

PART II D

Social Science Global Literature Review

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1. Introduction

Economically, spatially, environmentally and socially, rural and urban areas can no longer be considered completely separate, distinct phenomenon. Improved transportation and communication networks and the need to diversify livelihoods are among some of the factors giving rise to a rural-urban continuum, in which many facets of life are inexorably linked. The rural-urban linkages and interactions vary considerably between regions, with sub-Saharan African peri-urban areas having few similarities to South-east Asia "desakota" areas (McGregor et al. 2006). Here we provide an overview of the trends in peri-urbanism between four regions: sub-Saharan Africa, South Asia, the Amazon-Andean region and China. Population, economic, and peri-urbanisation trends are examined within the context of their effects on local ecosystem services and provisioning. There are difficulties in extrapolating regional trends from global population and economic trends and projections that are themselves fraught with uncertainty. The report is not comprehensive and identifies only some of the main points uncovered in the social trends literature review conducted by ISET-International.

2. Global Trends

2.1 Population Trends:

According to the UN (2007a), the world population is expected to increase to roughly 9.2 billion by 2050, with most of the population growth occurring in the less developed regions. In less developed regions, the "population is expected to rise from 5.4 billion in 2007 to 7.9 billion in 2050" (UN 2007a: 5). Fertility is not expected to reach below-replacement levels in developing regions until around 2050. Mortality has been decreasing, except in those countries with the HIV/AIDS epidemic. The UN notes "the projected population trends depend on achieving a major increase in the proportion of AIDS patients who get antiretroviral therapy to treat the disease and on the success of efforts to control the further spread of HIV" (p. 6). 40 of the 62 countries most affected by the epidemic are located in Africa. Global population projections are lower if the AIDS epidemic continues as is, although no actual numerical projections were available.

Migration rates are expected to help buoy the populations of Europe and North America, which are at below-replacement levels (barring the United States). Even so, populations in the developed countries are expected to remain largely stagnant. The UN population projections mask internal migration rates.

On a longer term basis, the UN (2004) and liAS A (Lutz et al. 2001: 543) project that the world's population will stabilise between 9-10 billion by 2100. Yet, as the previous numbers indicate and the following table projects, these stabilisation projections mask regional discrepancies. The following chart sums the UN population projections for 2050. Unfortunately, in the UN summary report, Asia is treated as one large lump. "Constant" means that fertility levels remain the same at 2007 levels through 2050.

Major Area	Population (millions)			Population in 2050 (millions)			
	1950	1975	2007	Low	Medium	High	Constant
Africa	224	416	965	1,718	1,998	2,302	3,251
Asia	1,411	2,394	4,030	4,444	5,266	6,189	6,525
Latin America and the Caribbean	168	325	572	641	769	914	939

UN regional population projections. Adapted from UN 2007a: 7, Table 1

2.2 Urbanisation Trends:

Since 1900, urbanisation processes have led to nearly 50 per cent of the world's population living in urban areas by 2005 (Carpenter, Bennett et al. 2006; UN 2006). Urban population concentrations are expected to increase, with 56 per cent of the population of less developed countries living in urban areas by 2030. Migration of people into urban zones has driven more construction into areas more prone to natural disaster, such as flood plains. There has been nearly a four-fold increase since 1960 in the number of natural disasters that affect 1 million people or more (Carpenter, Bennett et al. 2006). Though urbanised zones represent less than 3% of the earth's surface, they are responsible for 78% of its fossil carbon emissions, 60% of its domestic water usage, and 76% of wood used (Grimm et al. 2008).

A caveat to reading urbanisation trends and projections is that its full meaning can be misinterpreted. The term "urbanisation" does not necessarily mean people living in megacities but in variable conditions including medium sized to and small cities and even market towns of less than a few thousand people (Cohen 2004). Additionally this urbanisation trend is not entirely due to migration but can also be due to natural growth and urban expansion (Cohen 2004). Furthermore, each nation's definition is different and the UN projections depend on each nation's self-reported population and urbanisation trends.

Urbanisation trends between the developed and developing regions are also different. By 2015, 17 of the projected 22 mega-cities (cities with 10 million or more people) will exist in developing countries. Yet, most urban dwellers continue to live in small cities with populations fewer than 500,000. "During the next few decades the urban areas of the less developed regions are projected to absorb all the population growth expected worldwide (UN 2006: 2). "In 2005, 71 per cent of all rural dwellers lived in Asia, primarily in India, China, Indonesia and Bangladesh, in order of rural population size" (p. 3). In 2005, Asia and Africa were the least urbanised, but by 2030, a complete reversal is forecast with nearly 70 per cent of the world's urban dwellers being in either Asia or Africa. Specifically, "the proportion urban is projected to reach 54 per cent in Asia and 51 per cent in Africa by 2030" (ibid).

What is not discussed in the UN report is their definition of rural and urban areas, or the peri-urban continuum that exists in many regions of the world. This is partly due to the limitation

with the UN data that is based on national statistics which use highly variable definitions of urban. For example, India's population, which is considered 70 per cent rural, would be redefined to be largely urban using China's definition of urban (Cohen 2004). Further confusion of what constitutes urban, which in some contexts is based on household livelihood, can be seen in China's definitions of urban which in some circumstances incorporate regions where 66 per cent of the population derive their income from agriculture.

The following table summarizes pertinent urbanisation projections for the period 2005-2030.

	Population in millions			
	Urban Populations		Rural Populations	
Major Area	2005	2030	2005	2030
Africa	347	742	559	721
Asia	1,533	2,637	2,352	2,236
Latin America and the Caribbean	434	609	127	113

Adapted from UN 2006: 10, Table 2

2.3 Education Trends:

Education is a fundamental right. The first sentence of Article 26 (1) of the United Nations Declaration of Human Rights states "Everyone has the right to education." The UN declaration considers primary education to be important enough to make it compulsory while higher levels of education should remain accessible for all willing and able to enter.

Yet despite its declaration as a fundamental right, many people in the world have little or no formal education. In parts of the developing world, the funding for education remained static from the mid 1970s through the end of the 1990s at \$20 per pupil with real spending decreasing by 20% over that time (Watkins 1999). The process of using loans as the basis of international aid by the developed world was at least partially responsible for this funding trend as servicing this debt led many national governments in the developing world to trim spending on health services and education (Power 2000). This funding lack was compounded by the stress of the new regime of economic decentralization and restructuring which led to further reductions in government spending on education with some schools reporting student teacher ratios of 100:1 (ILO 1996).

In the last decade there have been some notable improvements in funding of and interest in education. In Kenya, educational funding increased by over 320% during the late 1990s (Fleshman 2005). During the same period, increased funding was also seen in Uganda (Kirungi 2000).

One major global trend is the migration of people, both internally and internationally. Often, those that migrate represent a marginalized or otherwise discriminated against group within the social context of the larger nation state. This migration has led to culturally based conflict over the role of public education and to, in some circumstance, the denial of the right to education (Power 2000). In future, education systems might be called upon to educate people about the new hazards of global information exchange by helping people to know how to make wise choices of information consumption and utilisation (Power 2000).

2.3.1 Education and Economic Growth

Though growth in GDP is not synonymous with poverty alleviation, it can be viewed as a prerequisite. Within this context, the focus on education is frequently on the behalf of the very young where it is assumed that education will lead to economic benefits in future. This assumption, which is based on the fact that one's level of education is an indicator for earnings potential for individuals, may not apply when considering people in aggregate within the developing world (Lutz et al. 2008). There is also the need to address issues of secondary education in developing nations. In most cases the bulk educational resource is devoted to educating a nation's primary aged children. This value of this strategy is based in both historical precedent, the young are physiologically wired for learning, and due to the limited resources available for funding and promoting education. Since it can take multiple generations before these young people will attain decision making positions in the developing nations, a focus on secondary education initiatives may have a larger impact on national economic outcomes (Lutz et al. 2008).

The benefit of secondary education was explored by Lutz et al. (2008) where they modelled the expected economic growth potential derived from extent of education (Figure 1). In the model, the authors use as a baseline (scenario 1) with a working age population distribution where 70% are 15 to 40 years old and 30% represent the 40 to 65 year old group. This population has a low starting level of income and investment rate and the following education background: half the population is without formal education, 40% with some primary education and 10% with at least junior secondary education (but no tertiary education). This scenario is roughly inline with the demographic make-up of some Latin American and African countries e.g., Guatemala, Honduras, Kenya, Rwanda or Uganda.

The next scenario (scenario 2) the authors investigate is one where the majority of the population is exposed to primary education but few continue on into secondary school. Scenario 2 is considered, by the authors, the standard approach used by international aid organizations for educational improvements with the goal of improving a nation's economic performance. Scenario 3 is one where a greater portion of the population (50% versus 10% in scenario 2) progresses into secondary education. In this scenario, there is about a 50% larger improvement in economic growth versus scenario 2 and a greater than five times improvement over the no aid scenario. Finally, scenario 4 represents an alternate approach to universal primary education where some portion of the population progresses through various levels of education, including tertiary levels, while a substantial segment has no formal education. This scenario was based loosely on the educational demographics of India. In this last scenario, the growth rate in GDP is reduced from the high rate found in scenario 3 and is roughly equivalent with that of scenario 2.

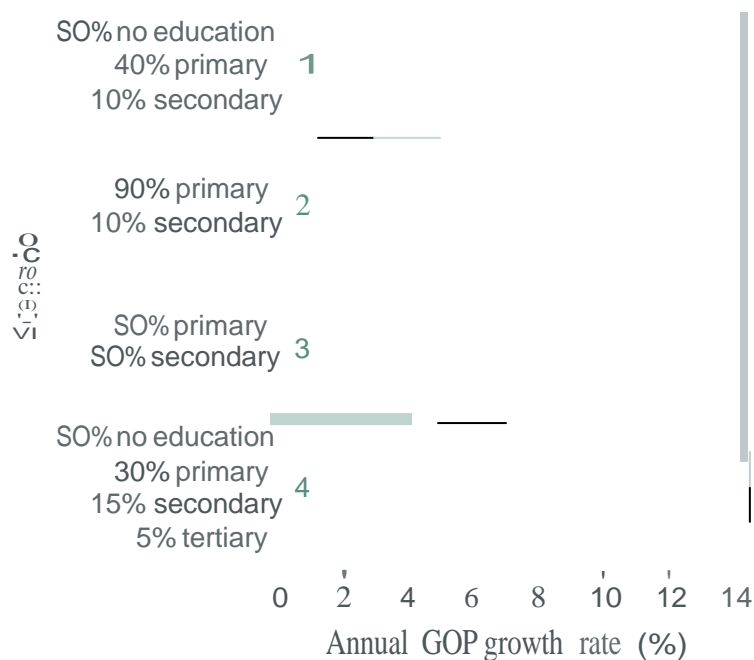


Figure 1: Four different education scenarios. Scenario 1 is considered the baseline scenario where no action is taken to improve education. Scenario 2 is considered the standard model of addressing improvements in education where a larger portion of the population is exposed to primary education. Scenario 3 is an alternate model where a larger portion of the population is exposed to secondary education. Scenario 4 is loosely based on the educational demographics of India as a comparison with other models (Lutz et al. 2008).

2.3.2 Adult Education

What was not addressed in any of the literature was the effect on economic growth of improved education for "post school age" adults. With the process of globalization, internal migration, urban and peri-urban expansion, and the requirement of people to address the changing landscape of employment opportunities, the need for lifelong education strategies should be addressed (Power 2000). Adult education is inclusive of those seeking enhancement of skills to those seeking remedial education as life opportunities improve with national economic expansion and concomitant change in social expectations.

2.4 Economic Trends:

Projecting economic futures is fraught with uncertainty, dependent on many factors such as international conflict and energy consumption. General projections however, indicate that the global economy will continue to grow, although annual rates will vary considerably. Economies in developing countries (economies in transition, developing economies and least developed economies) are growing at faster annual rates than developed economies (UN 2007c: iv) (Figure 2). The difference in scale of economies between the developed and developing regions remains quite large. However, the averaging of GDP growth masks regional trends, which are summarized below:

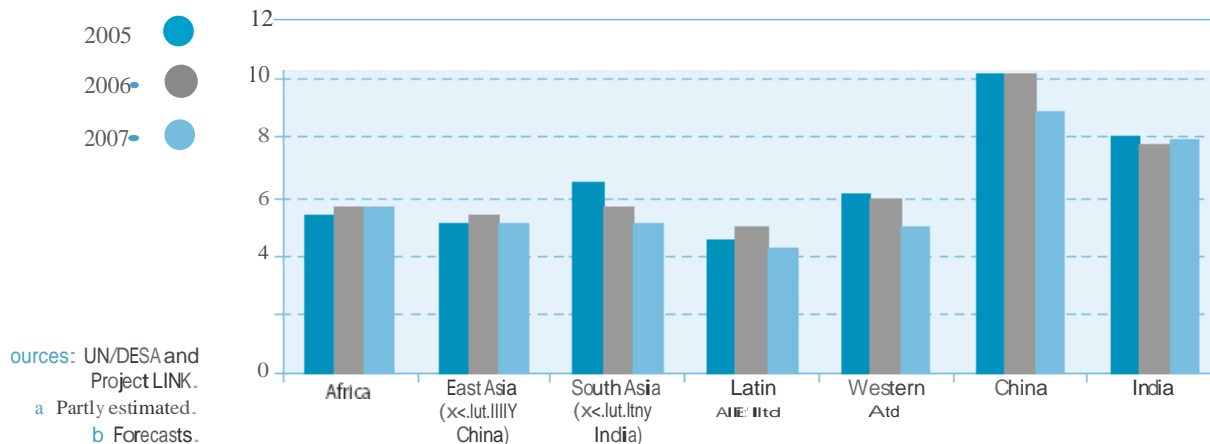


Figure 2: Regional economic percent growth projections. Source: UN 2007c: iv.

The economies of the two most populous nations, India and China, have grown at phenomenal rates over the past few years. The economic growth is increasing severe income gaps within the countries and is exacerbating resource extraction, use, and waste streams as the drive for more affluent lifestyles continues. Furthermore, greater demand for natural resources is contributing to international tensions, but the politics surrounding natural resource issues is beyond the scope of this review.

Ageing populations and declining birth rates will have an impact on local and global economies. The UN (2007b) projects that nearly 2 billion of the world's total population will be age 60 or older by 2050. This implies that a smaller workforce will be supporting a larger elderly population. The effects of a large older population on the world economy are not completely understood. The developed countries are already experiencing the effects of a smaller labour force in comparison with a larger aged population. Transition countries are also entering this phase. Developing countries still predominantly have large workforces in proportion to the aged population, but by 2050, nearly 80 per cent of the aged population will be in developing countries (UN 2007b: 2). In addition, there is a dearth of literature speculating how the ageing of populations might affect environmental trends or ecosystem extraction. The language of the UN economists, at least in the overview report, would seem to imply that they expect the markets and the global economy to continue to function in 2050 as they do now, and worry how an aged population will be supported. No literature was found in which economists explored the potential benefits (environmental or otherwise) of slowing population growth, a higher percentage of an aged population, or less consumptive societies.

2.4.1 Poverty and Economy

There are generally two categories of poverty; absolute and relative poverty. Relative poverty is highly contextual, being dependent on national income averages and medians. Relative poverty is usually set to some fraction of mean national income. On the other hand, absolute poverty is a means of defining the minimum level of food, energy and shelter needed for basic bodily survival and is largely independent of location and national income statistics. For a measure of absolute poverty to be achieved knowledge of the total quantity of all goods and services and their value need to be known. Most international institutions that focus on poverty issues use the

United Nations poverty threshold, of \$1 per day, as the level at or below which a household hits abject absolute poverty.

The use of \$1 per day as the threshold for absolute poverty is in dispute. Part of the problem is found in how poorly the value of provisioning and ecosystem services are quantified and addressed. But larger still are associated problems of poverty such as political and social marginalization. In the series *Voices of the Poor*, Narayan et al. (2000) turn the tables and ask the poor themselves how they would define their condition. Perhaps not so surprisingly, the poor do not define poverty within the context of income but within the context of asset management "...managing assets -physical, human, social, and environmental -as a way to cope with their vulnerability ..." (p. 7). In *Voices of the Poor*, a major issue that arises for the poor is social marginalization, which is expressed as having little or no political standing and poor access to education and healthcare. Surprisingly, this marginalization can extend to households with higher incomes. In the peri-urban slum of Caju outside of Rio de Janeiro, households with incomes considered middle class in Brazil still experience political and social marginalization due to the location of their home (ESMAP 2006).

Many argue that the \$1/day limit is insufficient to fully encompass all households that suffer under poverty and that such a threshold is too general to apply to a condition that has many regional and local contextual elements (Narayan et al. 2000). Yet, since international aid organisations and other institutions that address poverty and development need an internationally accepted and quantifiable value for the allocation of resources and to measure progress, such limits will likely continue to be used. The dual complexities of adding regional and local contexts to the definition of poverty and having a global, quantifiable definition have recently led to the use of a new threshold of \$2 per day to demark absolute abject poverty (Turner and Fisher 2008). One area that is still a centre of research in defining the poverty threshold is valuing various non-financial sources of income, such as food and shelter derived from ecosystem services.

Despite these known problems, the \$1 per day threshold is still in wide use. Viewing poverty within this framework indicates that the past twenty years have seen a noticeable decrease in global poverty (Chen and Ravallion 2004). Though there was a period of increase in the late 1990s, possibly associated with Asian market downturn, the total number of people in poverty decreased by 400 million during the last twenty years despite a growing world population. This poverty decrease was largely due to improved economic conditions in China and India with nearly 400 million coming out of poverty in China alone. This positive outcome has two caveats, though. One is that some level of improvement is at the expense of ecosystems as the perception of ecosystem services and provisioning are transformed from one of ongoing management for survival to one of ecosystems as a means to an improved, non-ecosystem dependent livelihoods (in perception). This is similar to the economic realities of the United States and Europe, where livelihoods are still ecosystem based but only indirectly. The other is that the number of people living on \$2 or less per day has increased by a larger amount over this time period suggesting a barrier to improvements for these somewhat more fortunate households.

PERCENT OF POPULATION LIVING ON \$1 PER DAY, 1981-2001

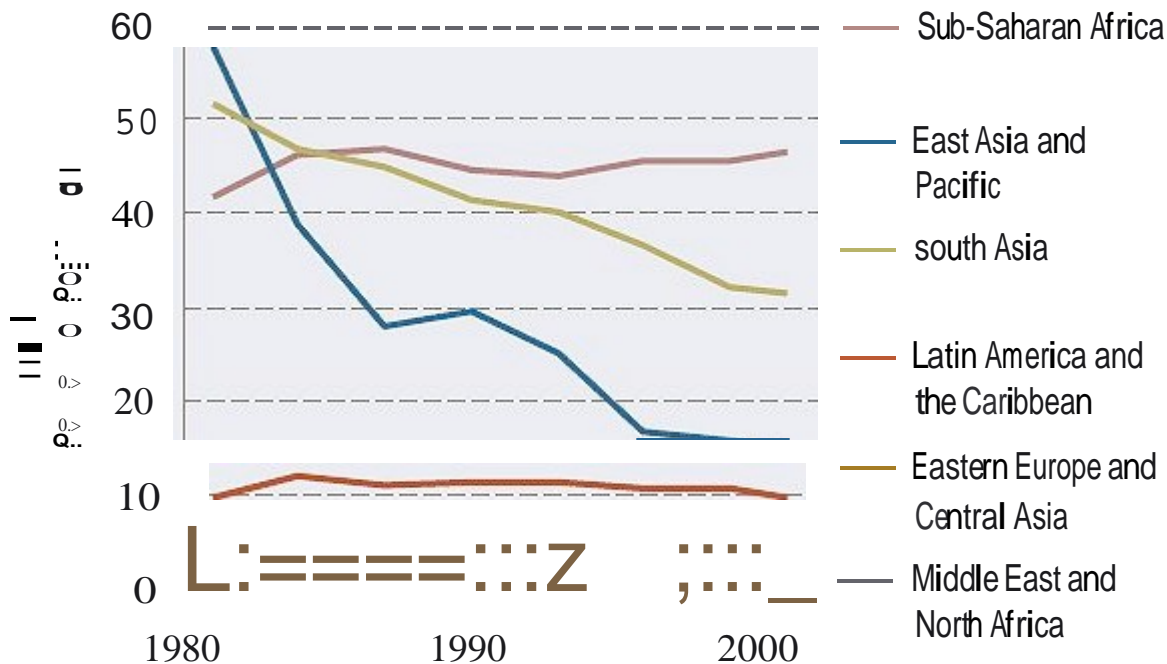


Figure 3: The percent of population living on less than a U.S. Dollar a day for six different regions from Chen and Ravallion (2004).

In terms of poverty, economies, and the peri-urban continuum, Jerve (2001: 92) contends that much of the policy and research focus on poverty has tended to focus rural poverty and urban poverty, rather than how the two are interlinked. The peri-urban continuum has been largely ignored. Poverty in the peri-urban continuum depends on migration, extended household consumption decisions (for example, the rural household might deliberately choose lower consumption to finance the education of family members who migrated to urban areas), remittances, divided households and access to transportation and communication networks. Further analysis demonstrates sharp differences in the relationship between poverty and the peri-urban continuum between countries.

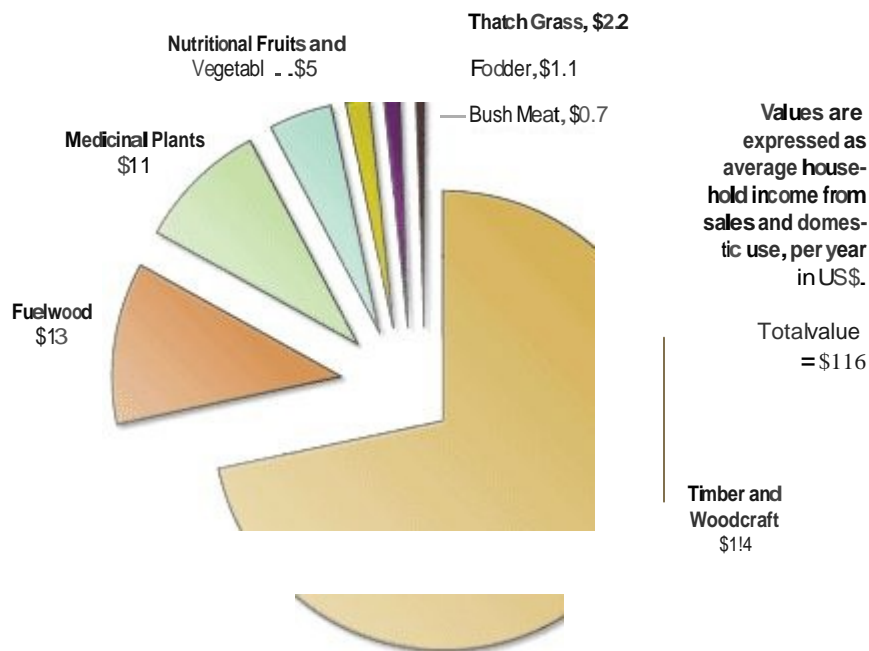
2.5 Ecosystem Services and Poverty Alleviation

Though many people are somewhat sheltered by cultural practices and technology, ultimately the entirety of the human race is dependent on products derived from the Earth for its survival. Yet the poor have a special relationship with ecosystems by having a larger portion of their livelihood derived directly from ecosystem services (Figure 4). In the literature, this income has been distinguished from other income sources, such as remittances or labour, as environmental income (Davis et al., 2004). Yet, ecosystem services, migration, remittances and poverty are quite linked. With increased migration and market access, virtual flows of ecosystem services and natural resources out of desakota areas are now important drivers of environmental and social change.

Yet, because the poor have a high time preference based on short-term survival, poverty can exacerbate local and global environmental problems leading to unsustainable land and resource use (Adhikari 2003; WRI 2005). In Malawi, those that use forests as natural insurance against shocks are most likely to live near the forest, to be male, and to be young (Fisher and Shively 2005). With the poor frequently dependent on ecosystem services as a means for survival, it is important that sustainable means of harvesting ecosystem products and accessing ecosystem services be found and maintained. Most of the literature is consistent on the amounts that environmental income adds to total family income (~20%) and on the importance of environmental income to poor families. Also consistent across the literature is the importance that undisturbed ecosystems play as insurance during crisis or other difficult times.

Money grows on trees:

Direct values from biological products through communal resource management (Ngiti) in the Bukombe district of Shinyanga Region, Tanzania



The total value of Ngiti services (including added value and non-species based services, such as pottery and water) represents three quarters of the total household income (\$574) in this district.

Source: Moneka, 1994. 2004. A Study on the Socio-Economic and Environmental Impacts of Forest Land Use Change in Shinyanga Region, Tanzania.

Figure 4: Valuing ecosystem services. Example from Tanzania.

In South Africa, Blignaut and Moolman (2006) implemented a poverty-ecosystems model to investigate community-based conservation and land restoration system as an alternative to subsistence agriculture. They compared the present value per hectare derived with the potential value derived from a restored ecosystem that had Category VI protection status (sustainable harvesting of resource as per IUCN). They found that a restored ecosystem could produce a

sustainable return of 300% more per hectare than is presently being extracted, with caveats on management, marketing of goods, and restoration as potential pitfalls.

The difficulty in using ecosystem services to alleviate poverty is expressed by Carpenter et al. (2006) in *Scenarios for Ecosystem Services: An Overview*:

A focus on poverty reduction that erodes the supply of ecosystem services can make poverty alleviation more difficult. Some strategies for achieving poverty and hunger reduction can increase pressures on ecosystems, thereby compromising the capacity to maintain benefits in the long run. In particular, enhancing the supply of a provisioning ecosystem service (e.g., food production) can reduce the supply of other provisioning ecosystem services (e.g., water, fish, or wildlife), thereby removing alternative income sources (pg. 7).

Further they continue:

The connections between poverty alleviation and changes in ecosystem services, and the trade-offs among ecosystem services, are especially challenging. Numerous approaches offer potential benefits, e.g., resilience building through response diversity, actively adaptive management, and green technology, yet in all cases, these benefits must be balanced against costs and risks. Benefits, costs, and risks are incompletely known and hard to predict. Yet, decisions must be made (pg. 11).

In peri-urban areas, the importance of both ecosystem service provisioning (access and usage of raw natural resources, such as timber for fuel or water for peri-urban agriculture or cottage industries) and ecosystem regulation (i.e. wetlands filtering and cleaning water sources) is especially clear. Peri-urban areas are marked by transitional economies and livelihood endeavours ranging from traditional farming or peri-urban agriculture to non-farm activities like tanning. Proximity to urban areas, the growth of peri-urban areas, and expansion and improvement of transportation networks is creating new opportunities for livelihood diversification and demand for goods. Many rely on ecosystem provisioning to provide the raw materials needed to meet economic demands. Nearby urban areas draw on natural resources to meet urbanisation demands as well. Large cities offer the most service oriented productivity (number of innovations as measured through financial services, patents, and scientific products), which grows faster than city size while, since physical infrastructure growth does not grow as quickly with city size, products and goods are harder to move around -thus get pressured to move into the peri-urban environment (Batty 2008). Furthermore, the wastestreams and pollution generated locally in peri-urban areas and the further urban areas, implies that peri-urban ecosystems face an undue regulation burden. Three ecosystem resources are discussed further in this section: soil, energy and water resources.

2.5.1 Soil

5-10 million hectares of agricultural land are lost annually, more than half of it by inappropriate agricultural practices (Kotschi 2000).

On the Caribbean Island of Saint Lucia in the peri-urban zone surrounding Anse La Raye, the residents grew banana and other established cash crops for their livelihood. The success of banana farming on the island led to increased cultivation of the steep slopes that are in the peri-urban zone. With the introduction of the banana, soil parasites followed which led to pesticide use and decreased productivity of beneficial soil microbes. The loss of soil microbes decreased available nitrogen and nutrient cycling. This was counteracted with increased use of fertilizers which ran off the steep slopes leading to eutrophication of coastal waters, the decrease in available fish stocks and dieback of the coral reefs. The Caribbean banana industry was largely maintained through a tariff regime that gave them favourable access to European markets. This tariff regime ended in the 1990s, causing many of the banana farms to fail. In an effort to shift activity off the hill slopes of Anse La Raye, an agricultural project was established by the German government during the early 1990s. To find a sustainable alternative, the community undertook raising chickens for meat and eggs, undertook prawn and small scale tilapia aquaculture. These activities were not sustained when outside funding ceased a few years later (Mycoo 2006). Unfortunately, the study did not follow up on changes to soil quality after the banana plantations were abandoned.

In peri-urban areas, proximity to urban areas can prove beneficial or detrimental to soil quality. In Ghana and in many desakota areas in South Asia and China, peri-urban agriculture can provide a livelihood option and meet some of the urban demand for vegetables (Drechsel 2007; Midmore 2003; Baumgartner 2001). However, lack of irrigation water and constrained garden plot size lead many to use urban wastewater for irrigation and solid urban waste to improve soil fertility. If the wastewater and solid waste has undergone a degree of treatment or composting before application, it can provide a viable and beneficial source of irrigation and fertilizer, while helping to alleviate some urban waste problems. If not properly treated, the waste can leach into local soil and water supplies, causing contamination, environmental degradation and horrible health side effects (Drechsel 2007; Wolf 2003; Khai 2007). Proximity to manufacturing and industry operations can also lead to contamination of soils, particularly tannery dyes and heavy metals. Finally, soil loss can be associated with the direct conversion of land into other products. One of the authors of this literature review is watching the top few meters of prime agricultural land being baked into bricks to meet construction demand in Kathmandu, Nepal (Figure 5). It is not clear if such land could be rehabilitated after the removal of the top layers of soil.



Figure 5: Farm soil being baked into bricks outside of Kathmandu, Nepal.

2.5.2 Energy and Fuel Consumption Trends

Energy is an essential service for living. At the most basic level, energy is used for the heating of homes and cooking of food. It is also used in micro-enterprises, such as bakeries or breweries, for production. In the context of desakota and the peri-urban zone, energy has a range of uses from cooking and heating homes to industrial uses such as brick making, baking and brewing. For the poor, energy is overwhelmingly derived from biomass sources (GNSSED 2007). Biomass sources include wood and other plant material from forest and grasslands, as well as dried manure. In the later case, the need for energy can compete with the need to fertilize crops.

Globally, energy consumption is on the rise due both to economic expansion and increased personal consumption. In the developed world, there is a general increase in the demand for energy which is being fuelled largely due to an increase in personal consumption and economic growth. An exception is the United States where the personal consumption/economic growth axis and the population growth axis are contributing to increased energy demand. For Sub-Saharan Africa the energy story speaks of many of the challenges the nations of this region have faced. Energy consumption is expected to decline on the continent even while population increases (Kadoshin et al. 2000).

For those poor who rely on biomass as their energy source, the quest for energy often competes with provisioning for other needs such as water and food. The competition for food is readily expressed through two conflicts. One conflict is the time commitment for provisioning energy supplies which competes for time invested in farming. The other is the use of dung as fuel which

competes with its use as soil enhancement in food production. This competition is of particular concern in Africa where farming is done primarily with human labour and many of the non-urban poor survive on less than 2000 calories per day (Karekezi and Kithyoma 2002). Ironically, with the onset of large scale biofuel production in recent years, the competition between energy and food is now also characteristic of the developed world.

Intrinsic to the discussion of energy and poverty is the belief that lack of available energy is one of the hindrances preventing improvement in the socioeconomic conditions of marginalised populations. Though poverty itself is crippling, often the poor represent a social class that is marginalised. These social barriers are not easily breached despite improvements in energy resources. An example can be found in Caju, a slum on the outskirts of Rio de Janeiro. This community was electrified in the early 1980s as part of a social agenda promised by a newly elected state governor. Though the addition of electricity and other services (*e.g.* sewerage services) led to a general improvement in quality of life for the residents of Caju, their social capital within the context of the larger community did not improve (ESMAP 2006) for which they still receive substandard health and education services.

The modernisation of energy beyond the established energy networks of the urban centre opens the opportunity to add renewable energy sources. In zones in close proximity to the urban core, fossil energy sources (*e.g.* liquefied petroleum gas) hold cost advantages to many renewable sources due to the established infrastructure (both physical and cultural) found there. This is not the case in more remote regions where the cost associated with the addition of distribution networks, particularly for electricity, can improve the relative costs of renewable energy (UNEA 2007). In recent years, the addition of photovoltaic systems in some of the more remote reaches of Africa and Asia has gained momentum. However, such systems have limitations (Karekezi and Kithyoma 2002). The energy needs of some micro-businesses, such as brewing, are greater than affordable photovoltaic systems can provide.

One area that receives little investment, yet may realise the greatest improvements in terms of sustainable ecosystems, is efficiency improvements for energy from biomass (Karekezi and Kithyoma 2002). Such improvements could have benefits for both energy and poverty alleviation. Biomass sources will continue to play a central role as an energy source for those outside the influence of urban cores, particularly in Africa. Though extracting energy from biomass is often seen in a negative light, due to both the health affects of pollution and the stress on ecosystems that this entails, the likelihood that the poor in areas with available biomass resources will abandon this ready energy supply is unlikely. This idea is made apparent where lands that have been set aside for preservation, such as national parks, are in close proximity to resource needing populations. The ecosystem under protection will often be exploited anyway since the logistics and finances for policing are not present and few affordable energy alternatives are available to nearby residents (Blignaut and Moolman 2006). Since improved use efficiency frequently leads to reduced resource use and emissions per energy unit, an investment in technologies that improve use efficiency can improvement both health and ecosystem services issues such as water quality and availability.

In addition to increased fossil fuel and biomass consumption to meet energy demands, the production of biofuels to offset fossil fuels is increasing. As with any resource, resource

governance and policy can determine the ability of the resource to help or hinder environmental sustainability and poverty alleviation efforts. Studies by Zah et al. (2007 as cited in Scharlemann and Laurance 2008), indicated that 21 out of 26 common biofuels reduced greenhouse gas emissions by nearly 30% when compared with conventional fossil fuel combustion. However, 12 out of the 26 "including the economically most important ones, namely U.S. corn ethanol, Brazilian sugarcane ethanol and soy diesel, and Malaysian palm-oil diesel- have greater aggregate environmental costs than do fossil fuels" (p. 44). Furthermore, the current efficiency conversion of biofuels is not that large. The International Energy Authority (Fulton et al. 2004) determined that to convert 10% of the fossil fuel consumption of the United States and Europe to biofuels will require the conversion of approximately 43% (United States) and 38% (Europe) of cropland area to biofuel production. The United States and Europe currently import significant portions of their food. Further conversion of their cropland area to biofuel production could lead to greater global food insecurity and higher food prices. Righelato and Spracklen (2007: 902) state "...this low substitution level cannot be met from existing arable land, forests and grasslands would need to be cleared to enable production of the energy crops."

The biofuel debate centres around the true environmental impact of the biofuel, from production to final consumption and the land-use necessary to support the biofuel production, to its impact on global food markets. In policy circles and public press, biofuels derived from corn, sugarcane, palm oil, and soy have gotten the most attention. Yet, studies are beginning to emerge that demonstrate that these food plant biofuels require significant land conversion and chemical and water input, such that their total environmental impact is worse than fossil fuel consumption (Figure 6). Furthermore, trading such goods on the commodities markets may drive food prices beyond the reach of many in poverty and contribute to shortages in global grain stores in the future (Oxfam 2007, Runge and Senaur 2007). Other biofuel sources, such as manure, recycled cooking oil, and switchgrass, have been shown to have a smaller environmental impact than food derived biofuels, while achieving similar greenhouse gas emission reductions. However, the political will to develop markets for alternate biofuels is weak. The United States (corn and soy biofuels) and Brazil (sugarcane and soy biofuels) are very active in promoting their chosen biofuels on the international market. The European Union might temper the use of food derived biofuels, as the EU is debating energy policy in 2008 (Kirby 2008). Details of the policy are still unknown, but pressure from Oxfam, Greenpeace and other development/environmental organisations has been attempting to ensure that the policy promotes the use of greener, more "people-friendly" biofuels.

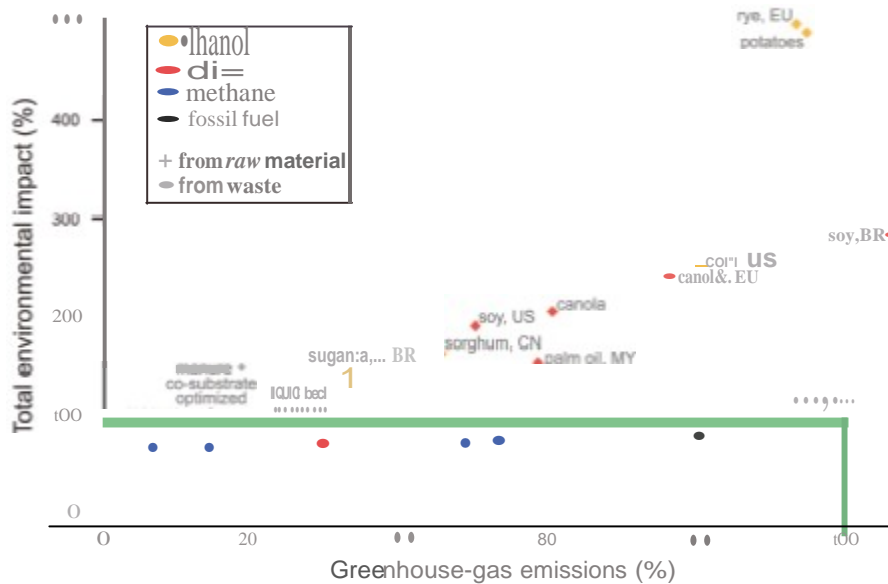


Figure 6
Greenhouse-gas emissions are plotted against overall environmental impacts of 29 transport fuels, scaled relative to gasoline. The origin of biofuels produced outside Switzerland is indicated by country codes: Brazil (BR), China (CN), European Union (EU), France (FR), and Malaysia (MY). Fuels in the shaded area are considered advantageous in both their overall environmental impacts and greenhouse-gas emissions.
 Source: Scharlemann and Laurance (2008) adapted from Zah et al. (2007).

On the other hand, some crop and non-crop biofuels represent opportunities to reduce poverty, provide cleaner burning fuels to help offset increases in transportation fuel demands and reduce bio-waste. Processes for converting manure and raw sewage into biofuels are being developed and present opportunities for cities to reduce their effluent footprint. These technologies could be particularly beneficial for dealing with wastestreams in rapidly urbanising developing contexts, as long as alternative sources of irrigation water and nutrients are established. Furthermore, utilisation of waste materials does not require the conversion of land. Canada has an operational test facility converting cellulosic plant waste to ethanol, and some European nations are beginning to construct test facilities (Fulton et al. 2004). The feasibility of constructing large-scale production plants that convert cellulose or waste to ethanol is not yet known. The ability to offset or contribute to environmental degradation will be determined by political will and the energy industry's push for certain market preferences.

Future Energy Sources

Despite the likely continued use of fossil fuels and some biomass for energy, there is a role for renewable energy technologies (RET) to the energy generation portfolios of rural and peri-urban zones. Greener utilisation of biomass also presents opportunities. Some of the advantages these regions offer are usually more readily accessible land onto which to install capacity, such as PV cells, or micro or nano scale hydropower. In terms of improving the social capital of these regions RETs allow for the establishment of local organisations and institutions that plan and govern resource planning and use. Also, RETs generally utilise local labour. These decision

making and employment prospects can empower and vest the local community and lead to local centres of civil activity and society.

Concentrating Solar Power

Concentrating solar power (CSP) is a clean, electricity generating technology that is presently more economical than photovoltaic (PV) power generation. The country leading the drive in CSP is Spain (Aldock and Tisdale 2007). The basic premise behind CSP is the usage of mirrors to focus thermal energy onto a receiver which transmits the heat for power generation.

Approximately 5 acres of land are needed for solar arrays to generate 1 MW of electricity (Kutcher 2008). Currently, three different mirror configurations are common (NREL 2008):

- 1) Parabolic-trough mirrors are curved, long rectangular mirrors that focus solar heat onto a pipe running through the centre of the trough. The pipes are filled with oil that is heated by the thermal energy, which is then used to heat water to power conventional steam generators. This system is currently the cheapest and provides high performance (Flavin et al. 2006).
- 2) Dish/engine systems use satellite dish-shaped mirrors to concentrate thermal energy onto a receiver which heats fluid within an engine. The heated fluid then expands to drive a piston attached to a generator or alternator that produces electricity.
- 3) Power tower systems utilise large fields of mirrors to concentrate sunlight on a receiver on the top of a tower. Molten salt flowing in the receiver is heated in this manner. A conventional steam generator utilises the salt's heat. This system is optimal for generating electricity beyond peak demand hours as the salt's heat storage capacity is quite high. Thus, electricity can be produced on cloudy days or into the night, which is optimal in developing country situations.

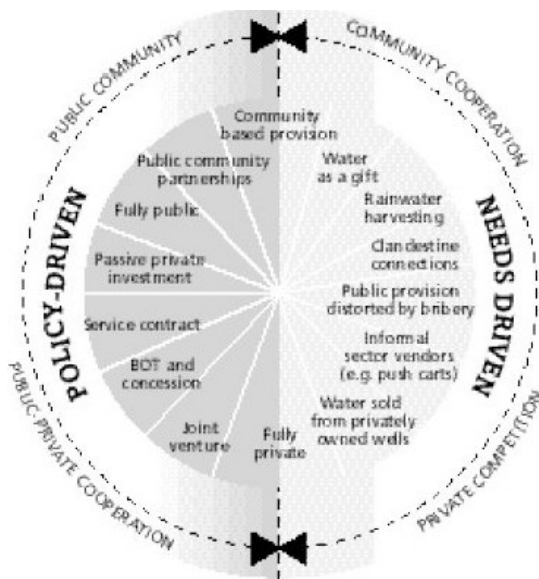
Concentrating solar power is more economical than solar photovoltaic electricity. Current estimates of the price of CSP are approximately 14 cents/KWh while typical PV costs are 30 cents/KWh (Kutcher 2008). The cost for CSP compares favourably with conventional fossil fuel turbine plants, in which energy production costs range from 10 to 16 cents/KWh (Stoddard et al. 2007; Flavin et al. 2006). Furthermore, "CSP is a fixed cost generation resource -that is the cost of generating each MWh of electricity is primarily dependent on the capital cost of the facility, rather than on fuel costs as is the case with natural gas fuelled generation" (p. ES-3). Thus, if the futures market on carbon resources remains volatile and fuel prices continue to increase, CSP will increasingly become an attractive technology. Note, the cost estimates are based on US market prices and plant construction cost estimates. In addition to less volatile costs, the yearly emissions reductions from the typical 4,000 MW CSP plant are 7,600,000 tons of CO₂, 300 tons of NO_x and 180 tons of CO (p. ES-5).

2.5.4 Water Resources Consumption Trends in Peri-Urban Areas

Peri-urban areas face a unique set of challenges in securing safe drinking water and sanitation that are only starting to be recognised in the academic and applied literature, which have typically examined such issues in terms of a strict rural-urban divide. Furthermore, wetland ecosystem services and provisioning is frequently compromised in peri-urban contexts as rural areas are transformed by urbanisation processes. As with other areas of this study, the applied literature is more developed on the issue of peri-urban water supply and sanitation than

theoretical literature. Much of the applied literature is connected to DFID's peri-urban research program.

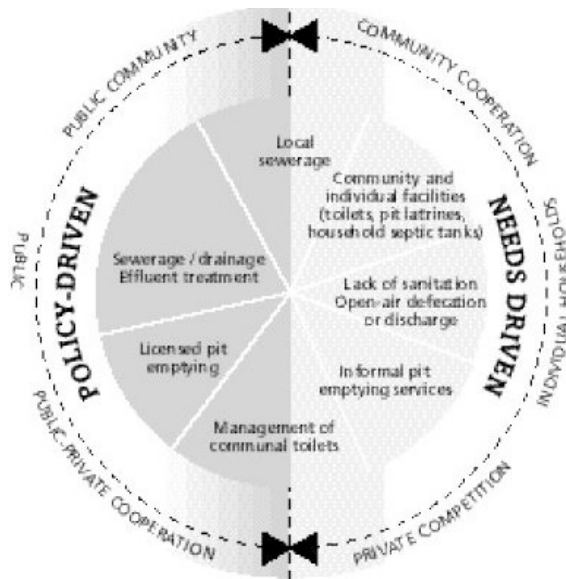
Location and livelihood diversification place peri-urban water users at a unique juncture between the rural and urban water continuum. Governance and formal institutions for drinking water and sanitation delivery often do not exist in peri-urban areas (Allen et al. 2006a). Migration, whether cyclical or permanent, enhances urban growth and expansion to a point where it outstrips formal institutional capability to provide water and sanitation. Without regular water delivery, many peri-urban dwellers rely on local water resources, either by accessing surface water or groundwater. Women and girl children spend significant amounts of time collecting drinking water and conveying it back to their households. Yet, where supplies have become degraded or diminished due to overdraft or to serve nearby urban areas, many peri-urbanites must utilize the informal water sector to supply their needs. The informal water sector can consist of such diverse means as community cisterns operated by religious authorities (such as Orangi township in Karachi, Pakistan) to water tankers or fee payment to use another's well (Ahmed and Sohail 2003; Llorente and Zerah 2003). Frequently, water costs are much higher than those borne by many urban dwellers, who might have easier access to more formal, regulated water services (Budds and McGranahan 2003; Allen et al. 2006b; Norstrom et al. 2007; Ahmed and Sohail 2003). For instance, in Luanda, Angola, peri-urban residents were spending up to a quarter of their income on water (Allen et al. 2006a).



BOX 6: The Water Supply Wheel

The 'water supply wheel' outlines policy and need driven practices characteristic of water provision in the peri-urban interface. The left and right sides of the wheel correspond to what are usually referred to as 'formal' and 'informal' practices. As the wheel demonstrates, the lines between formal and informal practices are frequently blurred.

Figure 7: The 'Water Supply Wheel' of Allen et al. (2006b)



BOX 7: The Sanitation Wheel

The 'sanitation wheel' shows the public, private and community aspects of sanitation and common means of intervention where these sectors overlap.

Peri-urban areas are often the dumping grounds for urban wastewater streams. Inadequate regulation and enforcement of wastewater and industrial wastewater, combined with lack of

wastewater treatment infrastructure, often leads to significant amounts of waste being dumped into waterways. Municipal jurisdiction often does not extend beyond city boundaries into peri-urban areas, thus denying such areas regulatory protection. Downstream peri-urban and rural areas frequently bear the health, pollution, and ecosystem degradation brunt of city effluent. Women are particularly vulnerable to the impacts of inadequate sanitation, having to worry both about personal safety and reproductive health implications. For instance, due to safety reasons in urban and peri-urban areas, women cannot leave their homes at night to go to the toilet and are often forced to dispose of human waste just outside their homes (Norstriim et al. 2007). This can contaminate water supplies and create unhealthy living conditions. Improper wastewater treatment creates multiple health hazards and can impact peri-urban agriculture.

Yet, wastewater also plays a significant role in an important income source, particularly for women, peri-urban agriculture. The demand for produce and proximity/access to urban area markets, via transportation networks, has led to the take off of peri-urban vegetable cultivation in many areas of Africa, South and Southeast Asia and China (Midmore and Jansen 2003; Drechsel et al. 2007; Wolf et al. 2003). However, as fresh water supplies are often insufficient in peri-urban areas, many growers utilize urban and peri-urban wastewater for irrigation. The untreated waste water can lead to pathogen contamination of agricultural produce, besides creating breeding grounds for other disease vectors, such as mosquitoes. Application of raw sewage can further contaminate local water supplies. Additionally, many peri-urban and urban agriculturalists utilize solid waste as fertiliser, which can wash into local water supplies.

Finally, watershed ecosystems are affected by the land-use changes accompanying increasing urbanisation and peri-urbanisation. Livelihood diversification, ranging from agricultural intensification to non-farm activities, impacts watershed ecosystems in numerous manners. As built areas and infrastructure expands, wetland ecosystems are converted for other land-use purposes. Converting land to built area increases the extent of impervious surface. This reduces groundwater recharge and enhances urban and peri-urban flooding. On one hand, the floods can temporarily cleanse urban area waterways, such as seen in Rawalpindi, Pakistan (Khan and Mustafa 2007). However, the flood waters merely route the pollution to a downstream area. At the same time, changes in water demand, usage and disposal directly affect the ability of wetland ecosystems to provide provisioning and regulating services. Agricultural and industrial intensification can lead to water pollution by pesticides, fertilizers, chemicals from industry, and elevated water temperatures. In our literature review, we did not cover the types and effects of water pollution. Besides the typical chemical pollution from urban and peri-urban runoff, an important pollutant is thermal pollution. Elevated water temperatures can be exceedingly detrimental to aquatic ecosystems.

2.6 Ecosystem Disruption Trends

The most immediate ecosystem disruption trends are those caused by the increased demand for agricultural/ livestock products, energy and water consumption and increasing climate variability. Globally, more meat and animal products are being consumed, creating adjustments in grain consumption. Political pressure to utilize grains for biofuels, versus other plant sources, poses a threat to food security and global food prices. Population growth, but more importantly, unsustainable economic growth and increased consumption without cradle-to-cradle product planning will continue to drive many ecosystem disruption trends.

Land-use changes represent a major force in ecosystem degradation and destruction. Widespread land-use changes include the conversion of marginal lands to marginal agricultural lands; increased land clearing (e.g. the Amazon rainforest for soybean or livestock production and Indonesian forests for timber products and pineapple and banana plantations); increased areas under monoculture (leading to increased disease potential and the need for more pesticide application) and loss of biodiversity. The side-effects of these pressing issues can already be seen. Urban sprawl and the associated loss of impervious surfaces also results in ecosystem disruption.

Increased fertilizer and pesticide application associated with agricultural intensification and expansion into marginal lands represents a major challenge to maintaining the health of ecosystems. Agricultural intensification and uncontrolled use of chemical inputs has significantly enhanced nitrogen deposition in coastal zones and other wetland ecosystems, among other effects. Many sizeable dead zones now exist, some year round, in what used to be some of the world's most productive estuaries and gulfs. These dead zones further hamper the ability of small-scale fishermen and women from developing countries to access vital sources of protein and compete against large commercial fishing operations.

Increased waste streams due to consumption based economies degrade ecosystems. The production and transportation of goods generates waste streams, as does their consumption and disposal. Air pollution and water pollution are well documented. A phenomenon of increasing importance is electronic waste, created by the rapid obsolescence and improper disposal of computers, televisions, cell phones and other electronic products. Many electronics contain significant amounts of toxic metals and plastics (Carroll 2008).

Climate change and shifting demands on water in terms of timing of flows (varies for regions, types of crops, industry or urban needs), are impacting the quality and quantity of flows. Water scarcity, for human consumption and ecosystem sustainability, is expected to become a significant issue in many countries by the end of the century. Portions of developed countries, such as the western United States, will be impacted affected as well. Access to clean, abundant drinking water and sanitation is already beyond the reach of nearly one billion people (UN 2006b).

Increasing energy demand is leading to greater fossil fuel and biomass consumption and dependency. The global economy is a carbon economy, largely relying on carbon-based fuels for most aspects of industrialized life. Until we can make the shift from relying primarily on carbon-based fuels for everything (plastics and food production chemicals being key beyond transportation and heating needs), we are dedicated to accelerated rates of environmental degradation and higher levels of greenhouse gases. Furthermore, as well highlighted by governments, reliance on foreign fuel supplies can enhance global geopolitical instability.

Climate variability and change are altering the very nature of many ecosystems, most notably hydrologic cycles. The Kings College of London research team is investigating the impacts of climate change on ecosystems and ecosystem services.

2.7 Resource Governance Trends

The ability to mitigate potential environmental changes and adapt to inevitable changes depends largely on the interplay between societal behavioural change, governance and the evolution of economies. Governments provide the legal framework in which markets can effectively operate. The following resource governance trends highlight the difficulties in responding to the ecosystem disruption trends mentioned earlier.

There is very little effective, binding global resource governance. International legislation, such as the Montreal Protocol, the Kyoto Protocol and the Stockholm Accord, has been negotiated for several environmental issues. The effectiveness of the treaties is mixed, as making them binding and enforceable is difficult. The Montreal Protocol has been highly successful in bringing about a ban on and phase-out of chloroflouro compounds. Negotiating and implementing reductions in greenhouse gas emissions has proved more difficult, with major emitters unwilling to sign on. Nonetheless, such international treaties can provide the framework for individual nations and states to create tougher environmental standards. A difficulty is that individual measures can be challenged as trade barriers and challenged in the World Trade Organisation (WTO). If an entity has the political and economic clout to defy WTO rulings (such as the European Union defying the United State's challenge of certain environmental standards), then that nation or entity can effectively enact environmental legislation in a vacuum of global resource protection.

A major impediment to natural resource management is the mindset and policy development of resources and ecosystem as being "national". Only in a few instances are there trans-national agreements defining resource sharing or ecosystem management such as forests or watersheds. Even in instances of trans-national agreements, signatory nations often still try to exploit or manage the resource or ecosystem to their perceived short-term national economic and development goals. Similar problems exist when governing world fisheries and coastal management zones.

Markets may provide some impetus for international resource governance and environmental standards. Fledgling markets in trading carbon emissions highlight the potential benefits and pitfalls of relying on markets to solve environmental problems. Theoretically, trading markets can provide the impetus to help companies decrease their ecological impacts by giving incentives to clean-up. However, no agreements have been made on valuing emissions, governments have not been keen to provide the regulatory framework for the market's existence, and governments have also increased the number of credits available for trading, devaluing the market. However, the improper valuation of ecosystem services and provisioning can impede markets ability to act as a forum for transnational natural resource management. Resource extraction and use are counted as positive additions to a country's GDP, but no negative externalities are accounted for in the calculations of GDP. Thus, if a country increases power generation by tapping its coal reserves, this action only counts as a benefit.

Yet, there is hope that governments will begin reversing policy, if only because environmental situations have become dire. Extreme environmental degradation in certain areas are prompting some national governments (for example, China and India) to sound the alarm and begin pushing for legislation to protect ecosystems. However, national policy effectiveness at the local level is questionable. On the other hand, some local initiatives are proving more effective in promoting

change than national policies (for example, actions by states such as California in the United States).

3. Regional Trends

3.1 Latin America:

The nature of the rural-urban continuum is quite different in Latin America than the *desakota* phenomenon found in Asia (excluding China) or the urbanisation processes currently under way in Africa. The Amazon-Andes area is already highly urbanised, with more than 80 per cent of the population living in urban areas. Godfrey and Browder (1996: 441) argue that Amazonia is a predominantly urbanised region and has been since the 1970's. The expansion of urban areas into the Amazon interior is the result of "frontier" development schemes by various governments, as well as increased formal (and informal) transportation and communication networks and responses to global demand for agricultural products and forest resources.

There are marked discrepancies in the drivers behind further land-use change between the countries in the Amazon-Andes region. In Brazil, urban expansion into Amazonia is due not only to local population and governance trends, but access to global markets. Brazil is helping to meet the global increase in demand for meat products by expanding soybean production into the rainforest. Overall beef and milk production increases are exacerbating deforestation as well in Brazil, Peru, Ecuador and Honduras (Caviglia-Harris 2004). This in turn contributes to illegal/legal road construction and the expansion/creation of urban areas within the Amazon. Government policy is also contributing to deforestation in the region. The Brazilian government has instituted *Avan9a Brasil*, through which it is instituting large-scale development projects in the region. "These plans include the expansion of paved roads into central Amazonia, and the construction of ports, waterways, railways, and hydroelectric power plants... which facilitate migration to the region" (Caviglia-Harris 2004: 182). Government policies to expand into the Amazon seem to be sparking a new trend in migration and urbanisation. Urban dwellers living in well established Brazilian urban centres are frustrated by lack of livelihood opportunity and lured by the prospect of creating livelihoods in the new urban areas in the frontier zones.

A main hindrance to economic growth in Latin America is the lack of transportation infrastructure. Communities situated closely to port areas are at a definite advantage to communities located in country interiors. What infrastructure exists is often in poor condition and the distances between urban centres quite large. For years, existing infrastructure was constructed to support the extraction and exportation of natural resources, such as wheat and iron ore, but the transportation infrastructure is not well linked. Hoffman (2006) notes "Air and sea ports link to mines and factories, but rarely to each other. Latin America and the Caribbean have almost 1.25 million miles of roads, only 14 percent of which are paved. Just 5 percent of roads in Brazil are paved... Brazil loses \$35 billion a year to logistics and transportation inefficiency-- coincidentally almost exactly what the country earns from exports." However, various Latin American countries are in the process of securing internal funds and investments from foreign donors and corporations to expand and link transportation networks. In 2006 alone, investment in infrastructure improvement doubled to \$18.4 billion (Shirai 2007). This rate of infrastructure investment is still quite low and it will be years before improved transportation networks are in place.

Complimenting the gradual expansion of road networks is the growth of personal transportation means. The trend of using motorcycles to get around seems to have spread even to the urban/peri-urban areas in frontier areas of the Amazon-Andes. Gradually increasing and improving road infrastructure (largely informally constructed or built by local authorities) are enhancing auto and motorcycle transportation in the region (which using a gross generalisation, tends to rely on river transportation). This, coupled with expanding local milk and meat markets, has increased motorcycle ownership as households have more disposable income and the need to transport goods to the markets. Caviglia-Harris (2004: 191) notes: "Motorcycles... cost significantly less and have seen recent growth: 22 per cent of farmers owned them in 1996." By 2000 when Caviglia-Harris returned to the study area, nearly 64% of the households had motorcycles. The types of motorcycles, their cost, and their origin of manufacture, were not completely explored. Nor was any other literature found about motorcycle penetration in other parts of Latin America. However, this study suggests that more households, even in remote areas, are gaining access to vehicles than before.

The trickling influx of cheaper motorcycles and gradually increasing road infrastructure has knock-on effects for land-use change and ecosystem degradation that need to be monitored. The frenzied road building (both formally sanctioned, but largely informal construction) is fragmenting the Amazon and opening up previously inaccessible areas to human influence. Access to automobiles, coupled with oil agreements with Venezuela and access to fossil fuels, is beginning to contribute to air pollution in several Latin American urban conurbations. Another development to watch that could impact land conversion rates is the increasing international demand for biofuels. Cellulotic biofuels (particularly those derived from sugarcane and soy) supply nearly 30% of Brazil's transportation fuel needs (Fulton 2004). While the Brazilian government claims to grow most of its biofuels on existing marginalized agricultural lands, it is not clear how Brazil could enhance production to meet international ethanol demands without converting significantly more land.

Gradually improving communications and transportation networks are also opening lands to urbanisation and contributing to the rates of internal migration. As is happening across Africa and Asia, the sheer distance and costs associated with telephone land lines prohibited the development of communications to rural and peri-urban areas for a long time. A plethora of cell phone companies and incentives are making cell phones popular throughout the farthest reaches of the region (Ellsworth 2004). In 2004, 118 million subscribers (roughly 1 in 5 Latin Americans) existed in Latin America; the rates are probably higher in 2008. The key driver of cell phone expansion in the region is pre-paid service, which allowed many to apply for phones in spite of the lack of regular monthly income.

Land-use changes are also affecting wetland ecosystems throughout the Amazon-Andean region. The water quality of some municipalities, including Bogota, Colombia, is quite high because the source is a wetland ecosystem which filters, cleans and releases water (Postel and Thompson 2005). Bogota has protected its watershed by creating a national park. Other wetland ecosystems throughout the Andes and the Amazon ecosystem do not have the same level of protection. Population growth and urbanisation pressures, including inadequate treatment of municipal waste, are threatening the viability of many wetland ecosystems in the region (Ringler et al. 2000).

While disarticulated urbanisation (Godfrey and Browder 1996) and global and local markets are contributing to rapid land-use change in the Amazon-Andean region, the incomes of many rural and peri-urban dwellers are linked to nontimber forest products and the conservation of these resources. Stoian (2005: 1475) notes that in Bolivia, "life in the peripheral neighbourhoods is characterised by limited access to basic infrastructure, such as electricity, potable water, and inexpensive public transport. Most residents need to buy foodstuffs as they lack access to arable land... Consequently, many peri-urban households maintain their links with the rural areas." The links are maintained so that peri-urban and urban dwellers can utilize nontimber forest products to supplement their incomes and agricultural products for additional food.

Finally, as indicated previously, much of the deforestation and land-use change in the Amazon-Andes region is driven by economics, perception of opportunities for improved livelihoods, migration and remittances. As noted earlier, it seems much of the internal migration is occurring as people leave well-established, large urban centres such as Sa6 Paulo to settle in the new, rapidly developing urban areas in the frontier zones. Outward migration to the United States and Spain is also significant, despite legal barriers imposed by the United States. Those who migrate send remittances back to remaining family members. Acosta et al. (2008: 89) indicate that Latin American countries receive 27 per cent (nearly \$40 billion) of all remittances to developing countries, making it the "top remittance-receiving region in the world." Such remittances are important to poverty reduction in many Latin American countries. Yet, at the same time, reliance on remittances presents a risk when the primary currency of the remittance is devalued or the preferred country of migration (the United States) suffers and economic downturn. Initial International Development Bank figures for January 2008 indicate that Latin American remittances fell nearly 6% when compared to last year for the same period (Painter 2008).

3.2 Sub-Saharan Africa

The rates and reasons for urbanisation in Sub-Saharan Africa are as diverse as the region. In some countries, conflict prevented urbanisation and encouraged dispersed migration. In other countries, migrants fled to urban areas for protection, leading to increased rates of urbanisation (McGregor et al. 2006). Furthermore, urbanisation in Sub-Saharan Africa has occurred without major increases in industrialization, as seen in Latin America and Asia. Access to markets, interest in livelihood diversification, and degradation of rural agricultural and pastoral lands are also factors contributing to migration and urbanisation phenomena in this region. Most of the farmers in the urban areas are migrants and have been viewed as responsible for the uncontrolled expansion of urban areas and for urban surpluses of labour. However, it appears that migrants are not disadvantaged when compared with non-migrants regarding economic inequalities in that there were many urban poor before migration and urban areas have failed to keep pace with migration (Beauchemin and Bocquier 2004). In some Sub-Saharan countries, towns and cities are becoming less desirable for migrants and urban natives: job opportunities are becoming scarce compared to the influx of migrants, urban facilities are deteriorating, and cities often lack the institutional ability to provide formal services such as water and sanitation to the migrants. In this context, urban growth registers signs of a slowdown in some West African cities largely because of the redistribution of rural-urban migration flows (Beauchemin and Bocquier 2004).

Impacts of increased population pressure on food demand and land resources have sparked an interest in nutrient balances at a range of scales. Rural areas provide the majority of the calorie-

rich food, while urban and peri-urban areas provide the perishables mostly used in fast food sectors. Food imports, like rice and poultry dominate the supply of processed food. Growing urban markets and common lack of refrigerated transportation and storage are leading to informal irrigation and agriculture in urban and peri-urban areas, particularly in Ghana. Vegetable marketing is the most profitable and in contrast to farming, in most cities it is the domain of women. Even though vegetable farming is widespread in most countries in Sub-Saharan Africa, it remains in a state of *laissez-faire* without enforced restrictions or government regulation (Drechsel 2006). Land tenure is low and infrastructure investments are also lacking in these regions. A major challenge is to bridge this gap of socio-economic and ecological disparity between urban and rural sectors due to the commodity-specific dependency of the cities on agricultural production (Drechsel 2007).

Cities are becoming nutrient and water sinks. In some countries like Ghana, informal irrigation in the rural-urban interface covers an area larger than the area under formal irrigation in the whole country. This calls for policy shift as informal irrigation receives so far little recognition and is facing many constraints. Manual water fetching is the most common means of accessing water resources, which contributes to gender inequalities. As in other municipalities around the world, the rapid pace of urbanisation has outpaced the ability of the formal water sector to provide water and sanitation services. There is no controlled waste treatment or resource recovery which, leads to almost 90% of the domestic water going waste in the city of Kumasi. Furthermore, much urban waste water goes untreated and is disposed into water ways. This pollution creates health hazards and degrades ecosystems in many peri-urban areas (McGranahan et al. 2004; Allen et al. 2006b).

Water scarcity is becoming a major challenge in urban Sub-Saharan Africa. Urban groundwater sources were largely depleted in the 1970's and the piping of distant surface water supplies is standard practice (Showers 2002; Masiyandima and Giordano 2007). Domestic and industrial wastes pollute groundwater and rivers. There is a growing demand for water especially in the generation of electricity. A holistic thought is required of the urban-rural water cycle linkages, and the equitable regional policies and practices that support ecosystem function. Key issues to be addressed in the interactions of urban, peri-urban and rural areas are: access to land and land tenure, agricultural production systems and access to markets, income and occupational diversification and migration. There is a need to understand the underlying reasons for change in livelihoods strategies which may vary depending on location, wealth, gender, generation and ethnicity. Research is needed to understand the intra-household dynamics and the relations between genders and between generations as they reveal a great deal on the cultural and social transformations (Ikeme 2001).

Sub-Saharan Africa is considered, in terms of usage of modern energy, to be energy poor. Sub-Saharan Africa's energy poverty is not due to the lack of available resources but is due to low usage. This is owing to both to the lack of the resource infrastructure for some nations and to start-up and logistical costs associated with modern energy supplies relative to traditional means of energy (Kadoshin et al. 2000). In the African context, the traditional energy sources are biomass for heating and cooking and human labour for transport and farming. In term of modern energy, Sub-Saharan Africa is the least developed. Nearly 90 per cent of the population derives energy from traditional biomass sources (Table I). Though in most energy consumption situations the concern focuses on the reduction in *per capita* consumption, usually through

efficiency improvements, the situation in Africa is usually presented through the lens of insufficient per capita consumption (Kadoshin et al. 2000; UNEA 2007).

Country/region	Percentage share of population
China	56
Indonesia	74
Rest of East Asia	37
India	58
Rest of South Asia	41
Latin America and the Caribbean	23
North Africa and Middle East	0.05
Sub-Saharan Africa	89

Table 1 The proportional dependence of regional populations on traditional biomass energy sources. (GNESD 2007)

The two major energy issues Sub-Saharan Africa faces is the lack of fertilizers and nearly absent rural electrification. Degraded and worsening soils have begun to produce lower yields. Sub-Saharan Africa is the only region where agricultural productivity decreased during the 1990s (Be 2006). Recently farmers have had to contend with a drastic increase in the cost of fertilizer as demand has grown with the diversion of crops into the production of biofuels. Additionally, the cost of natural gas has increased due to higher international demand. While there are significant natural gas resources in several Sub-Saharan Africa nations, in-country transportation and refinement capacity is limited and much of Sub-Saharan's fossil fuel resources are exported for use in the United States, Europe and China. This has led to a more than 200% increase in the cost of fertilizer in 2007 alone (M:ongabay.com 2008).

Sub-Saharan Africa also has the lowest rate of electrification of any region with only 5% coverage in rural areas (Karekezi and Kithyoma 2002). Since the distances from power generation plants to rural communities are so great in Sub-Saharan Africa, the costs of rural electrification are prohibitive. This issue is recently beginning to be addressed with the installation of photovoltaic systems. However, these systems do not address the power needs of medium and small industries, such as brewing, which are seen as being essential nodes for the development of rural economies.

3.3 South Asia

South Asia is undergoing rapid change due to globalisation, increased urbanisation and incomes. These are contributing to changes in the socio-economic, natural resources management and the built environment.

Increased incomes are changing the food consumption patterns in India and elsewhere, which have implications on future food supply and water demand. The consumption of non-grain crops is increasing compared to grain foods which will require a need for diversification of future agricultural production. However, grain production will also have to increase to meet greater demand in milk and livestock products. Access and availability of water resources will play a major role in agricultural expansion. There is a need to develop water saving techniques and

develop water pricing policies that would be beneficial in conservation and equitable distribution of water among urban and rural areas (Amarasinghe et al. 2007).

Growth in the peri-urban areas is very dynamic throughout South Asia and has an impact on ecological systems. In India, major wetlands are being lost to development pressures (Chopra and Adhikari 2004). Another side effect of economic development is large-scale pollution of air and water. The rapid pace of urbanisation and acquisition of motorcycles and cars by urban residents is exacerbating pollution. Lack of effective emissions controls for industry (formal or informal), is also a contributing factor. Regulatory institutions have not adapted fast enough to match the decline in environmental quality that has accompanied economic and demographic growth (Dasgupta 2004; Veron 2006).

Globalisation is putting pressure on the regions, especially the coastal areas in Asia and urgency is felt in coping with this impact. The challenge is how to make these coastal regions more resilient to these disruptions and be able to identify the complex interrelationship between the different stakeholders and institutions. The negative consequences of globalization on resilience can be seen in the two case studies in Junagadh District in Gujarat State, India and Banawa Selatan, in Central Sulawesi, Indonesia (Armitage and Johnson 2006). Both areas relied on coastal and marine ecosystem services to provide livelihood bases. The Gujarat fishery experienced a peak in catch in the 1990's, due to steady demand from Chinese markets and improved fishing technology. Today, the fishery stands on the brink of collapse, similar to many other fisheries around the world that have been over-exploited. Short-term economic activities in response to local and global markets are also seen in the widespread conversion of coastal ecosystems, such as mangrove forests, to brackish water aquaculture farms. Expanding prawn farms in Banawa Selatan have resulted in the destruction of 69 per cent of the area's mangroves, leading to declines in coastal fisheries, pollution problems, and loss of protection from tidal and storm surges. Unregulated and poorly designed aquaculture farms continue to propagate throughout Asia, enhancing livelihoods on short-term bases, but with immediate and long-term ecosystem consequences.

There is an urgent need for interdisciplinary research aimed at developing technologies for integrated economic and environmental analyses that take account of interactions between peri-urban producers, the urban waste management sector, municipal planners and consumers (Midmore 2003). Key issues in the vegetable production in peri-urban regions of Asia are: development of alternative production technologies to help keep pace with the growing demand for vegetables in urban areas, need for effective linkages between the peri-urban agricultural and urban waste sectors, with particular attention to cost of waste separation, adequate quality control and logistic issues and improving land tenure. Due to lack of adequate property rights and land tenure, communities are being displaced for industrial development and ecosystem conversion to brick kilns and aquaculture ponds, among other activities (Armitage and Johnson 2006). Industrial development has started to squeeze natural resources, polluting air and water in South Asia, where environmental controls can be lax (Raju 2007).

Public infrastructure development is key to reducing disparity between urban and rural areas. Good road network and telecommunications help in bridging the gap in these areas. In Asia, particularly in Vietnam and India, investments in improving road connections are helping the

rural population access wider areas for the sale of goods. The motorbike has become the major mode of transport in Asia. They form over 70%-80% of the vehicular fleet in Asia. In Laos, produce such as fruits are carried on motorbikes to market centres. What used to be a day's trip on foot to some market areas has been reduced to a couple of hours via motorcycle. Cheap Chinese motorcycles, which sell for approximately \$440, have transformed the livelihoods of villagers. They also play a key role in access to good health facilities, which are usually located in major towns or cities (Fuller 2007).

Much like China, fossil fuel consumption for transportation and electricity generation is increasing significantly in South Asia. However, access to energy still remains a problem throughout the region. In India alone, Sagar (2006) notes "about a third of our total primary energy supply still comes from non-commercial sources (biomass, dung) that are used mostly in a traditional fashion-direct combustion-by an estimated two-thirds of the country's population (mostly the rural poor) for their energy needs." Nearly 50% of India's electricity generation relies on imported coal and 65% of its oil is imported (Wayne 2005). Other South Asian countries face similar energy constraints, with access to fuel and electricity highly unequal. Furthermore, fuel supply for transportation, cooking and electricity generation are subject to global price shocks and supply constraints, as well as, conflict disruption of supply routes. For instance, Nepal recently suffered a fossil fuel shortage (affecting household energy needs and transportation demands) as conflict in the Terai region prevented fuel supplies from reaching the country. Nearly 90% of Nepal's fuel is imported from India and is transported via road networks through the Terai region in southern Nepal (Haviland 2008). Other countries in South Asia face similar fuel constraints and tenuous energy security, being forced to import most of their fossil fuels.

Technological advances in mobile telephone networks are changing the rural connectivity. Farmers in rural and peri-urban India use this technology for efficient communication and business development. This enables residents to remotely run price checks, to get instant help during unexpected events and to access advice on crops and animals (Blixt 2005).

3.4 China

A survey of the literature concerning changes to the peri-urban environment in China gives not so much any direct analysis of the *desakota* phenomenon as an assessment of trends and changes in the ecology as a whole and the environmental footprints of the various population groups within the country that all necessarily create and affect *desakota* areas with both rapid and slow onset, long-lasting, impacts.

The rapid economic growth of China is resulting in socio-economic inequalities and significant environmental damage. In one of the poorest, mountainous regions of China (Pingbian County), for example, the value of ecosystem services has been evaluated to have declined by US\$24.5 million between 1973 and 2004 (Li et al 2007). This was largely due to deforestation, with agricultural expansions and the conversion of grassland into cropland contributing to the decline. China's rivers are heavily polluted (Amarasinghe et al. 2005). The worsening of this problem is resulting in greater awareness and concern over the state of the country's rivers, with efforts to control water pollution and reverse their decline underway (Amarasinghe et al. 2005).

Together with the steady population growth of the world's most populous country, there has also been constant income growth in China, leading to changes in food consumption and dietary composition, with more meat now being favoured. Between 1985 and 2000, feed grain demand increased by close to 300% (Amarasinghe et al. 2005). This will have impacts on total cultivated land and land converted to pasture and grazing, which is more environmentally destructive than natural habitat, most of which will occur in the peri-urban region.

Regionally within China, the significant increase in irrigated arable land (15.4 MHa in 1949 to 52.2 MHa in 2005) has transformed economies and landscapes and has allowed China to remain self-sufficient in food despite its population growth (Amarasinghe et al. 2005). IWMI (2005) notes that the increase in food production intensity obtained through irrigation resulted in a decrease in total arable land, from 99 to 94 MHa between 1980 and 2000. Lin (2007), however, states that this same decline in total arable land is not only related to higher yields but also significantly to the conversion of agricultural land to non-agricultural uses as a direct result of population growth, urbanisation and industrial development. Significantly, according to Lin (2007), this massive loss of farmland has caused international concern over the ability of the Chinese to feed themselves.

Interestingly, while in most regions of the world the relationship and feedback mechanisms between changes in land-use and climate have been negative when forest has been converted to agriculture, in China, this change has been significantly (in terms of net global change) positive (Rarnankutty et al. 2006). The replacement of mixed forest by crops over the North China Plain has resulted in greater rainfall during the summer and fall, enhancing the hydrologic cycle and rendering the land more suitable for cultivation. This will have contributed to the increase in yield of crop per hectare of land and will minimize the decline in value of over-cultivated land experienced in most other regions of the world.

China has had some of the world's fastest growing cities over the past few decades and its urban population is expected to double from current levels by 2025. There has been a concurrent decrease in the rural population (Amarasinghe et al. 2005). Since the mid-1990s, international trade and economic liberalization has been causing industrial agglomeration on the coast and increasing the income gap between urban centres and rural areas (Hu 2002; McGranahan & Tacoli 2006). However, while Hu (2002) states that this internal rural-urban migration is impoverishing the hinterland, McGranahan & Tacoli (2006) state that as rural poverty has been declining since the 1980s, urban poverty has been increasing. According to McGranahan and Tacoli, the poor urban population includes temporary or unregistered migrants, urban residents made redundant from state-owned enterprises following economic reform, and residents of peri-urban dwellers who have lost their land due to urban expansion.

Despite differing arguments on the trend in the economic gap between urban and rural populations, the value of land in urban areas is significantly higher than neighbouring rural land. This is causing ever-increasing conversion of land from rural to urban uses (Lin 2007).

While urbanisation is increasing dramatically in China, this trend will have differing impacts on water availability in the peri-urban regions of various locations. The south of China is abundant in water resources for all sectors of demand (Amarasinghe et al. 2005). Many areas of the north,

however, are already water scarce and will not be able to meet water demands without major investments in water resource development. The groundwater currently used to meet demand in the North is heavily over-exploited. Central government plans for large-scale transference of water from the south to the north over very large distances need to be borne out before the idea can be relied on (Amarasinghe et al., 2005).

The current focus in the literature (from the pool of articles for the China sub-regional study for this report) leans toward examining socio-economic and environmental changes and impacts within cities themselves without much attention paid to the concurrent changes occurring in rural or peri-urban areas, even in literature concerning rural-urban migration within China (Fan 2001; Parnell 2002; Lin 2007). Lin (2007) also recognizes the dearth of information on land-use changes in China despite the massive development of land resulting from urban sprawl and rural urbanisation in a country that is rapidly urbanizing.

With economic growth China has become a major consumer of energy. In the last 6 years the average annual growth in China's energy consumption has more than double from 6.0 percent per annum to over 12.6 percent (BP 2007). This trend is expected to continue, if not expand, as China continues to develop. Presently more than 50 percent of China's energy needs come from coal with China being the top global consumer and growing at about 7 percent per year (Figure 8, BP 2007). Over the next twenty years China and India together will account for 85% of the increase in coal use and nearly 75% of total coal demand (Wayne 2005). Despite China having the second largest coal reserves in the world, coal is imported into some parts, primarily due to logistical constraints.

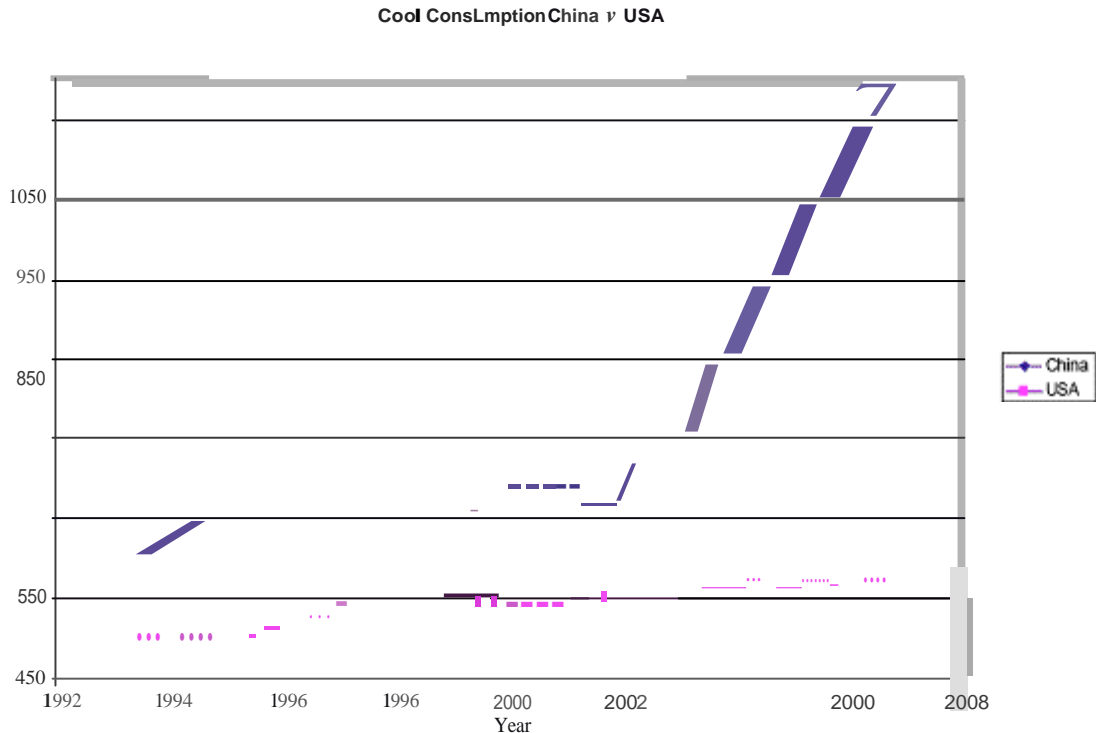


Figure 8: Coal consumption China v. the United States of America for the period 1992 to 2006. The units are in millions of tons of oil equivalent and are on the same scale. The downward trend between 1997 and 1999 is associated with the Asian economic crisis of 1997 (MacClune 2007).

Electrical demand in China has expanded at a rate similar to coal. Presently this growing demand is being met by the construction of a new coal fired power plant every two weeks on average. There are also plans for opening 40 new nuclear power plants in the next 40 years (Wayne 2005).

An area where China is likely to have the largest impact on global energy sources is in petroleum. China was responsible for 36% of the increase in oil demand globally between 2003 and 2004 and though Chinese oil production increased by 7 percent from 2000 to 2004 its demand exploded by over 35 percent in the same timeframe (Wayne 2005). This demand is expected to accelerate as more Chinese buy personal private transportation.

In the context of China the issue of energy reaches beyond its borders.

4. Further Points of Discussion

This section covers issues uncovered while conducting literature reviews for the previous sections. There appears to be a disjunction between theoretical literature and applied literature (namely DFID research) on the environmental impacts and linkages of peri-urban activities. Much of the theoretical literature is still focused on rural and urban areas as separate dichotomies. Applied literature has been noting for a while the issues of:

1. Urban, peri-urban and rural waste streams: who is being most impacted by those waste streams and physically where the waste streams end. The consensus is that peri-urban dwellers are the most adversely impacted. Much of an urban area's waste ends up outside of the concentrated urban centre in the peri-urban areas. Likewise, much of the waste

generated in the peri-urban area remains there as there is a lack of formal infrastructure for waste treatment.

2. Waste streams impact peri-urban and urban agriculture and human health. In all of the regions included in this study, there are numerous examples of the importance of peri-urban agriculture in meeting urban food demand, providing income for peri-urban dwellers (predominantly women), and the usage of urban waste/sewage water as fertilizer and irrigation inputs for the agricultural plots (Douglas 2006; Harris et al. 2006; Drechsel 2007; Midmore and Jansen 2003). Health issues (cholera, parasites, other water borne diseases) emerge when the waste is not treated or properly composted before application. Standing waste also creates breeding grounds for disease vector agents, such as flies, mosquitoes and rats.
3. The pollution footprint of the area. While an urban area's ecological footprint can be quite large and damaging, having an "urban" lifestyle dispersed over a large peri-urban area can be even more damaging and cause farther reaching pollution effects. If a city becomes more affluent, its environmental impact might decrease as urban dwellers can afford cleaner, more efficient technologies. Furthermore, the types of soils, vegetation, and ecosystems in the peri-urban and rural areas around a city are contributing factors to the vulnerability of the ecosystem to the pollutions emitted by the city and the peri-urban areas. For example, different soils have varying levels of reactivity with acidic pollutants, such as those found in electronic equipment manufacturing and disposal.
4. Access and usage rights to natural resources: Peri-urban dwellers can be at a disadvantage because: 1) loss of or insufficient property rights if they become part of the peri-urban interface when their village is absorbed by the expanding metropolis, their kinship network with rural family/friends is degraded and they lose access to resources, or urban policies and regulations give preference to urban dwellers; 2) the importance of natural resources in supplementing income; and 3) resource extraction to meet urban demand. The types of markets that exist locally and the ability to transport natural resources to an urban centre can greatly affect rates of resource extraction and consumption. How resources are extracted and consumed depends on many factors, including the duration a supplier intends to stay in business. If the supplier has only short-term business prospects, he or she is likely to conserve resources.
5. Resource governance and policy is a hodgepodge, ranging from non-existent in some areas to a mix of national and local laws enforced in varying and vying degree. At times, national policies can be contradictory. For example, the Brazilian government has pledged to conserve the Amazon, but national development policy (Avan9a Brasil) encouraging cattle ranching and agriculture encourage continued destruction of the rainforest.

Much of the theoretical literature, particularly the conservation biology or ecology literature is only beginning to view humans and human activity in the peri-urban or urban landscape as part of an area's ecology. Frequently, only the negative biological impacts of human activities were discussed, without the social or economic context to frame such activities. There is a much stronger discussion in the theoretical literature on "urban environmental footprints" which is extending to peri-urban areas (Brook and Davila 2000; McGranahan et al. 2004, also see other work by DFID and liED). The theoretical shift to encompass concepts understood by applied research seems only to be occurring within the last 3-4 years, with the predominance of articles

coming from 2005 through 2007 (Jorgenson and Burns 2007; Alcamo et al. 2005; Li 2007). Another common trend in theoretical literature is to focus on a single city or a couple of cities, probably because of issues of scale.

Finally, a major weakness of this literature review was the failure to investigate and include literature on foreign energy policy and international resource politics. Extensive political literature exists; it was simply not reviewed for this study. However, international markets (be they energy or other commodities), natural resource exploitation and global environmental change, are strongly influenced by governance trends. The processes of desakota and the linkages between desakota and ecosystem resources are shaped by international politics and shape international politics. A more comprehensive review and attempts to address environmental changes within development contexts will need to include international and transnational corporation trends.

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