improving the livelihoods of the poor.

The first is to provide financing directly, through involving the poor in payment for ecosystem services schemes and other measures that enhance the environments on which the poor depend (Alix-Garcia et al. 2008; Grieg-Gran et al. 2005; Pagiola et al. 2005; Pattanayak et al. 2010; Vincent 2012; Wunder 2008; Zilberman et al. 2008). Payments for the conservation of standing forests or wildlife habitat are the most frequent type of compensation programs used currently in developing countries, and they have been mainly aimed at paying landowners for the opportunity costs of preserving natural landscapes that provide one or more diverse services: carbon sequestration, watershed protection, biodiversity benefits, wildlife protection and landscape beauty (Grieg-Gran et al. 2005; Pagiola et al. 2005; Wunder 2008). Wherever possible, the payment schemes should be designed to increase the participation of the poor, to reduce any negative impacts on nonparticipants while creating additional job opportunities for rural workers, and to provide technical assistance, access to inputs, credit and other support to encourage poor smallholders to adopt the desired land use practices. More effort must also be devoted to designing projects and programs that include the direct participation of the landless and near landless.

However, one also has to be cautious in designing PES schemes to achieve both environmental and poverty objectives. Evidence from a number of developing countries across several regions indicates that trying to "add on" poverty alleviation targets can increase the transactions costs associated with PES programs, inhibit their implementation, and reduce their success in achieving their environmental objectives (Vincent 2012; Wunder 2008). Field experiments in Ecuador and Guatemala show that differentiating payments to smallholders might reduce the costs of implementing PES schemes but, as the poorest households engaged in subsistence farming are likely to receive lower payments than smallholders with larger land holdings, such payments might increase rather than reduce income inequality (Southgate et al. 2009). An analysis of implementing a PES program in the Brazilian Amazon reveals that institutional preconditions, such as land grabbing, insecure tenure and overlapping claims, would ensure that large landowners who are responsible for around 80% of deforestation would receive the greatest benefits from the scheme (Börner et al. 2010). In southern Mexico, the increased conservation associated with a PES scheme has not only increased inequality but also food

insecurity, due to the loss of customary agricultural land and hunting grounds available to poor households (Ibarra et al. 2011).

Spatial targeting of payments for ecosystem services may be one way of both reducing costs of implementation and also ensuring that more benefits reach the rural poor, as programs and studies in Costa Rica, Ecuador, Guatemala and Madagascar have shown (Southgate et al. 2009; Wendland 2010; Wünscher et al. 2008). Even in a poor African economy, such as Tanzania, a correctly designed payment for ecosystem services (PES) program can provide an important source of funding for sustainable land use practices in agriculture while leading to greater watershed protection (Branca et al. 2011). In the upstream catchment area of the Ruvu River, poor farmers face financial and technical obstacles to adopting sustainable land management that reduce soil erosion and enhance downstream water quality. By providing institutional, technical and financial support to farmers, a PES scheme for watershed protection delivers on these environmental goals while at the same time boosting crop productivity from improved soil conservation and fertility and thus raising farm incomes. The PES scheme is now trying to enhance sustainability by investing in an appropriate legal and institutional framework for long-term financing and expansion of sustainable land management among farmers to improve watershed management.

A second objective is to target investments directly to improving the livelihoods of the rural poor in remote and fragile environments. For example, in Ecuador, Madagascar and Cambodia poverty maps have been developed to target public investments to geographically defined sub-groups of the population according to their relative poverty status, which could substantially improve the performance of the programs in term of poverty alleviation (Elbers et al. 2007). A World Bank study that examined 122 targeted programs in 48 developing countries confirms their effectiveness in reducing poverty, if they are designed properly (Coady et al. 2004). A review of poverty alleviation programs in China, Indonesia, Mexico and Vietnam also finds evidence of "the value in specifically targeting spatially disadvantaged areas and households", although the benefits are larger when programs, such as PROGRESA in Mexico, were successful in employing second-round targeting to identify households in poor locations and thus reducing leakages to non-poor households (Higgins et al. 2010, p. 20).

Research, extension and agricultural development has historically been oriented towards major commercial and export-oriented crops in developing economies, not targeted for improving low-productivity agricultural systems or farming in less favorable environments. In other words, these efforts have been targeted toward increasing overall income growth and thus increases in per capita income, but not targeted toward reducing poverty. Yet such improvements with appropriate targeting can substantially improve the livelihoods of the poor, increase employment opportunities and even reduce environmental degradation (Barbier 2005; Carr 2009; Caviglia-Harris and Harris 2008; Coxhead et al. 2002; Dercon et al. 2009; Maertens et al. 2006). Empirical evidence of technical change, increased public investments and improved extension services in remote regions indicates that any resulting land improvements that do increase the value of homesteads can have a positive effect on both land rents and reducing agricultural expansion (Bellon et al. 2005; Coxhead et al. 2002; Dercon et al. 2009; Dillon et al. 2011; Maertens et al. 2006; Sills and Caviglia-Harris 2008).

Targeting the rural poor is even more urgent during major economic crises, which occur frequently in developing economies (Ravallion 2008; Ruel et al. 2010). Under-investment in human capital and lack of access to financial credit are persistent problems for the extreme poor,

especially in fragile and remote environments. Low-income households generate insufficient savings, suffer chronic indebtedness and rely on informal credit markets with high short-term interest rates. Two types of policies and investment programs targeted to the poor are essential in these circumstances. The first is a comprehensive and targeted safety net that adequately insures the poor in time of crisis. The second is the maintenance, and if possible expansion, of long-term educational and health services targeted at the poor. Unfortunately, during financial and economic crises, publicly funded health and education services are often the first expenditures reduced by developing country governments, and the provision of such services to the poor in remote and fragile areas are usually threatened the most by budget cuts (Ruel et al. 2010).

In addition, policies need to address the lack of access of the rural poor in less favored areas to well-functioning and affordable markets for credit, insurance and land, and the high transportation and transaction costs that prohibit the poorest households in remote areas to engage in off-farm employment, which are the major long-run obstacles that need to be addressed. As discussed previously, such problems lie at the heart of the poverty trap faced by many poor people in remote and less favored areas (Barbier 2010; Barrett 2008; Bird et al. 2010; CPRC 2004). For example, Carter and Barrett (2006, p.195) note that the existence of a poverty trap threshold "depends on the degree to which the household is excluded from intertemporal exchange through credit, insurance or savings, whether formally or through social networks. A household with perfect access to capital over time and across states of nature would not face a critical threshold." Similarly, Shively and Fisher (2004, p. 1366) maintain that "policies to reduce deforestation should focus on increasing returns to off-farm employment, strengthening rural credit markets, and ensuring farmers have secure tenure over existing agricultural land."

As argued by Barrett (2008, p. 306), "better integration of local markets into broader global markets limits the losses suffered by smallholders too poor to afford new technologies, increases the gains enjoyed by those farmers who do adopt improved production technologies, and increases the incentives to invest in adoption of new technologies." Thus, improving market integration for the poor may depend on targeted investments in a range of public services and infrastructure in remote and ecologically fragile regions, such as extension services, roads, communications, protection of property, marketing services and other strategies to improve smallholder accessibility to larger markets. For example, for poor households in remote areas of a wide range of developing countries, the combination of targeting agricultural research and extension services to poor farmers combined with investments in rural road infrastructure to improve market access appears to generate positive development and poverty alleviation benefits (Ansoms and McKay 2010; Bellon et al. 2005; Cunguara and Damhofer 2011; Dercon et al. 2009; Dillon et al. 2011; Müller and Zeller 2002; Pattanayak et al. 2003;Yamano and Kijima 2010). In Mexico, poverty mapping was found to enhance the targeting of maize crop breeding efforts to poor rural communities in less favorable and remote areas (Bellon et al. 2005). In the Central Highlands of Vietnam, the introduction of fertilizer, improved access to rural roads and markets, and expansion of irrigation increased dramatically the agricultural productivity and incomes (Müller and Zeller 2002).

Because they face higher transaction and transportation costs, poorer households in remote locations are less likely to participate in off-farm employment. Yet, as discussed previously, when off-farm employment opportunities are available in remote areas, they can reduce conditions fostering the poverty-environment trap faced by poor households (Ansoms and

McKay 2010; Bluffstone 1995; Coxhead et al. 2002; González-Vega et al. 2004; Pascual and Barbier 2004; Shively and Fisher 2004). For example, in Columbia, high-input, intensified, highly mechanized cropping on the most suitable land, as well expansion in cattle grazing has drawn labor from more traditional agriculture, so that "areas of marginal land are slowly being abandoned and left to revegetate" (Etter et al 2008, p. 17). Investments in expanded market opportunities, improving market access and expanding public infrastructure and services, including, rural education and health services, seem to be important factors in both reducing the barriers to poor households' participation in off-farm opportunities and expanding their supply.

Finally, in many developing countries, the current legal framework and formal institutional structures for resource management do not allow local communities any legal rights to establish and enforce control over the ecosystem goods and services on which the livelihoods of these communities depend (Aswani et al. 2012; Chhartre and Agrawal 2008; Ferraro and Kiss 2006; Jindal et al. 2008). Establishing an improved institutional framework does not necessarily require transferring full ownership of natural resources to local communities, but could involve co-management by governments and local communities that would allow, for example, the participation of the communities in decisions concerning the long-term management, development and utilization of these resources. Without such institutional involvement of local communities, multiple problems can arise from competing interests amongst stakeholders, undeveloped or inappropriate governance structures, poor science, or lack of political will, which can ultimately undermine well-intentioned efforts to improve poor people's livelihoods (Aswani et al. 2012; Chhartre and Agrawal 2008).

Improving participation and benefits to local communities may also hold the key to the age-old problem of reconciling environmental protection with the increased opportunity costs imposed on surrounding communities. Environmental protection, and especially the establishment of protected areas, is conventionally viewed as increasing rural poverty, as the costs of protection include the loss of agricultural land and the prohibition of local use of resource commons. However, recent evidence from Costa Rica and Thailand suggest that the establishment of protected areas may actually reduce rural poverty locally (Andam et al. 2010; Ferraro et al. 2011; Sims 2010). Such potential win-win gains occur if the market and geographical conditions for favorable protected area siting are also complementary for instigating rural economic development locally; i.e., as summarized by Ferraro et al. (2011, p. 13918), "these patterns are consistent with a hypothesis that protected areas have reduced poverty by being placed on lands with little agricultural value that, by their proximity to major markets, can benefit from tourism and associated infrastructure development (thus offsetting any losses from foregone agriculture and forest resource exploitation)." Similarly, in Uganda, it was found that the disproportionate presence of very poor households at park edges as evidence that protected areas create poverty traps; to the contrary, parks appear to provide some protection against desperation sales and farm loss among the poorest and most vulnerable (Naughton-Treves et al. 2011). In the Luangwa Valley, Zambia the potentially win-win gains from environmental protection and poverty reduction are further enhanced through a deliberate strategy of channeling some revenues from wildlife-based tourism in local parks to improve sustainable agricultural practices targeted at the least food-secure local households and to provide community marketing of agricultural products to higher value urban and export markets (Lewis et al. 2011).

Conclusion

The continuing geographical concentration of the rural poor in ecological fragile and remote areas remains one of the biggest development challenges facing many low and middle-income economies. As argued in this paper, the result is two interacting poverty traps that inhibit widespread rural development: a poverty-environment trap at the household and community level and a spatial poverty trap for any isolated region and its local markets. That such poverty traps remain an important obstacle to progress in alleviating rural poverty is evident from recent trends.

According to the World Bank (2008), rural poverty rates in developing economies have declined over the past decade but remain high in South Asia (40%) and Sub-Saharan Africa (51%). Reductions in rural poverty in most countries and regions are largely due to rural development and not rural-urban migration. In Brazil, Ecuador, Thailand, Malawi and Vietnam poverty rates are higher in remote areas, and in general, poverty incidence is greater in rural areas with less favored land. These findings confirm that "the extreme poor in more marginal areas are especially vulnerable, and until migration provides alternative opportunities, the challenge is to improve the stability and resilience of livelihoods in these regions" (World Bank 2008, p. 49).

Thus, the key ecological scarcity problem facing the rural poor located in resource-poor and remote regions is a vicious cycle of declining livelihoods, increased ecological degradation and loss of resource commons, and declining ecosystem services on which the poor depend. That is why addressing this vicious cycle calls for a new policy strategy that does not just focus on improving natural capital in general, but attempts to address the key elements that are the root cause of the poverty-environment and spatial-poverty traps. To be effective, such a pro-poor strategy needs to target the rural poor where they are geographically concentrated – in remote and ecologically fragile areas. The key elements of the strategy in such areas involve:

- Improving the productivity of marginal agriculture and resource productive activities.
- Overcoming the constraints on smallholder market participation.
- Fostering well-functioning and affordable markets for credit, insurance and land.
- Generating off-farm employment opportunities.
- Enhancing environmental protection and management of resource commons.
- Improving public services and infrastructure, including roads, communications, marketing, education and health services, and research and extension.

As indicated in this paper, considerable advances have been made in recent years in mapping the geographical location of the poor and assessing how poverty-environment and spatial traps emerge. Such tools and analysis are now helping to guide and direct policy interventions to overcome these geographical dimensions to rural poverty in the developing world (see Higgins et al. 2010, for a review). A more concerted effort is required to expand the lessons learned from such studies into a more comprehensive strategy to alleviate rural poverty throughout the developing world.

First, there is a need for better data on the spatial location of the rural poor. Of particular interest is determining the extent to which the rural poor in specific developing countries are concentrated in remote and fragile environments as compared to other locations. Determining geographical clusters of the rural poor is extremely important to the design of the appropriate policies, given the evidence presented in this paper that the "spatial poverty trap" of remoteness tends to reinforce the "environment-poverty" trap faced by poor households in ecologically fragile areas. For example, Ansoms and McKay (2010) identify clusters of poor rural households based on poverty, livelihood and environmental profiles, including the soil quality and amount of cultivated land and the remoteness of a household's location. For households in resource-poor but centrally located regions, policies should aim to improve access to off-farm employment opportunities and small-scale entrepreneurship, for households in remote regions the priority should be to enhance access to markets by improving rural road infrastructure and to improve availability of educational and health services, and finally, for relatively resource-rich households, the policy emphasis should be to reduce resource degradation, enhance market-oriented agriculture and provide better access to insurance, credit and other market services.

In addition, assessments of the various policy mixes and investments targeted to the rural poor need to determine not only the benefits of such targeted improvements for increasing the incomes of households in fragile and remote areas but also whether such investments are cost effective. Such analyses should also shed light on what type of delivery mechanism may be more appropriate, for example a proxy means test that distributes benefits based on the consumption and wealth characteristics of each household or community-based methods where beneficiaries are identified by the community or its leaders (Alatas et al. 2012).

The scale of the impacts of the various implemented policies and investments also requires evaluation. Did household and community incomes increase sufficiently to alleviate chronic poverty in the wider region? How much improvement to the surrounding natural environment resulted from these efforts? Assessing the scale of these effects is important to determine the overall effectiveness of the policies but may also identify follow-up actions. For example, policies aimed at addressing property rights weakness, lack of access to research and extension or affordable credit and the availability of off-farm employment could have a measurable impact on reducing regional poverty but less of an influence on management of common resources, such as forests, grazing land and watersheds, or on protected areas. Additional policies may need to be implemented to improve and support local management of these common resources (Aswani et al. 2012; Chhartre and Agrawal 2008; Ferraro et al. 2011).

Finally, a policy strategy targeted at improving the livelihoods of the rural poor located in remote and fragile environments must be assessed against an alternative strategy, which is to encourage greater out-migration from these areas. As pointed out by Lall et al. (2006, p. 48), rural development is essentially an indirect way of deterring migration to cities, yet because of the costliness of rural investments, "policies in developing countries are increasingly more concerned with influencing the direction of rural to urban migration flows – e.g. to particular areas - with the implicit understanding that migration will occur anyway and thus should be accommodated at as low a cost as possible." Rarely, however, are the two types of policy strategies, investment in poor rural areas and targeted outmigration, directly compared. In addition, only recently have the linkages between rural out-migration, smallholder agriculture and land use change and degradation in remote areas been analyzed (Mendola 2008 and 2012; Gray 2009; Greiner and Sakdapolrak. 2012; VanWey et al. 2012). Another important emerging

area of research is to examine the economic choices made by poor rural households to migrate to remote and environmentally poor frontier regions as opposed to urban areas (Barbier 2012; Carr 2009; Caviglia-Harris et al. 2012). Researching such linkages will become increasingly important to understanding the conditions under which policies to encourage greater rural out-migration should be preferred to a targeted strategy to overcome the root cause of the poverty-environment and spatial-poverty traps in remote and fragile areas.

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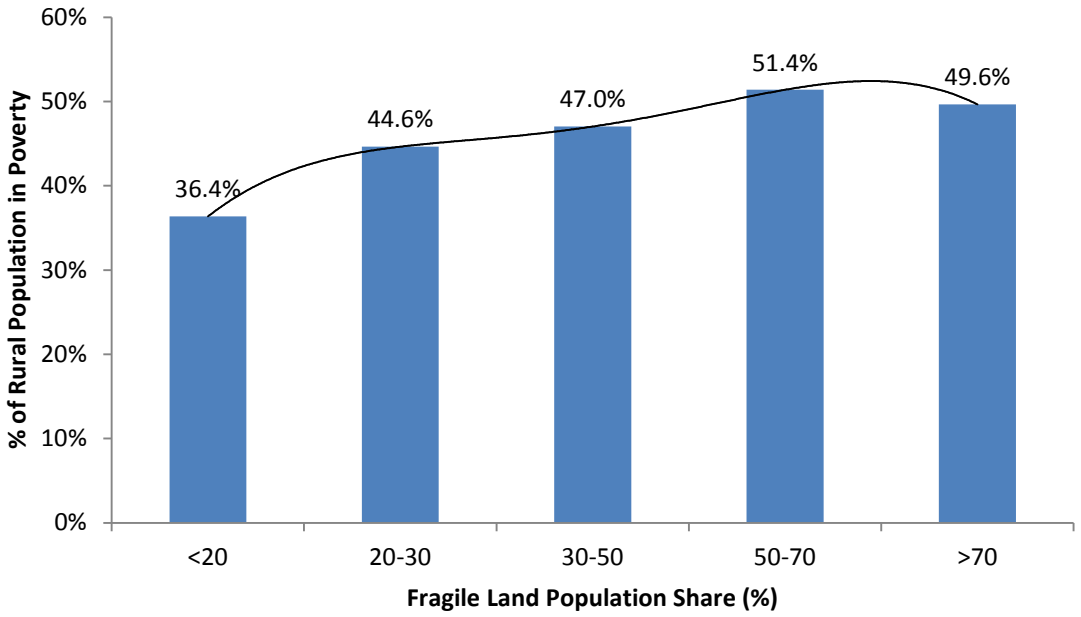
Figure 1 The rural poor and population on fragile lands in developing economies



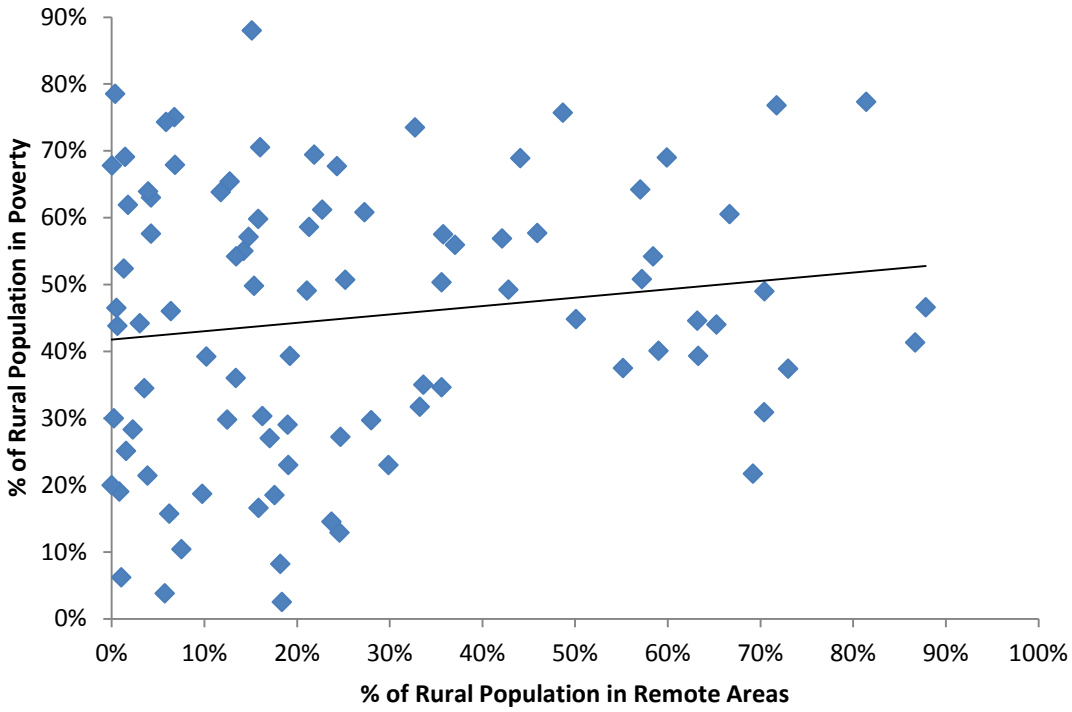
Notes: Developing economies are all low and middle income economies with 2009 per capita income of $12,195 or less, following World Bank (2012).

Percentage of rural population in poverty is from World Bank (2012).

Percentage of population on fragile land is from World Bank (2003).

Number of observations = 92 countries, of which 13 (<20% of population on fragile land), 32 (20-30%), 33 (30-50%), 9 (50-70%) and 5 (> 70%). The average rural poverty rate across all countries is 45.3%, and the median is 46.6%.

Figure 2 The rural poor and population in remote areas of developing economies



Notes: Developing economies are all low and middle income economies with 2009 per capita income of $12,195 or less, following World Bank (2012).

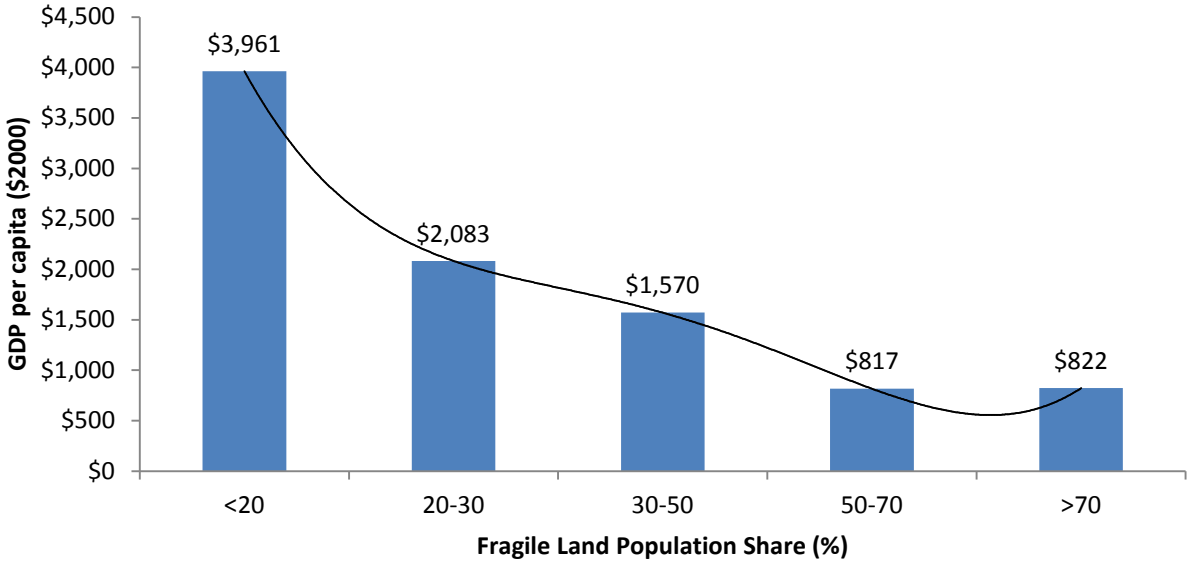
Remote areas are locations with poor market access, requiring five or more hours to reach a market town of 5,000 or more.

Percentage of rural population in poverty is from World Bank (2012).

Percentage of rural population in remote areas is from World Bank (2008).

Number of observations = 91 countries. Average (median) share of rural population in remote areas is 26.9% (19.0%). Average (median) share of rural population in poverty is 45.2% (46.5%). Pairwise correlation coefficient $r = 0.15$.

Figure 3 Fragile land population and GDP per capita in developing economies



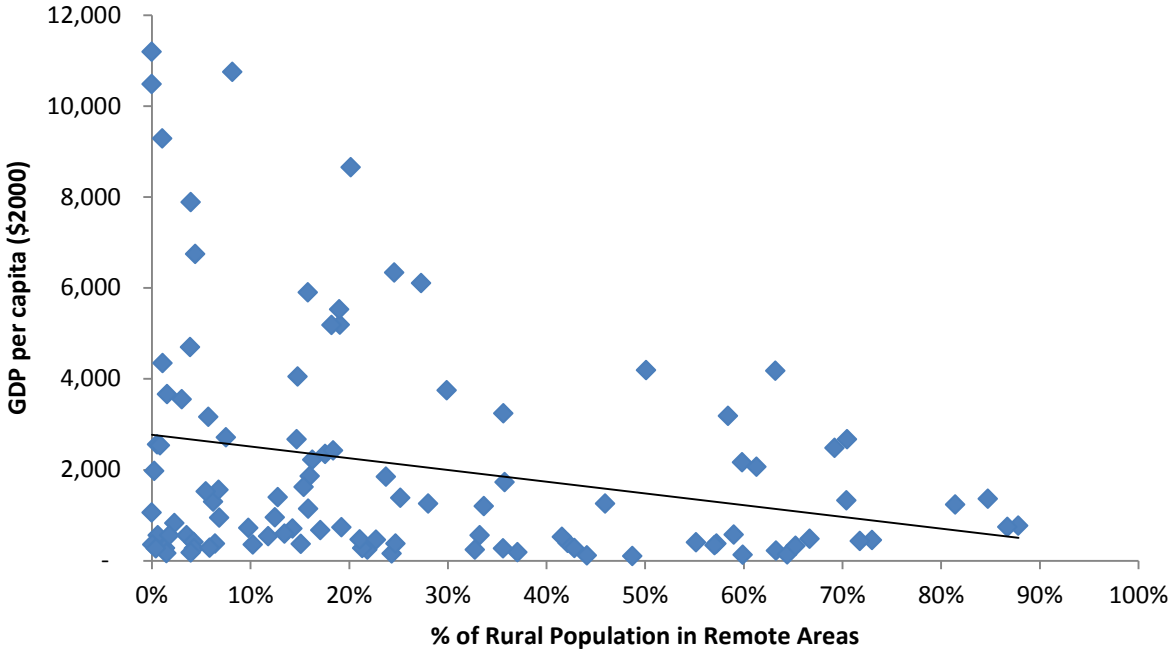
Notes: Developing economies are all low and middle income economies with 2009 per capita income of $12,195 or less, following World Bank (2012).

GDP per capita ($2000) is from World Bank (2012).

Percentage of population on fragile land is from World Bank (2003).

Number of observations = 104 countries, of which 15 (<20% of population on fragile land), 31 (20-30%), 42 (30-50%),11 (50-70%) and 5 (> 70%). The average GDP per capita ($2000) across all countries is $1,952 and the median is $1,144.

Figure 4 Remote rural population and GDP per capita in developing economies



Notes: Developing economies are all low and middle income economies with 2009 per capita income of $12,195 or less, following World Bank (2012).

GDP per capita ($2000) is from World Bank (2012).

Remote areas are locations with poor market access, requiring five or more hours to reach a market town of 5,000 or more.

Percentage of rural population in remote areas is from World Bank (2008b).

Number of observations = 104 countries. Average (median) share of rural population in remote areas is 26.9% (18.7%). Average (median) share of real GDP per capita is $2,075 ($1,100). Pairwise correlation coefficient r = - 0.26.

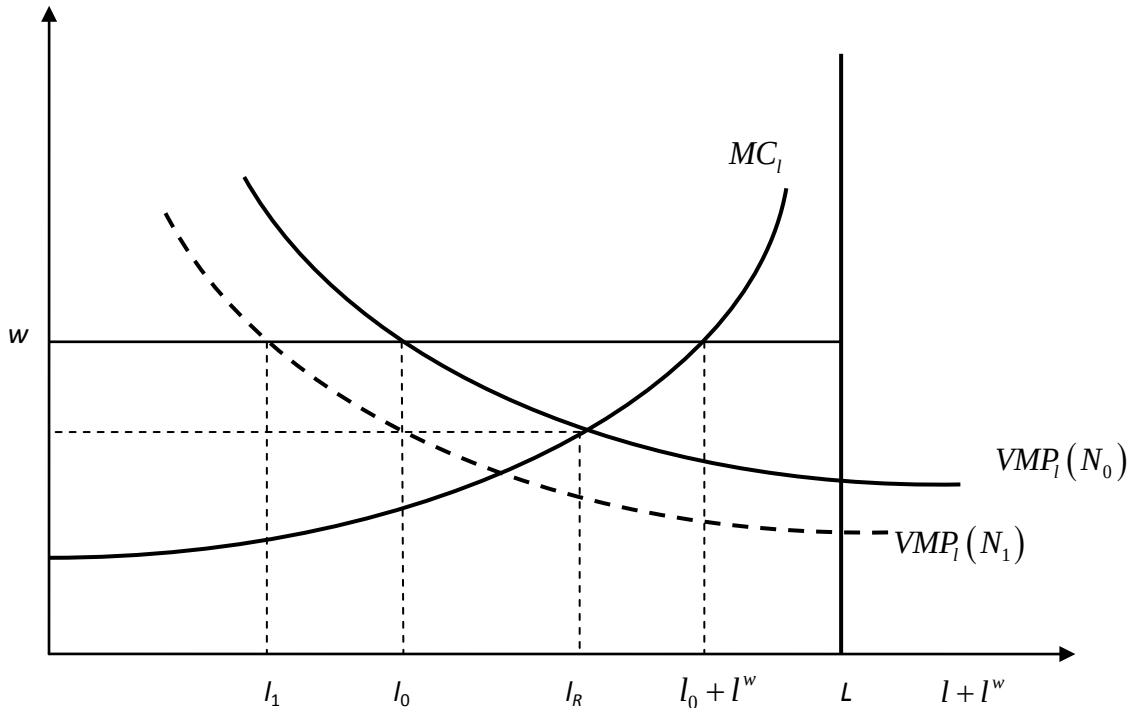
Table 1. Population in fragile and remote areas, rural poverty and GDP per capita

	Share of Population on Fragile Land ≥ 50%	**Share of Population on Fragile Land 30-50%**	**Share of Population on Fragile Land 20-30%**
GDP per capita less than $1,000 (Avg $409)	Afghanistan (55%, 38%) Burkina Faso (1%, 52%) Congo Dem. Rep. (49%, 76%) Eritrea (60%, 69%) Mali (4%, 58%) Niger (4%, 64%) Papua New Guinea (87%, 68%) Somalia (64%, NA) Sudan (42%, NA) Yemen (59%, 40%) Zimbabwe (65%, 44%)	Benin (6%, 46%) Cameroon (14%, 55%) Central African Rep. (22%, 69%) Chad (21%, 59%) Comoros (NA, 49%) Ethiopia (63%, 39%) Gambia (0%, 68%) Guinea (4%, 63%) Haiti (15%, 88%) Kenya (21%, 49%) Kyrgyz Rep. (57%, 51%) Lao PDR (33%, 32%) Lesotho (67%, 61%) Mauritania (23%, 61%) Nepal (36%, 35%) Nigeria (12%, 64%) Pakistan (17%, 49%) Rwanda (57%, 64%) Senegal (2%, 62%) Sierra Leone (0.4%, 79%) Tajikstan (43%, 49%) Tanzania (73%, 37%) Uganda (25%, 27%) Uzbekistan (13%, 30%)	Burundi (44%, 69%) Cambodia (4%, 35%) Côte d'Ivoire (13%, 54%) Ghana (10%, 39%) Guinea-Bisseau (2%, 69%) India (2%, 28%) Liberia (24%, 68%) Madagascar (33%, 74%) Mongolia (88%, 47%) Mozambique (42%, 57%) Togo (6%, 74%) Vietnam (10%, 19%) Zambia (72%, 79%)
GDP per capita $1,000 to $4,000 (Avg $2,066)	Bhutan (70%, 31%) Cape Verde (NA. 44%) Egypt (0.2%, 30%) Namibia (71%, 49%) Niger (66.0) Swaziland (7%, 75%)	Algeria (16%, 30%) Angola (85%, NA) Belize (3%, 44%) Guatemala (16%, 71%) Guyana (34%, 35%) Iran (60%, NA) Morocco (24%, 15%) Solomon Islands (NA, NA) South Africa (30%, 23%) Syria (6%, NA) Tunisia (6%, 4%) Turkmenistan (61%, NA) Vanuatu (NA, NA)	Azerbaijan (18%, 19%) Bolivia (81%, 77%) China (18%, 3%) Congo (46%, 58%) Ecuador (36%, 56%) El Salvador (0.5%, 47%) Honduras (13%, 65%) Indonesia (16%, 17%) Jamaica (2%, 25%) Jordan (1%, 19%) Kazakhstan (69%, 22%) Peru (58%, 64%) Sri Lanka (6%, 16%)
GDP per capita over $4,000 (Avg $5,992)		Botswana (50%, 45%) Costa Rica (19%, 23%) Equatorial Guinea (20%, NA) Grenada (NA, NA) St. Vincent & Gren. (NA, NA)	Dominican Rep. (15%, 57%) Malaysia (18%, 8%) Mexico (27%, 61%) Panama (16%, 35%) Trinidad & Tob. (0%, 20%)

Notes: GDP per capita ($2000) is from World Bank (2012). Share of population on fragile land is from World Bank (2003). First figure in parenthesis is the share of rural population in remote areas, from World Bank (2008). Second figure in parenthesis is the percentage of the rural population in poverty, from World Bank (2012). Total countries = 89, of which 48 with GDP per capita less than $1,000 (average share of rural population in remote areas = 31.1%, average rural poverty rate = 54.4%), 31 with GDP per capita between $1,000 and $4,000 (30.4%, and 37.5%), and 10 with GDP per capita greater than $4,000 (20.7%, 35.5%). Across all 89 countries, average GDP per capita is $1,613, average share of rural population in remote areas is 29.9%, and average rural poverty rate is 47.3%.

Figure 5. The household poverty-environment trap

(a) Labor allocation by the poor rural household



(b) The vicious cycle of the poverty-environment trap

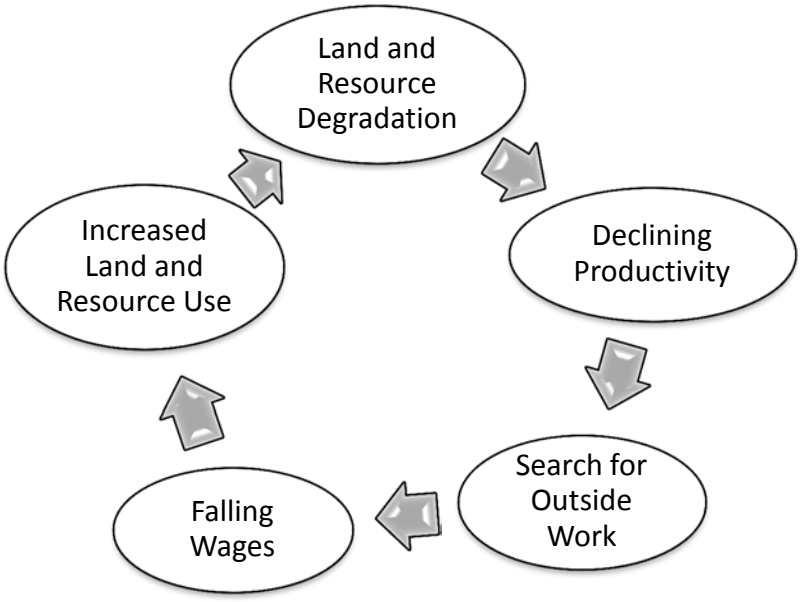
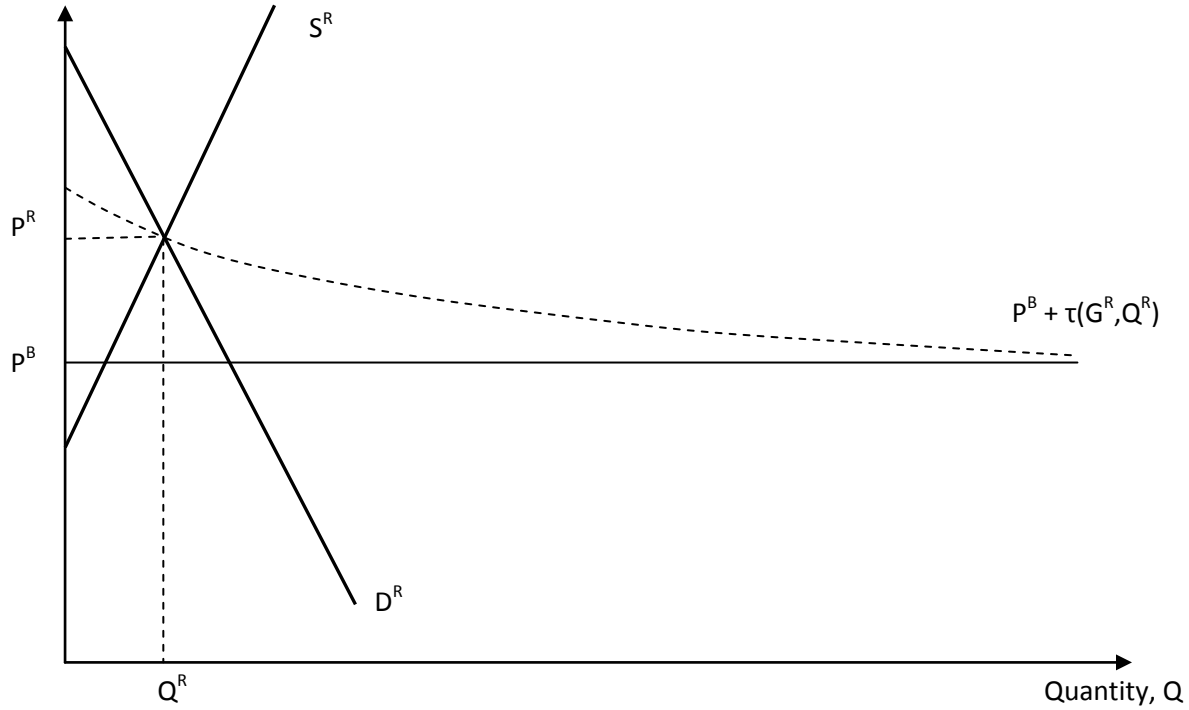


Figure 6. The geographic isolation of remote rural markets



Source: Adapted from Barrett (2008).