Towards Environmentally Sustainable Economic Growth (Green Growth) in Asia and the Pacific*

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<Abstract>

Asia and the Pacific, which is a vast region covering 40 per cent of the world territory, and is home to 61 per cent of the world's population, has been experiencing the fastest economic growth in the world. Without doubt, this has been placing enormous pressure on the ecological carrying capacity of the region. Unless economic growth is properly checked, the ecological carrying capacity for future generations will be seriously compromised. This is especially so because the carrying capacity is relatively more limited in the Asia-Pacific region than in other regions of the world. However, the need for continued economic growth is enormous, given the continuing high poverty levels and population growth.

This requires the region to embrace the new paradigm of environmentally sustainable economic growth or Green Growth, which was endorsed by the 5th Ministerial Conference on Environment and Development held in Seoul in March 2005. The purpose of this paper is to provide reasons for the urgency of shifting the current form of economic growth toward Green Growth, and explains the new concepts and systems that are required to achieve it. It is emphasized that Green Growth comes through increasing the eco-efficiency of consumption and production patterns, and creating synergy between the environment and the economy.

Keywords: growth, environmental sustainability, carrying capacity, environmental pressure, eco-efficiency
JEL Classification: O13, Q01, Q56, Q58

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1. Introduction

Asia and the Pacific, which is a vast region covering 40 per cent of the world territory, and is home to 61 per cent of the world's population, has been experiencing the fastest economic growth in the world. Dramatic economic growth has enabled the reduction of poverty and social progress in many parts of the region. However, this has been placing enormous pressure on the ecological carrying capacity of the region. Unless economic growth is properly checked, the ecological carrying capacity for future generations will be seriously compromised. This is especially so because the carrying capacity is relatively more limited in the Asia-Pacific region than in other regions of the world.

Despite it rapid growth in recent years, Asia and the Pacific is still home to two thirds of the world's poor. An increase in the total population of the region of some 676 million persons by 2020 is projected. About 712 million persons in the region, or about 65 per cent of the global total and 22 per cent of the region's population, are estimated to live on less than $1 per day. An estimated 545 million people in the region are still undernourished, comprising 65 per cent of the world's ill-fed (FAO, 2004). Therefore, the need for continued economic growth is enormous, given the continuing high poverty levels, population growth and a nutritional status that is still far from satisfactory in many countries

Therefore, the challenge is to achieve economic growth which is environmentally sustainable, as the Millennium Declaration calls for ensuring environmental sustainability as No. 7 of the Millennium Development Goals. For environmental sustainability to be obtained, economic growth should not incur an increase in the overall use of resources so as to ensure that the use of natural resources is in line with the region's carrying capacity. The link between economic growth and the use of natural resources and of environmental services needs to be broken. This requires the region to embrace the new paradigm of environmentally sustainable economic growth or Green Growth, which was endorsed by the 5th Ministerial Conference on Environment and Development held in Seoul in March 2005.

The purpose of this paper is to provide reasons for the urgency of shifting the current form of economic growth toward Green Growth, and explains the new concepts and systems that are required to achieve Green Growth. The paper is organized as follows. Section 2 will provide evidence that the current form of economic growth in Asia and the Pacific (and the World) is environmentally unsustainable. Section 3 will then examine whether economic growth will ultimately improve the environmental sustainability, as suggested by the so-called Environmental Kuznets Curve (EKC). It will be shown that that most measures of environmental sustainability (except a limited number of pollution measures) tend to deteriorate as income increases. Section 4 will discuss how the region can embrace the new paradigm of Green Growth. It will be emphasized that Green Growth comes through increasing the eco-efficiency of consumption and production patterns, and creating synergy between the environment and the economy. Section 4 will also address the new systems required to achieve Green Growth in the region. Concluding remarks are offered in Section 5.

2. Limited Ecological Carrying Capacity, but Increasing Environmental Pressure

2.1. Some Key Concepts

At the outset, it is worth defining some concepts that are going to be used throughout this paper. Environmental sustainability refers to the capacity of a development process to ensure that natural resources are not depleted faster than they can be regenerated and the ecological systems remain viable. In other words, environmental sustainability can be formulated as "living within the ecological capacity of the biosphere" (as IUCN/UNEP/WWF pointed out in *Caring for the* Earth, 1991) Therefore, in order to ensure environmentally sustainable economic growth, environmental pressure should remain within the limit of the ecological carrying capacity.

Hence, in order to improve the environmental sustainability of economic growth, we need to

- reduce environmental pressure of humanity or/and
- increase ecological carrying capacity.

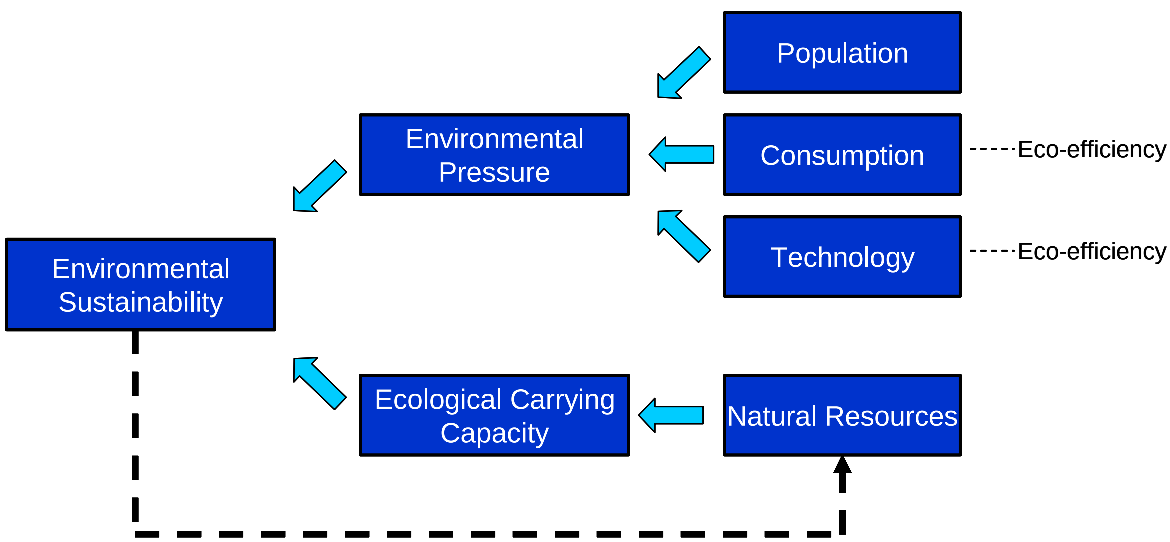
Environmental pressure is defined here as the "actual load" (the actual rates of resource harvesting and waste generation) that is imposed on the environment by people. It changes not only with (1) population, but also with (2) per capita consumption (amount and pattern), and (3) production pattern (i.e., technology with which goods and services are produced). As will be discussed more in Section 4, consumption and production patterns are closely related with eco-efficiency.

On the other hand, ecological carrying capacity is defined here as the "maximum load" (the maximum rates of resource harvesting and waste generation) that can safely be imposed on the environment by people so that it can be sustained indefinitely in a given space.[1] That is, carrying capacity is "sustainable limits" to environmental pressures. It is largely determined by the natural resource endowment and hence tends to remain constant over time. However, it can be increased by protecting, conserving, and restoring ecosystems and biodiversity. It is also noted that the term "ecological carrying capacity" is used here interchangeably with "environmental carrying capacity" or "carrying capacity".

To repeat, an environmental pressure is demand for biological product and services, while carrying capacity is the maximum supply of biological product and services that can be provided by the natural environment so that renewable resources are not depleted faster than they can be regenerated and that ecological systems remain viable. Therefore, in order to ensure that economic growth is environmentally sustainable, demand (consumption) for biological product and services should not exceed the maximum supply of biological product and services (the ability of nature to absorb waste and emissions). Overshoot reduces the ability of the natural environment to provide environmental goods and services to support humanity and hence may permanently reduce the ecological carrying capacity.

Figure 8.1 summarizes how environmental sustainability is related with the environmental pressure and the ecological carrying capacity. The environmental sustainability of a country is secured only when environmental pressure is within ecological carrying capacity In turn, the ecological carrying capacity is heavily determined by its endowed natural resources, while the environmental pressure of humanity is closely related population, amount (and pattern) of consumption per capita, and production technology.

Figure 2.1 Determinants of Environmental Sustainability

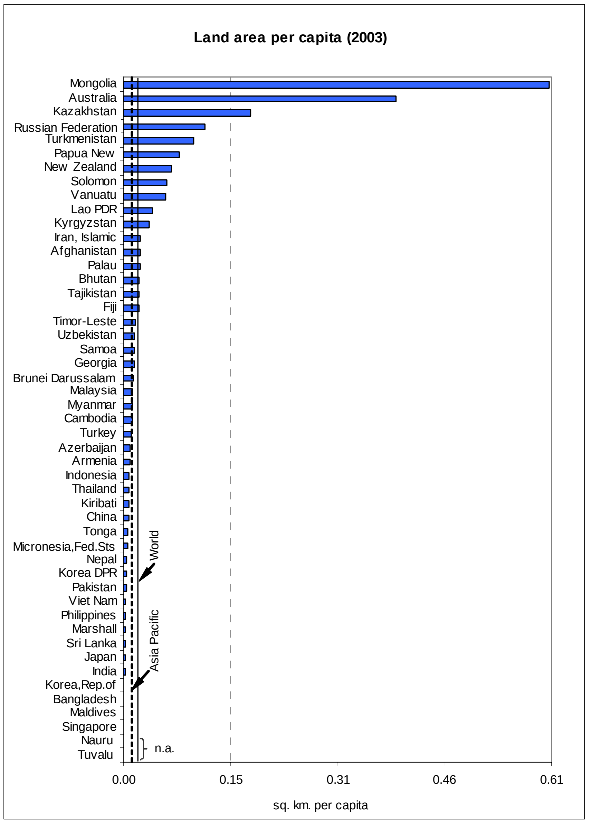


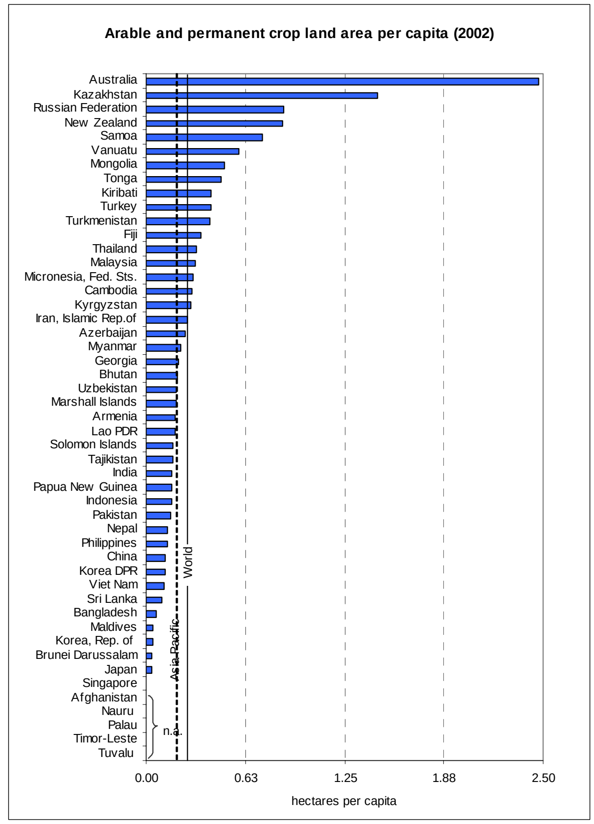
2.2. Limited Ecological Carrying Capacity

As noted above, a country (or region)'s carrying capacity is largely determined by the natural resource endowments, which can be measured with various variables such as land area, forest area, etc. Figures 2.2, 2.3, and 2.4 illustrate land area per capita, arable and permanent crop land per capita, and total forest area per capita, respectively, for the 49 ESCAP member countries located in the Asia-Pacific region.[2] Those countries with no data available are also included with "n.a." so that each figure maintains the same set of the entire ESCAP member countries in the region. For the purpose of comparison, weighted average values for the world and the countries in the region are also shown as solid and dotted lines, respectively.

As illustrated in Figure 2.2, the countries in the Asia-Pacific region, on average, have smaller land area per capita than the entire world: as of 2003, the region's land area per capita is 0.0136 km^2 while the world average is 0.0206 km^2 (i.e. the region's average population density is 73.5 persons per one square kilometer while the world's population density is 48.5 persons per one square kilometer). In particular, the countries which have extremely limited land area per capita (and hence extremely limited carrying capacity per capita) are Singapore (0.0002 km^2), Bangladesh (0.001 km^2), Maldives (0.001 km^2), the Republic of Korea (0.002 km^2), India (0.003 km^2) and Japan (0.003 km^2) . Among the 47 countries for which data are available, only 11 countries such as Mongolia, Australia, Kazakhstan, Russian Federation, etc. enjoy greater land area per capita than the world average.

Figures 2.3 and 2.4 also show that countries in the Asia-Pacific region, on average, have smaller arable and permanent crop land area per capita, and total forest area per capita than the world. This implies that most countries in the Asia-Pacific region, on average, have more limited carrying capacity than the countries in other regions of the world.





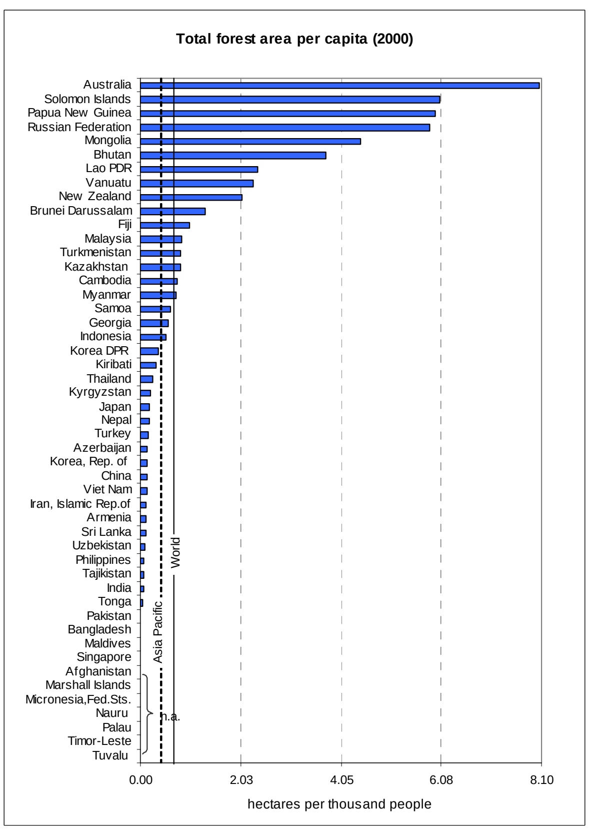


Figure 2.2 Land Area per capita (2003)
Source: World Bank, World Development Indicators, Available on-line at http://publications.worldbank.org/WDI/
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Figure 2.3 Arable and Permanent Crop Land Area per capita (2002)
Source: Food and Agriculture Organization of the United Nations (FAO), FAOSTAT on-line statistical service. Available on-line at http://apps.fao.org. Data can also be obtained electronically at: the WRI website (http://www.wri.org/) .

Figure 2.4 Total Forest Area per capita (2000)
Source: Food and Agriculture Organization of the United Nations (FAO). 2001. Global Forest Resources Assessment 2000--main Report. FAO Forestry Paper No. 140. Rome: FAO. Data can also be obtained electronically at: the FRA website (http://www.fao.org/forestry/) or the WRI website (http://www.wri.org/)

2.3. Increasing Environmental Pressure

As noted above, environmental pressure changes not only with (1) population, but also with (2) per capita consumption, and (3) production pattern. In order to compare the environmental pressure, GDPs per capita for the 49 ESCAP member countries located in the Asia-Pacific region are shown in Figure 2.5. Weighted average values for the world and the countries in the region are also shown as solid and dotted lines, respectively. As seen in the figure, the countries in the Asia-Pacific region, on average, have smaller GDP per capita than the entire world: as of 2003 in 2000 constant US dollars, the region's GDP per capita is 2,500 dollars while the world average is 5,345 dollars. Thus, assuming the ESCAP region has the same production pattern as elsewhere in the world, the region's individual on average is placing the environmental pressure which is about half of the world average. Among the 49 ESCAP member countries located in Asia and the Pacific, only 5 countries such as Japan, Singapore, Australia, New Zealand and Republic of Korea have GDPs per capita, greater than the world average.

Figure 2.5 GDP per capita (2003)

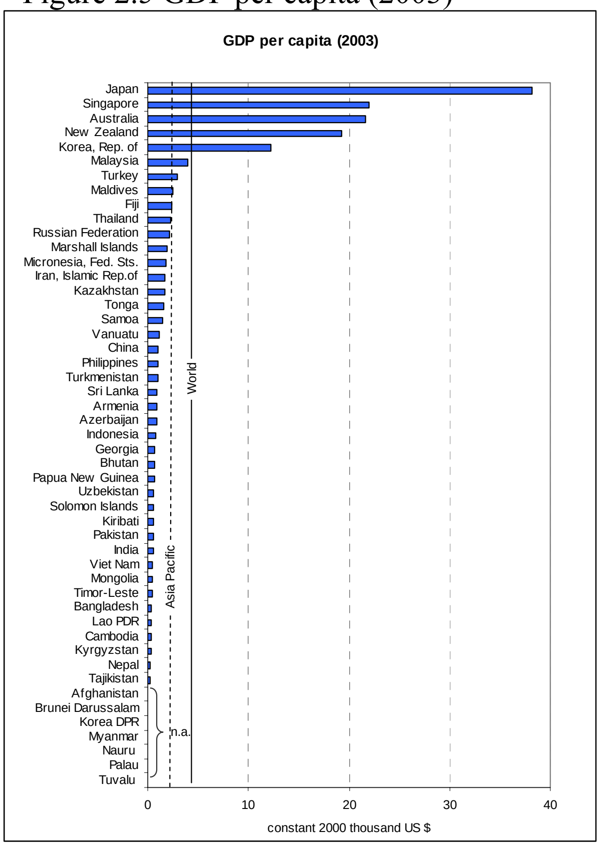
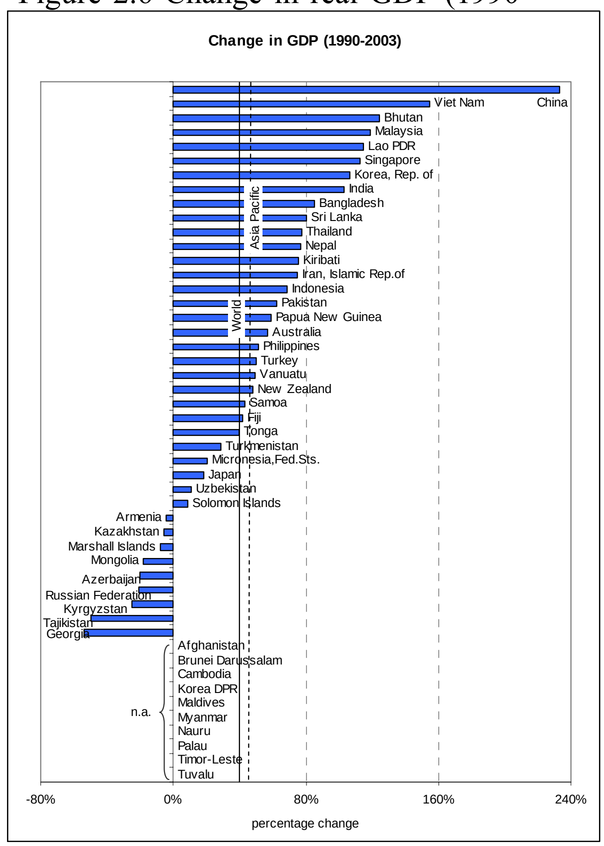


Figure 2.6 Change in real GDP (1990-



However, the region's environmental pressure is increasing more rapidly than elsewhere, as the region's economic growth is the fastest of the world. Figure 2.6 shows the real growth rate of GDP over the period 1990-2003 for the ESCAP countries. The weighted average growth rate for the Asia-Pacific ESCAP member countries was 44.3%, while that for the world was 40.2%. When excluding Japan which takes over 50% of the region's GDP and grew by only 18.7% for the period, the Asia-Pacific countries grew by 88.3%, greater than twice the world average. In particular, countries in East Asia such as China (233%), Viet Nam (155%), Bhutan (125%), Malaysia (119%), Lao PDR (114%), Singapore (113%), the Republic of Korea (107%) and India (103%) saw the fastest growth rates. Thus, most countries in the Asia-Pacific region have increasingly been placing more environmental pressure and are likely to experience

2.4. Ecological Footprinting: A Comparison of Carrying Capacity and Environmental Pressure

The fact that the Asia-Pacific region has more limited carrying capacity than the world average and is increasingly placing more environmental pressure may imply that the region is more likely to face environmental unsustainability than other regions of the world. However, this does not necessarily lead to a conclusion that the region is currently experiencing environmentally unsustainable economic growth. Therefore, we need a more comprehensive measure with which we can compare the carrying capacity with the environmental pressure.

In the *Living Planet Report 2004*, WWF International and Redefining Progress provide useful information on whether the ecological pressure of humanity's activities (Footprint) is within the carrying capacity of a country (or of the earth). A country's Footprint is defined as the total area required to produce the food and fiber that it consumes, absorb the waste from its energy consumption, and provide space for its infrastructure (Living Planet Reports 2004, p.10, Visit also Global Footprint Network, http://www.footprintnetwork.org). Thus, 'Ecological Footprint' is an indicator of human pressure on the biosphere. On the contrary, a country's 'Biocapacity' (Biological Capacity) in Footprinting analysis is defined as the total usable biological production capacity in a given year of a biologically productive area of a country. Thus, the term, Biocapacity, is used here for the annual regenerative and absorptive capabilities of nature, and has much in common with the biological carrying capacity, the term used in this paper.

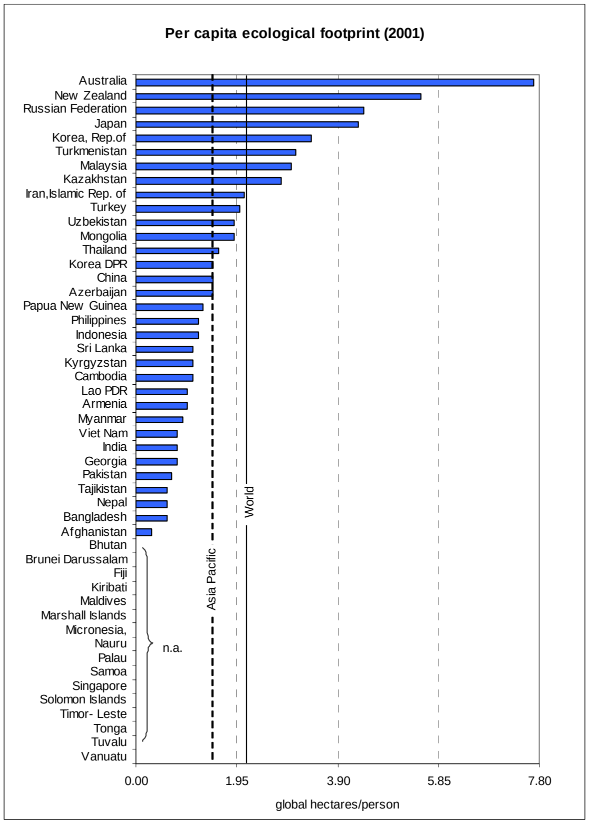
When humanity's Footprint is not within the Biocapacity, it is experiencing Ecological Deficit (i.e., its Footprint is unsustainable). It should be noted, however, that the Ecological Footprint methodology does not capture all of humanity's pressures on the environment. For example, non-renewable resources, toxic pollutions and species extinction are not incorporated into the Footprint model. Nonetheless, Footprinting offers useful information on whether the current form of economic growth is sustainable in the sense that humanity's use of natural resources is within the limit of the regenerative and absorptive capacity of a country (or the earth).

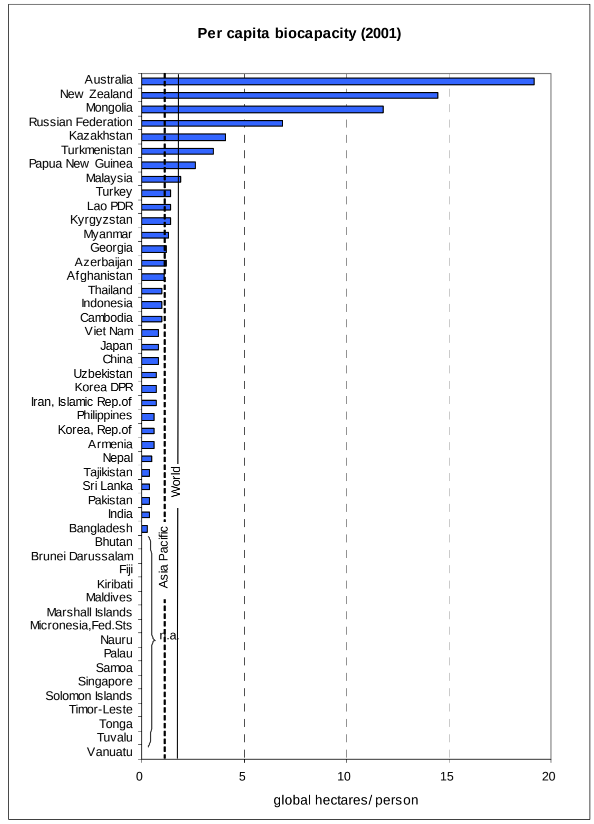
Living Planet Report 2004 suggests that as of 2001, the global Ecological Footprint is 13.5 billion global hectares, or 2.2 hectares per person. (a global hectare is 1 hectare of biologically productive space with world average productivity), while the Earth's Biocapacity is approximately 11 billion global hectares, or 1.8 global hectares per person. Thus, the Report concludes that humanity's Ecological Footprint exceeds global Biocapacity by 0.4 global hectares per person, or 21 per cent. This overshoot is possible because humanity can liquidate its ecological capital (i.e. natural resources) rather than living off annual yields, but only for some time.

Figure 2.7 illustrate per capita Footprints for the 49 ESCAP member countries in the Asia-Pacific region. Weighted average values for the world and the countries in the region are also shown as solid and dotted lines, respectively. The Asia-Pacific region has smaller per capita Footprints (1.5 hectares) than the world average (2.2 hectares). At an individual country level, however, per capita Footprints of eight ESCAP countries are exceeding the world average. Australia has the highest per capita Footprint in the region, at 7.7 hectares per person.[3] New Zealand (5.5 hectares), the Russian Federation (4.4 hectares), Japan (4.3 hectares), and the Republic of Korea (3.4 hectares) take the following places. China with the largest population in the World has 1.5 hectares of per capita Footprint, which is the same as the average per capita Footprint of the region. When it is translated to the total value, however, China alone causes 17.5% (1.9 billion hectares) of the world's total Footprint while it has approximately a little short of 10 percent of world's total Biocapacity. Therefore, China, which is already running a large sum of Ecological Deficit, is expected to run even greater unaccounted Ecological Deficits, as it continues its fast growth, unless its current growth pattern changes.

Figure 2.8 shows Asia-Pacific countries' per capita Biocapacities. As seen in the Figure, the carrying capacity of the Asia-Pacific region (1.1 hectares) is much smaller than that of the entire earth (1.8 hectares). The countries with the smallest per capita Biocapacity are Bangladesh (0.3 hectares), India (0.4 hectares), Pakistan (0.4 hectares), Sri Lanka (0.4 hectares), and Tajikistan (0.4 hectares) while the countries with the largest per capita Biocapacity are Australia (19.2 hectares), New Zealand (14.5 hectares), Mongolia (11.8 hectares), and the Russian Federation (6.9 hectares).

Figure 2.9 shows which countries are running Ecological Deficits. The figure shows that the Asia-Pacific region is running approximately the same amount of Ecological Deficit (0.4 hectares) as the world average. The countries with the largest per capita ecological deficit are Japan (3.6 hectares), the Republic of Korea (2.8 hectares), and Iran (1.4 hectares). Among the 33 Asia-Pacific countries in the sample, 20 countries are experiencing biological deficit. Despite the high per capita Ecological Footprints of Australia, New Zealand and Russian Federation, they run Ecological Surpluses (i.e. negative values in the table) due to their large per capital Biocapacities, with 19.2 hectares, 14.5 hectares, and 6.9 hectares, respectively.





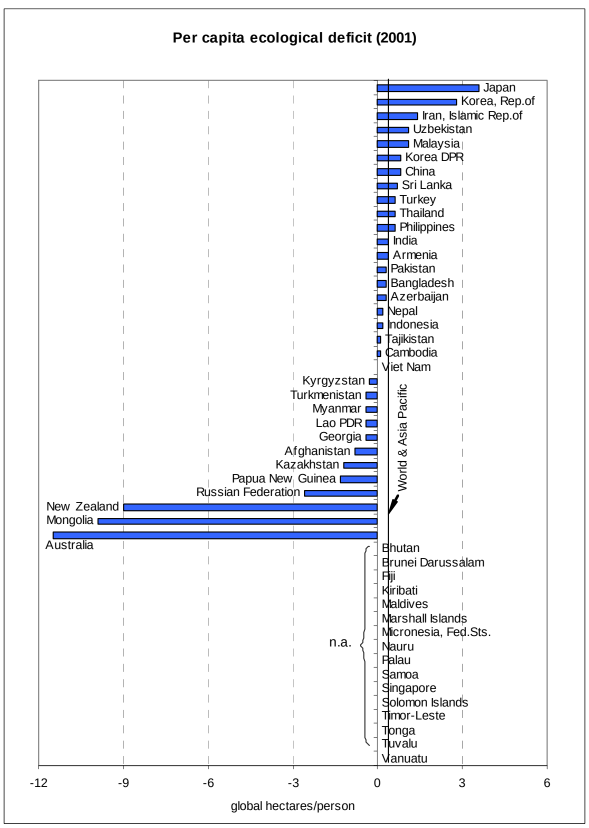


Figure 2.7 Per capita Ecological Footprint
Source: Global Footprint Network
(http://www.footprintnetwork.org)

Figure 2.8 Per capita Biocapacity
Source: Global Footprint Network
(http://www.footprintnetwork.org)

Figure 2.9 Per capita Ecological Deficit
Source: Global Footprint Network,
(http://www.footprintnetwork.org)

To summarize, the Asia-Pacific region, home to 3.9 billion people or over 60% of the global population is the place which causes 42% (5.6 billion hectares) of the world's total Footprint (13.5 billion hectares). The Asia-Pacific region has smaller per capita Footprints (1.5 hectares) than the world average (2.2 hectares). However, the carrying capacity of the Asia-Pacific region (1.1 hectares) is much smaller than that of the entire earth (1.8 hectares). Thus the Asia-Pacific region is running approximately the same amount of ecological footprint deficit (0.4 hectares) as the world average. In short, even though humanity in the Asia-Pacific region, compared with the global average, is still placing a smaller environmental pressure on the planet, the region's ecological deficit is no smaller than the world average because the region's carrying capacity is more limited than the global average. This implies that if the current form of economic growth continues in the Asia-Pacific region, the region's ecological Footprints will increasingly exceed the regenerative capacity of the region, at a scale greater than the global average.

It is also useful to examine the time trend of Footprints and ecological deficits for the World and the individual countries of interest. Figure 2.10 tracks the world's average per person Ecological Footprint and per person Biocapacity for the period 1961-2001. An additional dotted line (scale on right side of figure) shows the growth of the human population for the same period. This figure shows that the average Footprint in the World has increased from about 1.7 hectare per person in 1961 to about 2.2 hectare per person in 2001. On the other hand, per capita Biocapacity has declined from 3.5 hectare per person in 1961 to about 1.8 hectare per person in 2001. Per capita Biocapacity has declined mainly due to the fact that the world population has increased from some 3 billion to 6 billion during the period. As a consequence, in the mid-1980s humanity's collective Ecological Footprint breached the carrying capacity of the earth for the first time, and has remained unsustainable ever since.

Figures 2.11-2.15 track the per capita Ecological Footprints and per capita Biocapacities of China, India, the Philippines, the Republic of Korea and the Democratic Peoples Republic of Korea (DPRK), respectively over the same period. The figures show that ecological deficits of all of these countries are widening over time. Specifically, China has moved from using about 0.8 times its domestic Biocapacity in 1961 to over two times the Biocapacity of China in 2001; India has moved from using about 1.2 times its domestic Biocapacity in 1961 to twice the Biocapacity of India in 2001; The Philippines has moved from using a little less than its domestic Biocapacity in 1961 to over twice the Biocapacity of the Philippines in 2001; the Republic of Korea has moved from using about 0.7 times its domestic Biocapacity in 1961 to nearly six times the Biocapacity of the Republic of Korea in 2001. This makes the Republic of Korea's Footprint one of the most rapidly growing Footprints among all nations. Finally, Figure 2.16 shows that starting in the 1960s, the Democratic Peoples Republic of Korea carried an increasing ecological deficit. When its main sources of imports closed around 1990, the country's Footprint declined sharply, but it is still running an ecological deficit.

To summarize, when comparing the current Ecological Footprint with the capacity of the region's life-supporting ecosystems, it must be concluded that we no longer live within the ecological limits of the earth. In particular, the Asia-Pacific region has a relatively more limited carrying capacity and this suggests that the region is likely to run higher ecological deficits if it continues the current form of its economic growth. Thus, the region's ecosystems which are already suffering from overuse, will be suffering even harder if the region continues down the path of unsustainable exploitation and consumption.

Figure 2.10 Global Footprint and Biocapacity per person

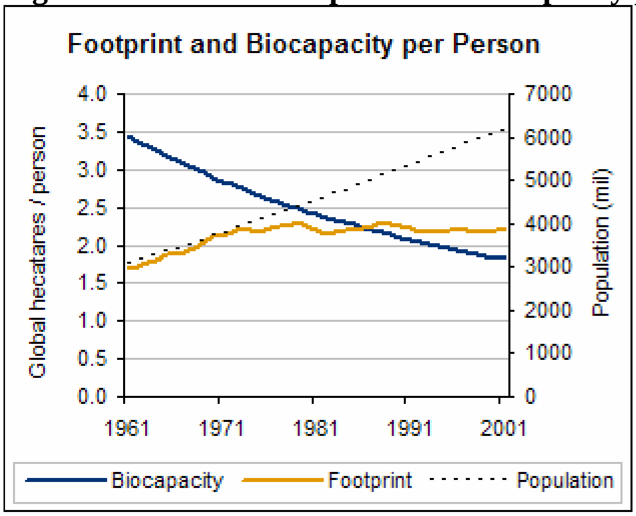


Figure 2.11 China's Footprint and Biocapacity per person

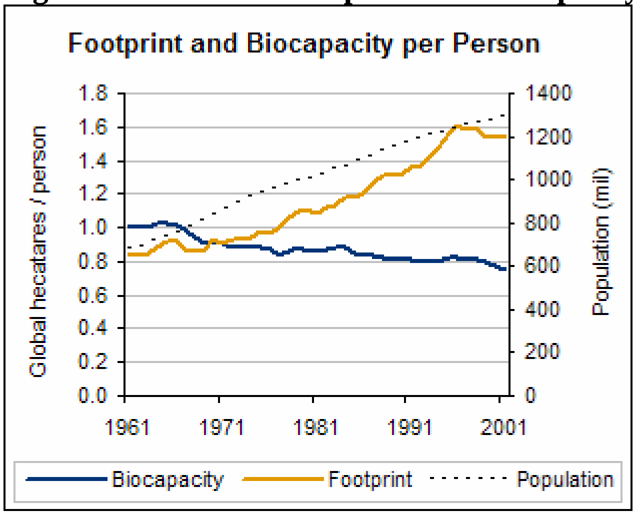


Figure 2.12 India's Footprint and Biocapacity per person

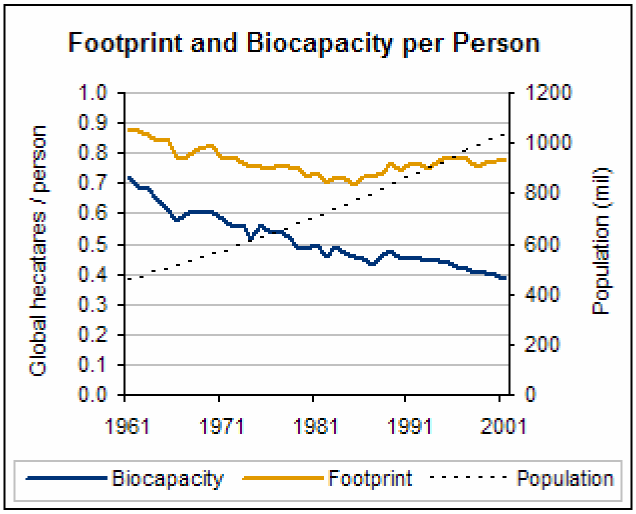


Figure 2.13 The Philippines' Footprint and Biocapacity per person

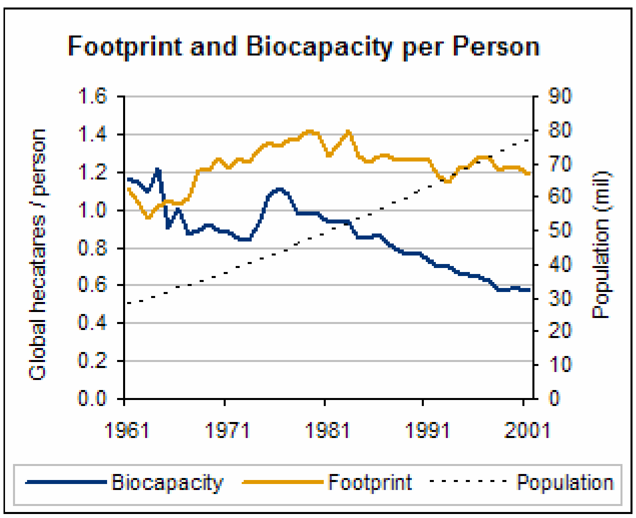


Figure 2.14 The Republic of Korea's Footprint and Biocapacity per person

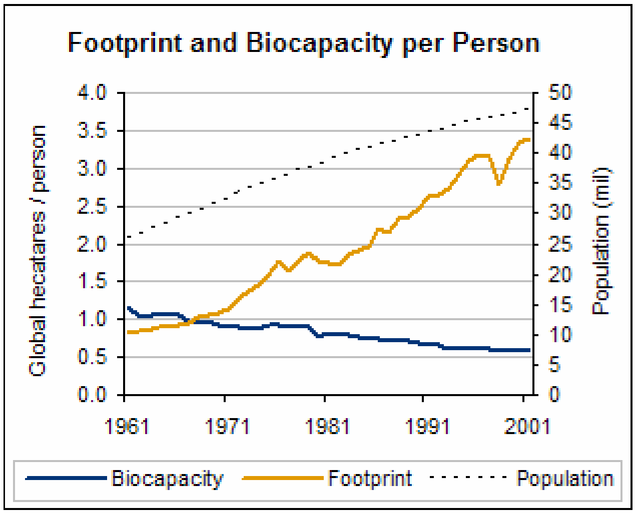
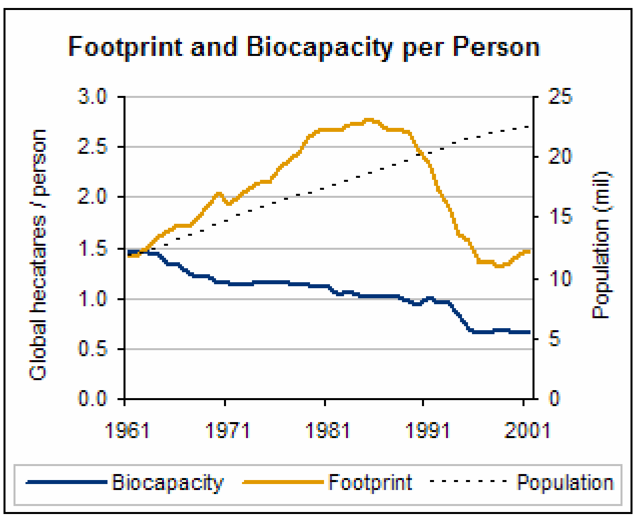


Figure 2.15 Democratic People's Republic of Korea's Footprint and Biocapacity per person



3. On the Relationship between Income and Environmental Sustainability

Having concluded that the region's economic growth has not been environmentally sustainable, this paper discusses whether countries in the region, in its current form of economic growth, will be able to achieve environmental sustainability in the foreseeable future.

For this purpose, this section will examine empirically the relationship between income and various measures of the environment (and environmental sustainability). It is important to examine the relationship between income and environmental sustainability because referring to the Environmental Kuznets Curve (EKC), one may argue that the environmental situation in the region will eventually improve as the region's economy keeps growing. The EKC is the empirical pattern that at relatively low levels of income per capita, the pollution level initially increases with rising income, but then reaches a maximum and falls thereafter. For example, the air in London, Tokyo and New York was far more polluted in the 1960s than it is today. The same pattern has been observed in other major cities in many advanced countries. Thus, the EKC shows that the relationship between economic growth and pollution is an inverse U shape.[4]

Many studies have attempted to explain the EKC theoretically.[5] It is worth noting, however, that the EKC explains the relationship between 'pollution' and income levels, while pollution represents only part of the environmental problem. Nonetheless, in part due to its name of the 'Environmental' Kuznets Curve, some policy makers and academics alike seem to believe that the environment as a whole tends to improve ultimately as income rises. For example, referring to the EKC, Brock and Taylor (2004a) state that "there is a tendency for the **environment** to at first worsen at low levels of income but then improve at higher incomes. (p.3)"

The Ecological Footprints data presented in the previous section will be first used to examine the relationship between income and overall eco-efficiency. Specifically, this section will examine whether high-income countries have smaller Ecological Footprints (per one unit of GDP and per capita). This chapter will then use the 2005 Environmental Sustainability Index (ESI) produced by the Yale Center for Environmental Law and Policy at Yale University, in collaboration with the Center for International Earth Science Information Network at Columbia University.[6] The ESI is a composite profile of national environmental stewardship based on a compilation of 21 indicators for 146 countries. Among the 21 indicators, some are pollution measures for air and water quality, and others are more eco-efficiency related measures of environmental sustainability.

As will be seen in the following, high-income countries tend to produce higher Ecological Footprints per capita than low-income countries. It will also be shown that while income has a beneficial impact on reducing pollution level, it seems to have a "detrimental" impact on most of eco-efficiency measures of environmental sustainability.

The evidence suggests that the region needs to focus not just on pollution control, but more on improving eco-efficiency of the society. That is, in achieving environmental sustainability of economic growth, it is crucial to ensure that eco-efficiency of production and consumption improves as the economy grows.

3.1. Relationship between Income and Ecological Footprints

As noted in Section 2, a country's Footprint is defined as the total area required to produce the food and fiber that it consumes, absorb the waste from its energy consumption, and provide space for its infrastructure. Therefore, Ecological Footprint divided by GDP (and population) can be understood as overall eco-efficiency of a country.

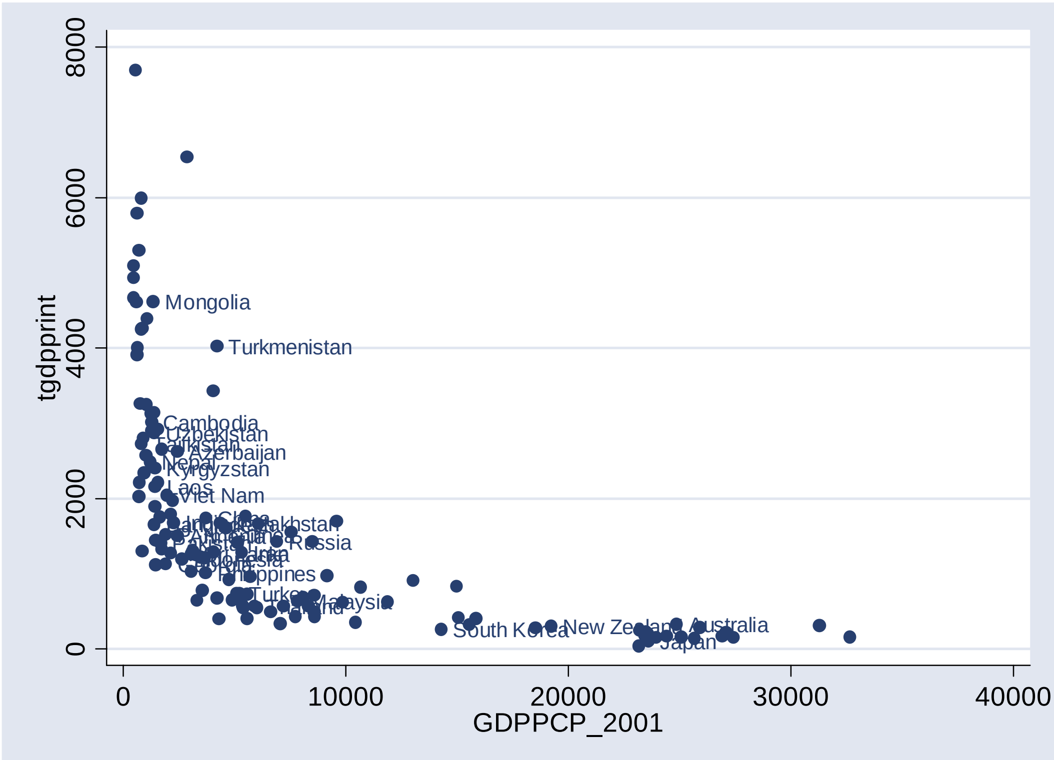
Figure 3.1 shows simple scatter plots of Ecological Footprints divided by GDP (i.e. Footprints per one unit of GDP) against GDP per capita (in 2001 value of purchasing power parity). The names of the Asia-Pacific countries are shown in the figure. The relationship seems negative and this implies that as income grows, the use of the environment to produce one US dollar value of goods and services becomes smaller.

Figure 3.2 shows another scatter plots of Ecological Footprints per capita against GDP per capita. The figure strongly suggests that high-income countries produce higher Ecological Footprints per capita than low-income countries. Because both variables are divided by population, this result implies that larger economies produce larger Ecological Footprints, and hence the economic growth of most countries has been accompanied by greater environmental pressure.

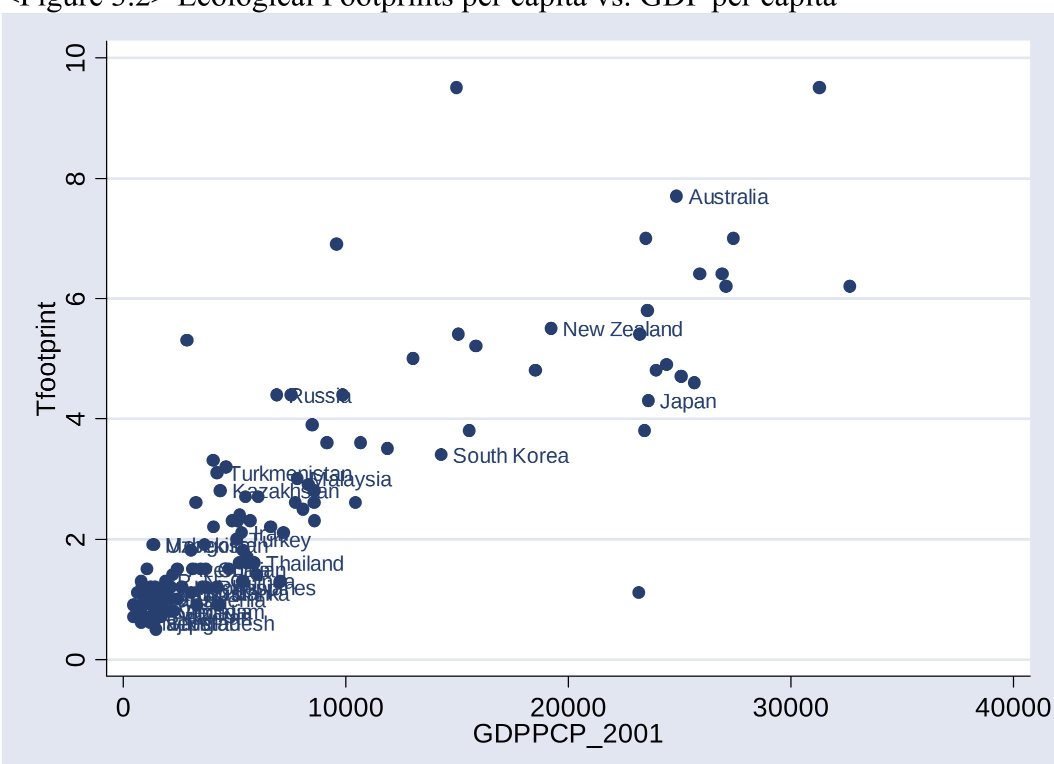
Thus, when considering Figures 3.1 and 3.2 simultaneously, it must be concluded that eco-efficiency of the economy may improve as income grows, but not as large as enough to reduce the total use of natural resources.

Finally, Figure 3.3 shows scatter plots of Ecological Deficits per capita against GDP per capita. The figure shows that the relationship between income per capita and ecological deficit is not as clear as the previous figures. But, there seems a tendency that ecological deficits are greater for higher income countries than lower income countries.

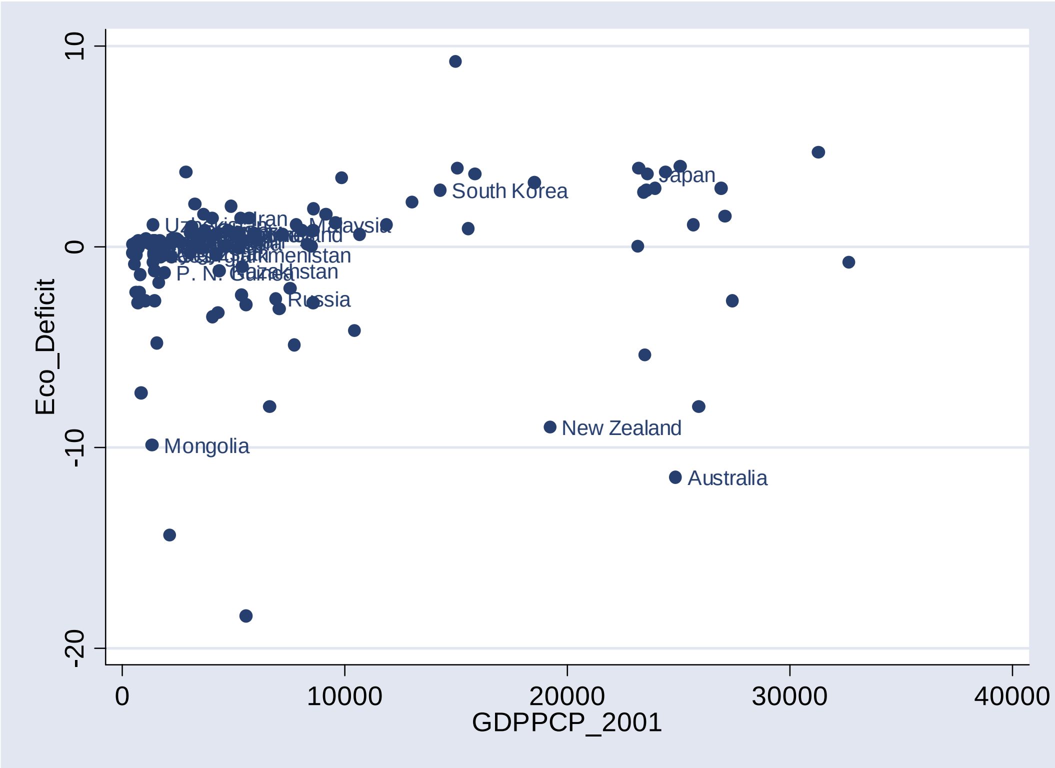
<Figure 3.1> Total Ecological Footprints per one unit of GDP vs. GDP per capita



<Figure 3.2> Ecological Footprints per capita vs. GDP per capita



<Figure 3.3> Ecological Deficits per capita vs. GDP per capita



3.2. Relationship between Income and Environmental Sustainability Indicators[7]

As noted above, the 2005 ESI represents an equally weighted average of the 21 indicator scores. Each indicator builds on between 2 and 12 data sets. For example, Air Quality (SYS_AIR) is a composite indicator that includes variables tracking the concentration of nitrogen oxides, sulfur dioxide and particulates in urban areas, and indoor air pollution from solid fuel use.

The world average of the ESI is 49.9, and Finland has the highest score with 75.1, while the Democratic People's Republic of Korea has the lowest with 11.7. The five highest-ranking countries are Finland, Norway, Uruguay, Sweden, and Iceland, while the five lowest countries are the Democratic People's Republic of Korea, Iraq, Taiwan, Turkmenistan, and Uzbekistan.

As noted above, distinguishing pollution measures from more fundamental eco-efficiency related measures of environmental sustainability is very important, because while the conventional environmental approach has focused mostly on regulating pollution and the discharge resulting mainly from production processes, the environment of most countries has been placed under increasing pressure, mainly due to the deterioration of most eco-efficiency measures of environmental sustainability.

Because we are interested in examining how different pollution measures and eco-efficiency measures of environmental sustainability are related with income, we select among the 21 indicators only those indicators which fall into either of these two categories. We select 2 indicators for pollution measures and 9 indicators for more eco-efficiency related measures of environmental sustainability.[8] Thus, the overall measure of environmental sustainability (ESI) included in the 2005 ESI does not represent accurately the degree of environmental sustainability defined in this report, as it is not just the average value of the 11 indicators but that of the 21 indicators also including 10 indicators which are considered not relevant and hence omitted in this study.

Table 1 shows in summary the nesting of indicators within categories and variables within indicators.

The pollution category includes 2 indicators: Air Quality (SYS_AIR) and Water Quality (SYS_WQL). The category for eco-efficiency related measures includes 9 indicators: Biodiversity (SYS_BIO), Land (SYS_LAN), Reducing Air Pollution (STR_AIR), Reducing Ecosystem Stress (STR_ECO), Reducing Waste and Consumption Pressures (STR_WAS), Reducing Water Stress (STR_WAT) Natural resource Management (STR_NRM), Energy Efficiency (CAP_EFF), [9] and Greenhouse Gas Emissions (GLO_GHG). In spite of a certain overlap between pollution measures and eco-efficiency related measures of environmental sustainability, there seems to be no direct relationship between the two. Therefore, the relationship between economic growth and environmental sustainability is best understood by examining the results with respect to these two distinct categories of environmental sustainability.

Table 1. Two Categories of Environmental Sustainability Indicators

	Indicator	Variable code	Variable
Pollution Measures	Air Quality (SYS_AIR)	NO2 SO2 TSP INDOOR	▪ Urban population weighted NO2 concentration ▪ Urban population weighted SO2 concentration ▪ Urban population weighted TSP concentration ▪ Indoor air pollution from solid fuel use
	Water Quality (SYS_WQL)	WQ_DO WQ_EC WQ_PH WQ_SS	▪ Dissolved oxygen concentration ▪ Electrical conductivity ▪ Phosphorus concentration ▪ Suspended solids
Eco-efficiency Related Measures	Biodiversity (SYS_BIO)	ECORISK PRTBRD PRTMAM PRTAMPH NBI	▪ Percentage of country's territory in threatened ecoregions ▪ Threatened bird species as percentage of known breeding bird species in each country ▪ Threatened mammal species as percentage of known mammal species in each country ▪ Threatened amphibian species as percentage of known amphibian species in each country ▪ National Biodiversity Index
	Land (SYS_LAN)	ANTH10 ANTH40	▪ Percentage of total land area (including inland waters) having very low anthropogenic impact ▪ Percentage of total land area (including inland waters) having very high anthropogenic impact
	Reducing Air Pollution (STR_AIR)	COALKM NOXKM SO2KM VOCKM CARSKM	▪ Coal consumption per populated land area ▪ Anthropogenic NO_x emissions per populated land area ▪ Anthropogenic SO_2 emissions per populated land area ▪ Anthropogenic VOC emissions per populated land area ▪ Vehicles in use per populated land area
	Reducing Ecosystem Stress (STR_ECO)	FOREST ACEXC	▪ Annual average forest cover change rate from 1990 to 2000 ▪ Acidification exceedance from anthropogenic sulphur deposition

	Reducing Waste & Consumption Pressures (STR_WAS)	EFPC RECYCLE HAZWST	▪ Ecological Footprint per capita ▪ Waste recycling rates ▪ Generation of hazardous waste
	Reducing Water Stress (STR_WAT)	BODWAT FERTHA PESTHA WATSTR	▪ Industrial organic water pollutant (BOD) emissions per available freshwater ▪ Fertilizer consumption per hectare of arable land ▪ Pesticide consumption per hectare of arable land ▪ Percentage of country under severe water stress
	Natural Resource Management (STR_NRM)	OVRFSH FORCERT WEFSUB IRRSAL AGSUB	▪ Productivity over fishing ▪ Percentage of total forest area that is certified for sustainable management ▪ World Economic Forum Survey on subsidies ▪ Salinized area due to irrigation as percentage of total arable land ▪ Agricultural subsidies
	Energy Efficiency (CAP-EFF)	ENEFF RENPC	▪ Energy efficiency ▪ Hydropower and renewable energy production as a percentage of total energy consumption
	Greenhouse Gas Emissions (GLO_GHG)	SO2EXP POLEXP	▪ Carbon emissions per million US dollars GDP ▪ Carbon emissions per capita

Figures 3.4 – 3.5 show the regression results of pollution measures for Air Quality (SYS_AIR) and Water Quality (SYS_WQL), respectively, on per capita GDP expressed in natural logarithms. Scatter plots of original data and the names of 32 Asia-Pacific countries are also shown in the figures. Both figures show that there is a positive relationship between the pollution measures and income level. This seems to suggest that high-income countries tend to have lower degree of air and water pollution problems.

Figures 3.6 – 3.14 show the regression results of eco-efficiency related measures of environmental sustainability on per capita GDP. The picture is quite different. None of these measures show a positive relationship with per capita GDP. In fact, Reducing Air Pollution (STR_AIR), Reducing Water Stress (STR_WAT), Natural Resource Management (STR_NRM), and Greenhouse Gas Emissions (GLO_GHG) seem to have a relatively strong "negative" relationship with per capita GDP. The results seem very alarming because the Figures show that the higher-income countries tend to have lower values of eco-efficiency related measures of environmental sustainability.

To summarize, the examination has revealed that while income appears to have a beneficial effect on pollution measures, it has a detrimental effect on most eco-efficiency related measures of environmental sustainability, *ceteris paribus*. This suggests that environmental sustainability of a country may tend to deteriorate as its income increases. This also suggests that while conventional policies focus more on pollution control, they need to be coupled with policy options focusing on eco-efficiency aspects of environmental sustainability in the process of economic development. Otherwise, economic growth will continue to degrade environmental sustainability in most countries.

Figure 3.4 Regression of “Air Quality” (SYS_AIR) on per capita GDP (R-squared = 0.191)

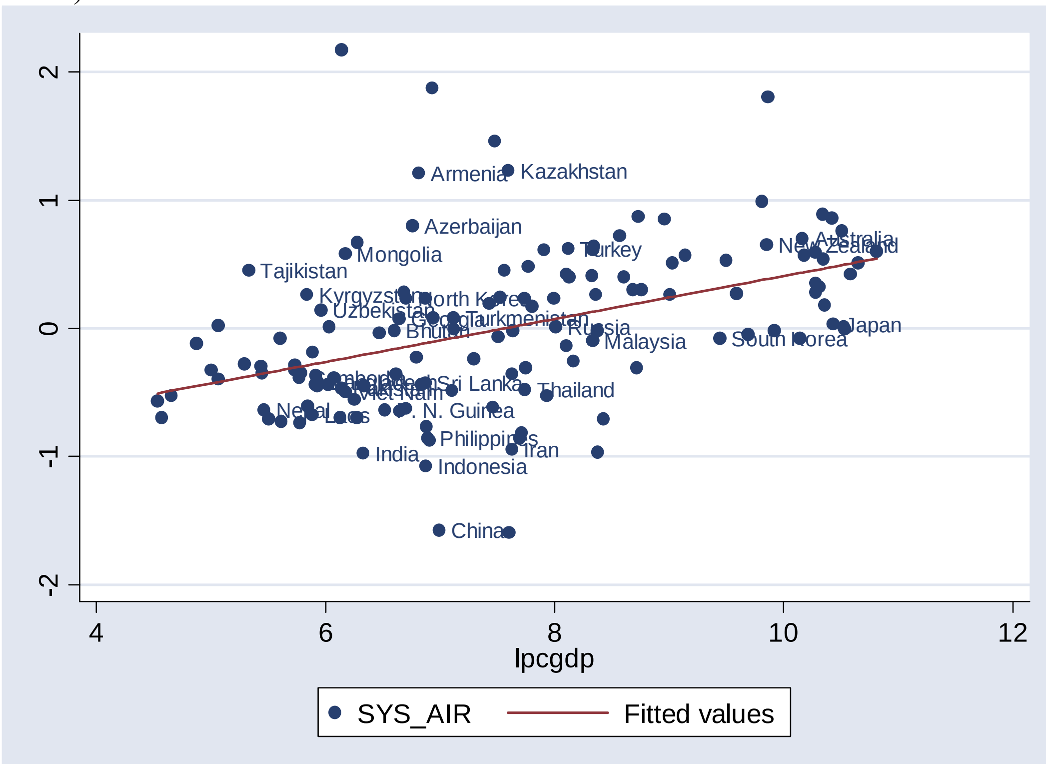


Figure 3.5 Regression of “Water Quality” (SYS_WQL) on per capita GDP (R-squared = 0.243)

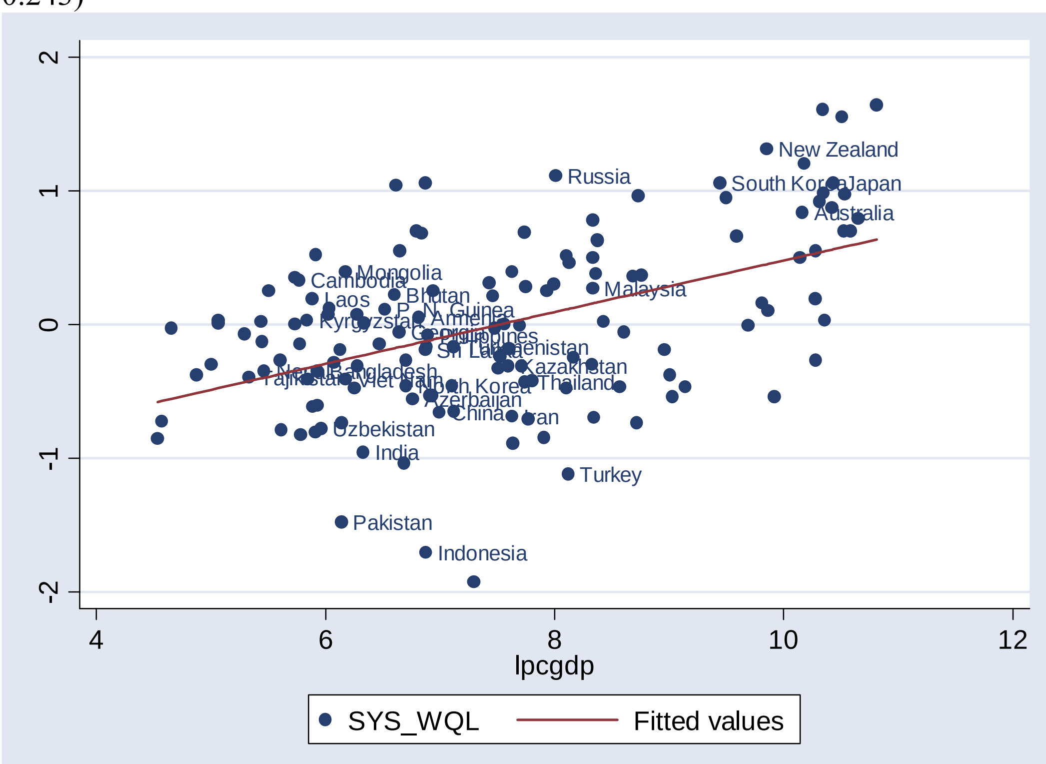


Figure 3.6 Regression of “Biodiversity” (SYS_BIO) on per capita GDP (R-squared = 0.058)

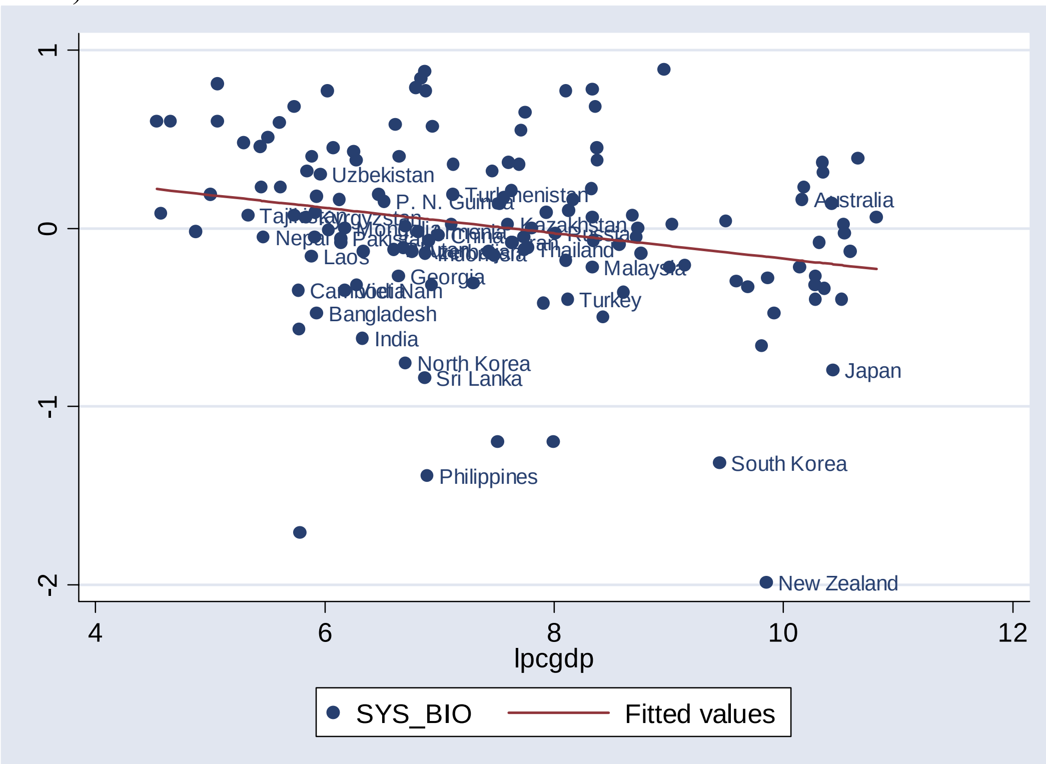


Figure 3.7 Regression of “Land” (SYS_LAN) on per capita GDP (R-squared = 0.122)

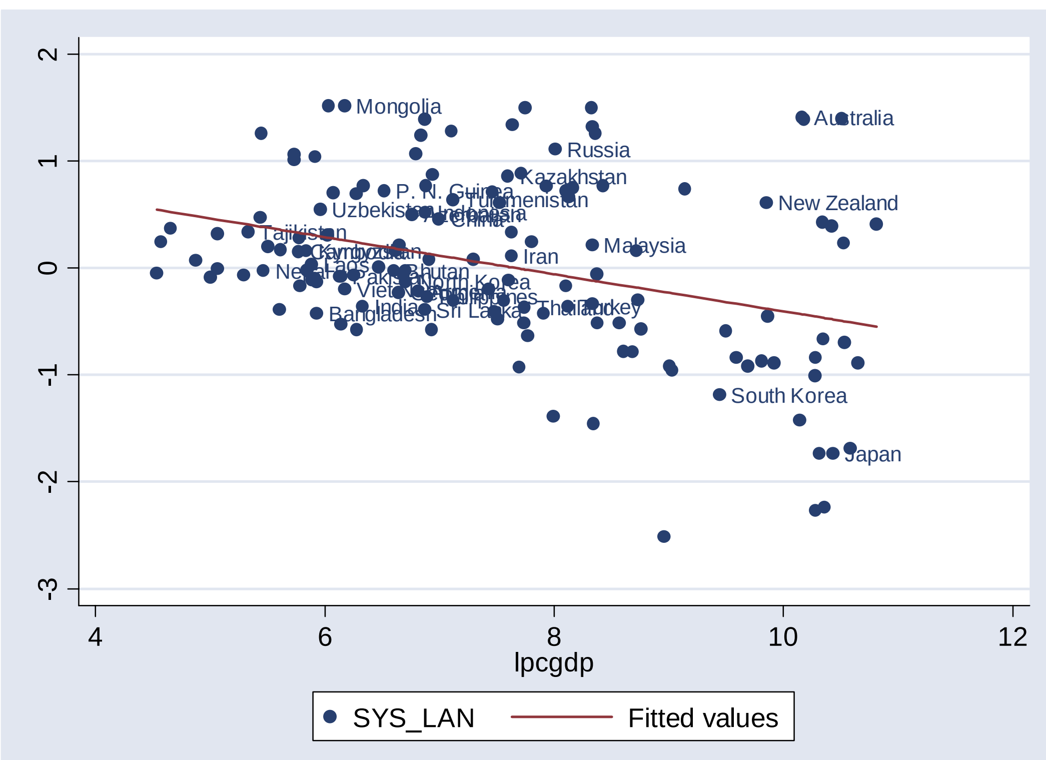


Figure 3.8 Regression of “Reducing Air Pollution” (STR_AIR) on per capita GDP (R-squared = 0.557)

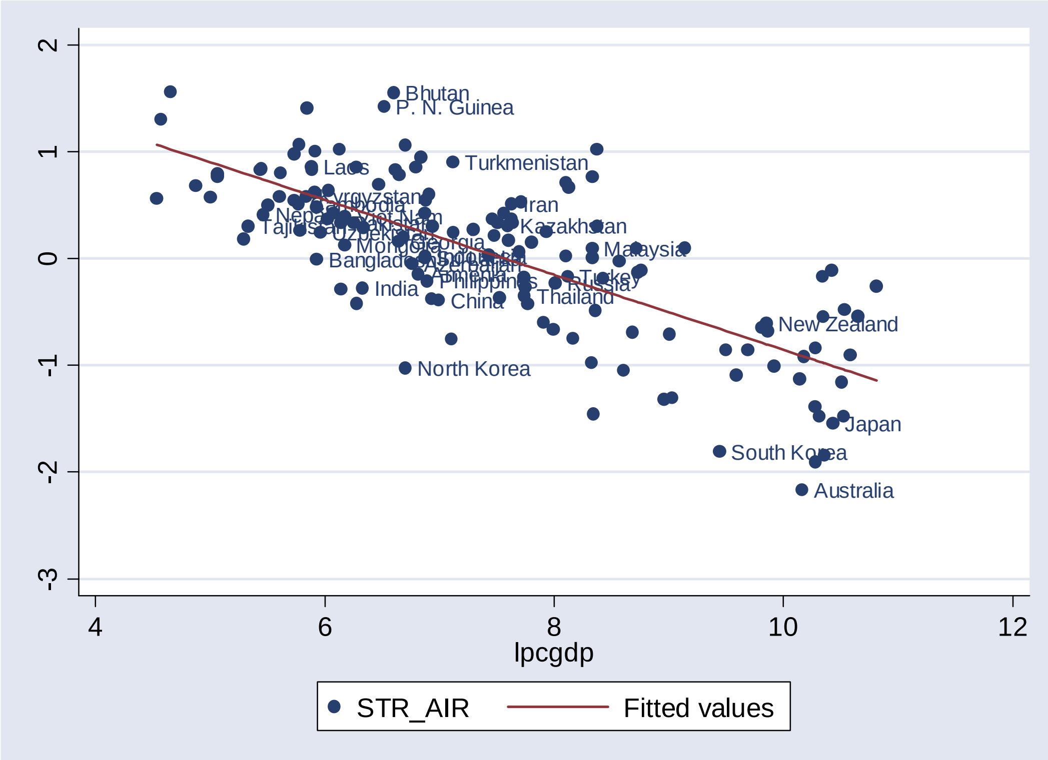


Figure 3.9 Regression of “Reducing Ecosystem Stress” (STR_ECO) on per capita GDP (R-squared = 0.004)

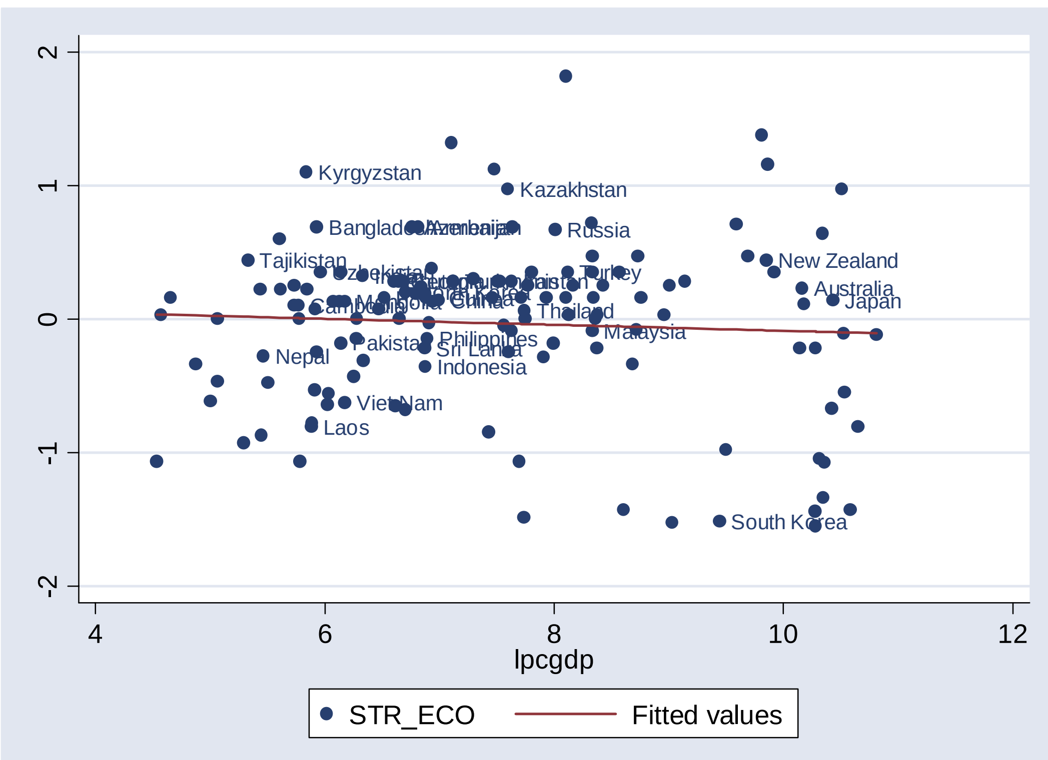


Figure 3.10 Regression of “Reducing Waste & Consumption Pressures” (STR_WAS) on per capita GDP (R-squared = 0.178)

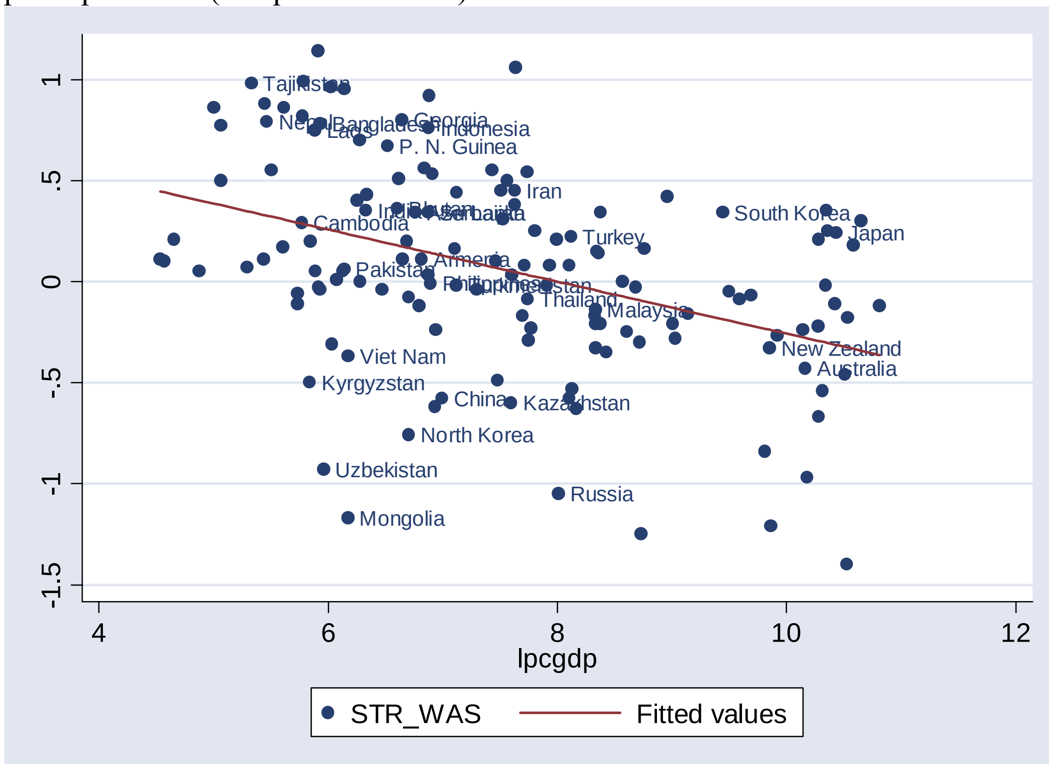


Figure 3.11 Regression of “Reducing Water Stress” (SYS_WAT) on per capita GDP (R-squared = 0.375)

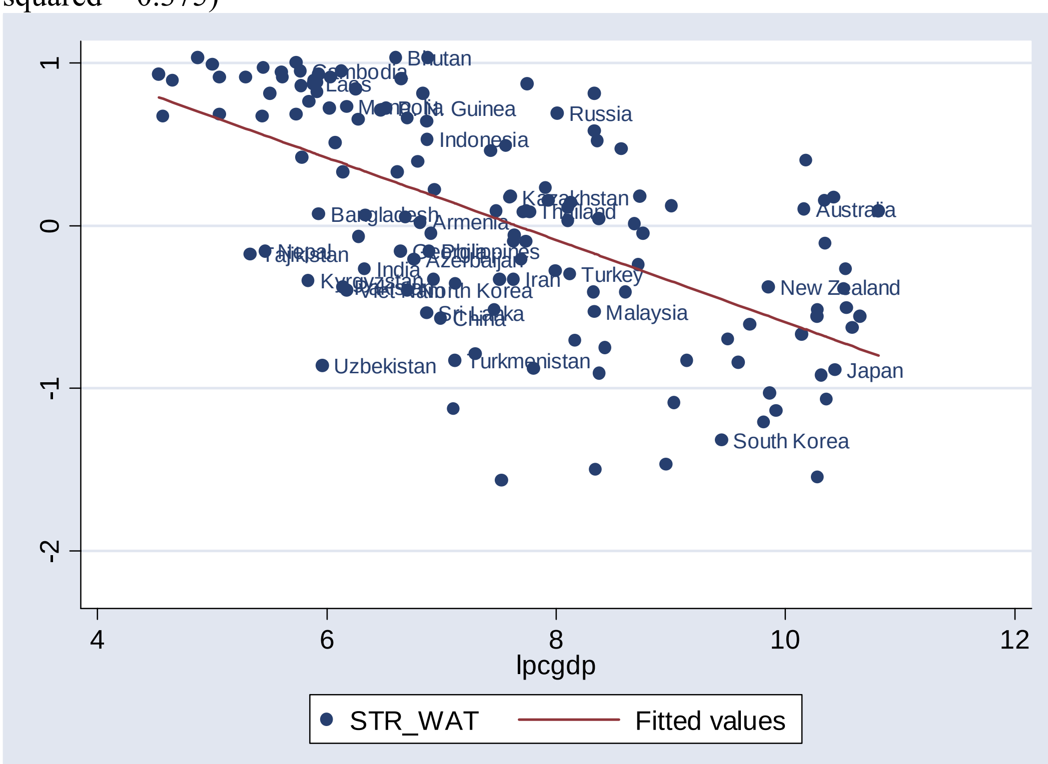


Figure 3.12 Regression of “Natural Resource Management” (STR_NRM) on per capita GDP (R-squared = 0.239)

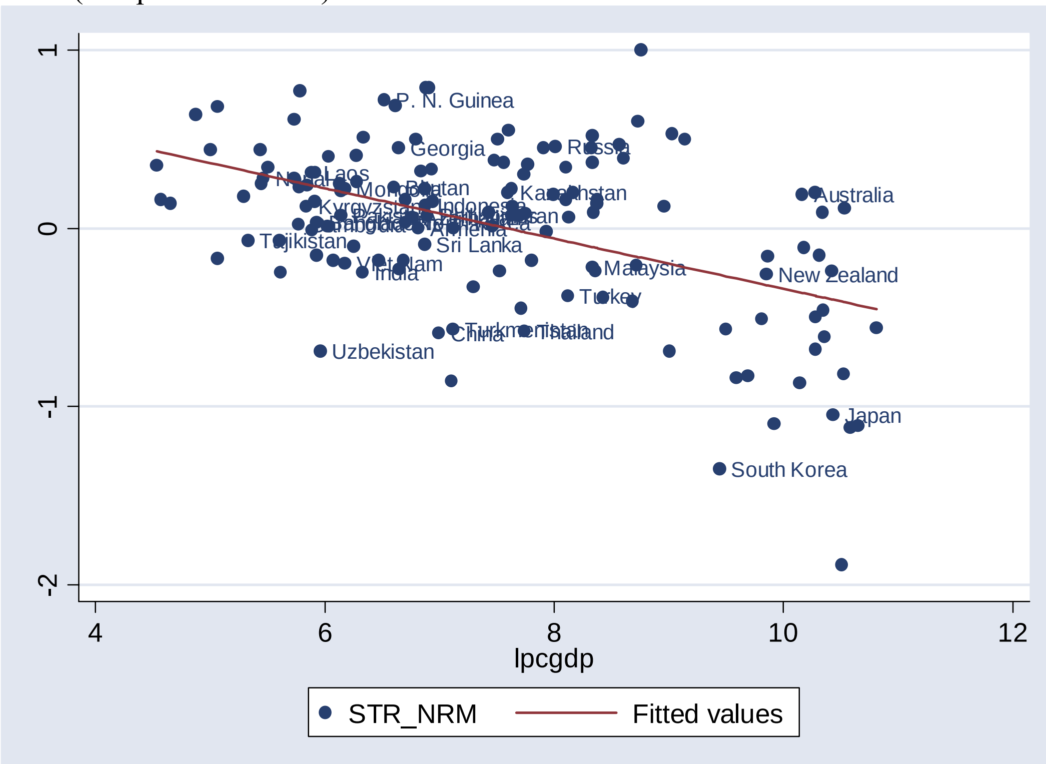


Figure 3.13 Regression of “Energy Efficiency” (CAP_EFF) on per capita GDP (R-squared = 0.057)

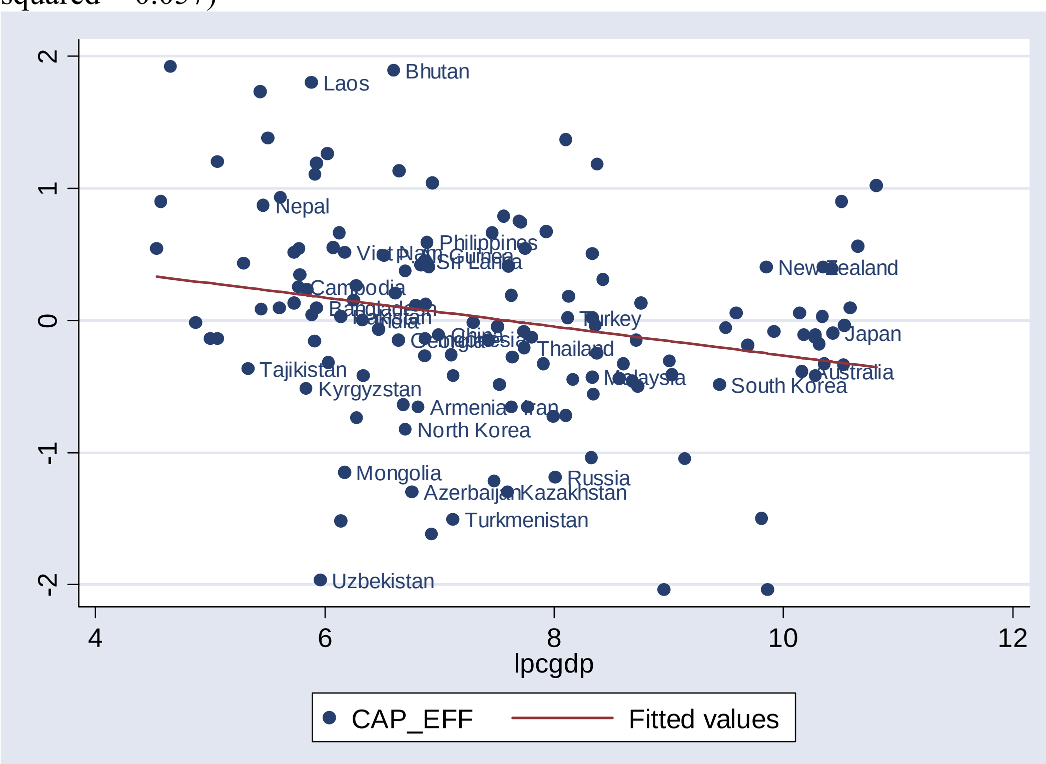
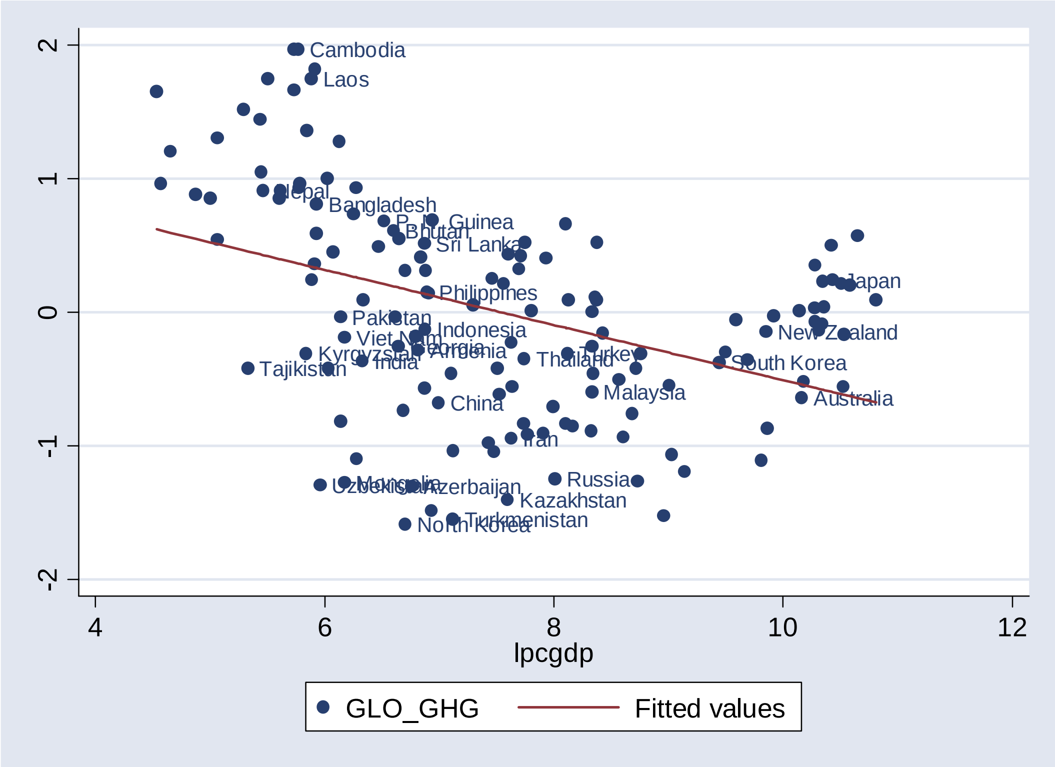


Figure 3.14 Regression of “Greenhouse Gas Emissions” (GLO_GHG) on per capita GDP (R-squared = 0.171)



4. Shifting Towards Green Growth in Asia and the Pacific

While its carrying capacity is relatively more limited than other regions of the world, the Asia-Pacific region has been experiencing one of the fastest economic growth in the world and this has been placing enormous environmental pressure on the region (and the entire planet).

Referring to the Environmental Kuznets Curve, one may hope that the region's environmental sustainability will ultimately improve, as economic growth continues and income rises in the countries of the region. The previous section, however, has revealed that while the pollution level seems smaller in high-income countries than low-income countries, the relationship between income and environmental sustainability as a whole remains in question as there is much evidence that many measures related with eco-efficiency are worse in high-income countries than in developing countries.

Therefore, the region needs to adopt a new paradigm of economic growth, namely the paradigm of Green Growth or environmentally sustainable economic growth. There is a need to break the link between economic growth and the use of natural resources and environmental services. Without doubt, one of the most important aspects of Green Growth paradigm is that a society as a whole improves eco-efficiency in such a way that it produces "more with less energy and raw materials" by shifting to more eco-efficient technologies, and consumes "less with greater satisfaction" by adopting a more ecologically friendly lifestyle. New concepts and systems required for Green Growth are explained in the following.

4.1. Concept Changes for Pursuing Green Growth

Not just pollution control, but more on eco-efficiency improvement

Conventional environment management has focused primarily on pollution control. As seen in the previous section, however, pollution control alone cannot reduce the increasing pressure arising from economic growth and ensure "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs",[10] unless environmental sustainability is improved through "a fundamental change in the way societies produce and consume". In view of the limited ecological carrying capacity of the region and the large population, improving the eco-efficiency of economic growth will be a more pressing concern in the days to come. That is, the extent of the success of Green Growth will depend more on the measures for the eco-efficiency of production and consumption that countries in the region adopt.

As a matter of fact, the eco-efficiency of production and consumption has recently been recognized with the term "sustainable production" and "sustainable consumption" which gained international prominence at the United Nations Conference on Environment and Development (UNCED) in 1992. The World Summit on Sustainable Development (WSSD) in 2002 again highlighted the significance of the sustainable consumption and production pattern in achieving sustainable development. The Johannesburg Plan of

Implementation (JPoI) in its Chapter 3 emphasizes that changes in the way societies produce and consume are indispensable for achieving sustainable development. The JPoI, thus, calls for the development of a 10-year framework of programmes for sustainable consumption and production, in particular, to promote social and economic development within the carrying capacity of the environment, and de-linking economic growth and environmental degradation. The JPoI suggests that these challenges should be achieved through improving efficiency and sustainability in the use of resources and production processes and reducing resource degradation, pollution and waste, which can simply be recapitulated as improving eco-efficiency.

In addition, the Millennium Declaration calls for ensuring environmental sustainability as No. 7 of the Millennium Development Goals, e.g. by reversing the loss of environmental resources.

In spite of Millennium Development Goal No. 7, on environmental sustainability, and the call in the Johannesburg Plan of Implementation for a fundamental change in the way society produces and consumes, the issue of eco-efficiency has not yet achieved prominence in the minds of policy makers in the region. The reason for this is that, as eco-efficiency is relatively a new concept, the policy options are multidisciplinary and therefore requires the participation of all the stakeholders in a society; they cannot simply be left up to the environment ministry.

Conventional economic development planning has primarily focused on the supply side of the economy by emphasizing the building of more power plants, dams and highways to increase the supply capacity for energy, water and roads rather than improving the efficiency of energy and water use. However, eco-efficiency requires policy options focused mainly on demand-side management, such as expanding public transportation and railroads, controlling water and energy prices to improve the efficiency of consumption and licensing the right to purchase private passenger cars. This is all the more pressing in view of the limited ecological carrying capacity of the region and the prospect for rapid economic growth on a large scale.

In short, Green Growth is feasible only when pollution control is coupled with the improvement of the eco-efficiency of the way economic growth is pursued.

Synergy between the environment and the economy can be created

Many economic policy planners and businesses alike in the region tend to believe that investment in the environment is a sunken cost and a burden on the economy and businesses. However, the environment and the economy can be integrated to create synergy in both public and private sectors.

(1) Synergy to be created in the public sector

Despite awareness of the need to protect the environment, the major reasons that Governments have not taken proactive environmental policies are the concerns that: allocating scarce financial resources to environmental protection is a burden and cost; and strengthening environmental regulations will damage industrial competitiveness.

These conventional concerns are based on a static negative view on the environment and the economy. What is needed is a dynamic and synergistic view such that investment for the environment is regarded not as a burden on the economy but as a driver of economic growth and employment. The fact that the environment requires a higher degree of investment means that the environment industry has a greater potential for promoting economic growth as well as creating employment opportunities. For example, many countries in Asia and the Pacific require a massive investment in environmental infrastructure, such as wastewater treatment plants. China and South-East Asian countries are planning for large investments in environmental infrastructure. These investments will contribute to their economic growth and employment. Therefore, the environment should be considered as a growth driver, not as a burden on growth.

Another example of a possible synergy between the environment and the economy is the case of "double government failure" where policies are economically and environmentally flawed. There are many instances of double government failure. One notable example is the extensive use of subsidies that encourage the use of coal, electricity, pesticides and irrigation and promote expansion of grazing and timber extraction on public lands. Such subsidies are common in Asia and the Pacific. Relatively low taxes on products such as detergents, fertilizers, batteries, pesticides and large-size cars are another example of government failure. In this case, removing such subsidies and/or the implementation of environmental taxes can yield both economic and environmental benefits.

It should also be noted that because of the 'public good' nature of environmental benefits, there are many instances of "double market failure" where the present business practices yield both environmental externality and economic inefficiency. For example, private investments in research and development that contribute to upgrading the environment remain sub-optimal in general. In this case, the introduction of new incentives is required for the private sector to introduce changes in methods, processes or products, including systems of resource and waste management.

Conventional economic thinking theorizes that strict environmental regulation would affect industrial competitiveness negatively. Many empirical studies, however, find little statistical evidence of adverse effects on competitiveness due to environmental regulation (for example, Jaffe *et al.* 1995). Instead, such researchers as Porter (1991) and Porter and van der Linde (1995) argue that environmental regulation can reduce production costs and stimulate competitiveness. This view, known as the "Porter Hypothesis", argues that the regulations spur environmental innovations that strengthen the competitive position of firms and can offset the cost of regulatory compliance.

In fact, environmental regulations and incentives can pressure firms to upgrade their technology and quality and provide new innovations in areas of important consumer and social concern. Thus, technological innovation stimulated by environmental regulations can result in new products or new business opportunities and thus have positive effects on both the environment and the economy. Environmental regulation coupled with government research and development support and other incentive measures will be more likely to motivate firms to exploit win-win opportunities. There are a number of real-world examples where a new environmental initiative turned out to be profitable for a given firm or industry.[11] Thus, the upgrading of environmental regulation has to be regarded as an opportunity for spurring technological innovations and for creating an environmental market and industry.

(2) Synergy to be created in the private sector

Private businesses also tend to regard the environment, in many cases, as an extra cost. However, as the economy grows and income rises, the demand for environmentally friendly and resource-saving goods and services increases. In fact, the environment industry is growing rapidly. The environmental goods and services industry worldwide has been estimated to be larger in size than the pharmaceutical industry. In the United States, growth was around 5% per year in the 1990s, while in Germany growth has been estimated at 5-6% per year (Vickery and Iarrera, 2000). The environmental market for Asia (excluding Japan) was estimated at US$ 19 billion in 1996 but, with double-digit growth, is expected to exceed US$ 50 billion by 2005 and continue to increase apace with industrial growth in the future (Annandale *et al*, 2005). Thus, the environment industry is now a major industrial sector in its own right.

This recent trend provides the private sector with a good business opportunity. A firm that innovates new "green products" and new "green technologies" before others do will be in a position to enjoy a competitive advantage. Some firms are actively exploiting new opportunities and are even promoting environmental marketing. The environment should no longer be seen as an extra cost but rather as a new business opportunity.

In sum, there is substantial evidence that so long as the correct policies are put in place, growth and business activities need not be constrained, and indeed can be enhanced, by protection and improvement of the environment. Thus, we can have a "win-win" outcome as a result – growth increases and environmental quality improves.

4.2. More on Eco-efficiency

As set out in the previous section, improving eco-efficiency is one of the most crucial concepts required for Green Growth. Therefore, this subsection offers more detailed explanation about how eco-efficiency is related with the patterns of consumption and production.

To ensure that environmental pressure is within the carrying capacity, environmental pressure needs to be decreased or the carrying capacity needs to be increased. Because the carrying capacity is heavily determined by its endowed natural resources, it tends to remain unchanged at least in the short run. On the other hand, environmental pressure can be decreased by (1) lowering population, (2) reducing the amount of and changing the pattern of per person consumption of goods and services, and (3) improving the technology with which goods and services are produced.

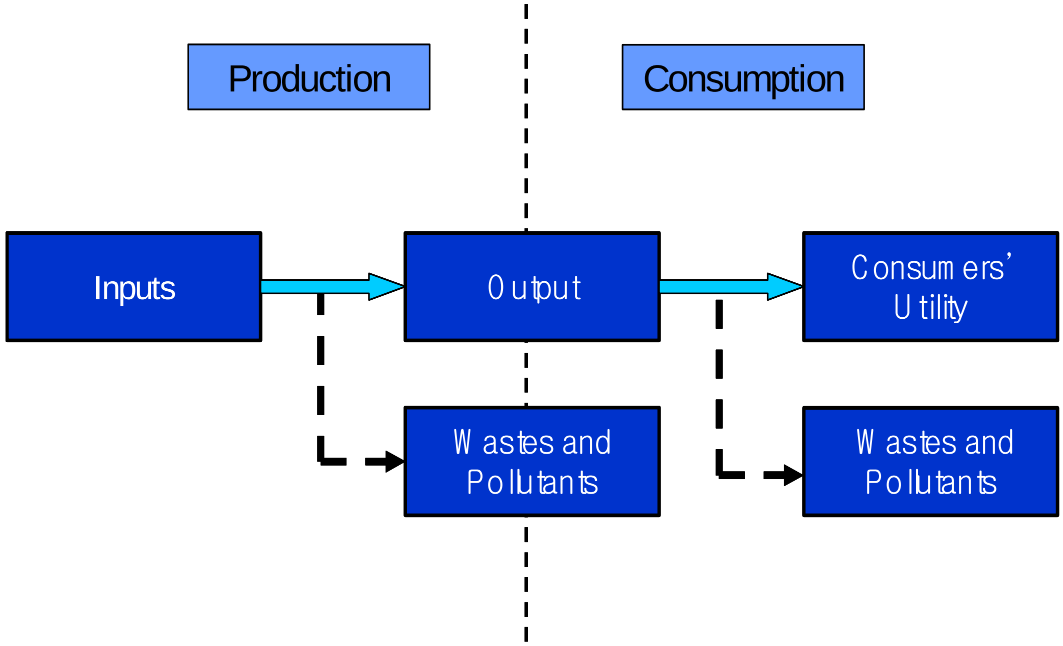
Improving eco-efficiency is to use fewer resources in meeting the human need and to minimize the impact on the nature. Therefore, it needs to address (2) and (3) of the above mentioned ways to reduce environmental pressure. That is, to reduce environmental pressure and hence to improve the environmental sustainability of economic growth, we need to improve the eco-efficiency of consumption and production. It should be noted that the term eco-efficiency is used here in its broadest sense, to be applied not only to production activities, but also consumption levels and patterns. That is, the term eco-efficiency is different from the one widely promoted by the World Business Council on Sustainable Development (WBCSD), which describes eco-efficiency as "creating more values with less impact".[12] On the contrary, eco-efficiency is used here not simply as a business concept, but rather as a concept also valid for activities related with consumers and the entire society.[13]

As summarized in Figure 4.1, eco-efficiency is concerned with producing and consuming goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological pressures and resource intensity to a level at least in line with the earth's carrying capacity. Specifically, it is concerned with two broad objectives:

(1) Achieving high-quality lives in consumption more through a focus on 'qualitative sufficiencies' rather than from 'quantitative sufficiencies'.
(2) Creating more value added with less use of materials and energy and with reduced emissions.

It is worth noting that conventional economics tends to focus on how output can be maximized using a fixed amount of inputs and on how consumers' utility can be maximized using a fixed amount of goods and services. In this process of production and consumption, how much of wastes and pollutants are emitted are not adequately considered. However, eco-efficiency in production concerns with how output can be maximized using a fixed amount of inputs while minimizing wastes and pollutants. Similarly, eco-efficiency in consumption concerns with how consumers' utility can be maximized using a fixed amount of goods and services while minimizing wastes and pollutants. The natural ecosystems of the Asia-Pacific region (and the earth) will not cope with the future if most people in the region follow the lifestyle seen today in Europe or North America. In any society, once a lifestyle is established, it is quite difficult to change it. Thus, it is all the more important for the countries in the Asia-Pacific region to adopt an eco-efficient way of consuming early in the course of its economic growth, and hence, the eco-efficiency of consumption must also be the core focus of the policy options.

Figure 4.1 Eco-efficiency in the Flows of Production and Consumption



For the eco-efficiency in consumption to be accomplished, consumers need to change and improve their consumption pattern, which is opt for a different way of living that can offer a better quality of life and more welfare for all, while limiting the use of resource and pollution to acceptable levels. "A sustainable society …. could focus on mindfully increasing the quality of life rather than mindlessly expanding material consumption……" (Meadows *et. al.*, 2004, *Limits to Growth: The 30-Year Update*). The consumption pattern can be changed in such a way that consumers enjoy greater satisfaction while consuming a smaller amount of "environmentally harmful" goods and services, which can be translated into a greater eco-efficiency of the use of natural resources. Examples are the use of public transport instead of passenger cars, more renewable energy than fossil energy, and the like.

On the other hand, the success of fulfilling the second object depends on how the business sector improves the efficiency of production systems that convert energy and resources into goods and services, and wastes and pollutants. This requires not only incremental efficiency improvements in existing practices and habits, but also creativity and innovation in the search for new ways of doing things. WWF's *Living Planet Report 2004* concludes that in order to leave enough ecological space for the 5.5 billion people not living in OECD countries to achieve good living standards, without incurring any further environmental insecurities, there must be at least ten-fold reduction in the use of energy and materials.

The first object is related with consumers while the second is with firms. Therefore, policies to promote eco-efficiency should address both producers and consumers, as it requires an integrated effort to address consumption and production patterns.

Specifically, the government takes much of the responsibility for ensuring that the external costs of resource are internalized into the respective prices, that perverse subsidies are eliminated, and that those who avoid pollution and use less resources are rewarded. Thus, eco-efficiency calls for the entire society including consumers, firms, and the government work together to achieve greater welfare with less use of materials and energy and with reduced emissions.

To summarize, environmental sustainability is related not just with pollution but rather with more fundamental measures such as eco-efficiency, which cannot be changed unless a society changes the way it produces and consumes. In other words, for the environment to be sustainable, a society needs not only to limit the level of pollution but also to improve more fundamental measures such as eco-efficiency of a society as a whole.

4.3. System Changes for Pursuing Green Growth

In pursuit of Green Growth, what needs to be changed is not only the concept of the environment but also the system in which the economy functions.[14] Improving eco-efficiency requires the internalization of environmental costs into the price structure. In countries that lack the financial and technical capacity, this will require support through international and regional cooperation.

Internalization of environmental costs into pricing mechanisms

One of the fundamental reasons for environmental problems is that the environment is regarded as a free good, and pricing mechanisms do not reflect environmental costs. Under such circumstances, people end up abusing the environment. If environmental costs could be fully reflected and internalized into the market price structure, then people would no longer abuse the environment.

Internationalization of environmental costs into pricing mechanisms would allow the market to determine the appropriate level of use at the established price and ensure users and producers to pay the full costs of their use of environmental resources. This is the most efficient and effective tool for improving the eco-efficiency of the way people consume natural resources and generate waste.

Thus, it is urgent that policy makers devise a system where the price of protecting the environment is duly reflected in the price structure of the market. Internalizing environmental costs can be effected through economic instruments, such as charges, levies and green tax reform. It can also be achieved by the removal of environmentally harmful subsidies. For example, environmental regulation coupled with government's R&D support and other measures will be more likely to motivate firms to exploit win-win opportunities.

Policies motivating individuals to take environmentally-friendly choices into account for consumption are also crucial in promoting eco-efficiency. The social cost of traffic jams and proliferations of private passenger cars must be reviewed and the eco-efficiency of railroads vis-à-vis highways, public transport vis-à-vis private cars must be duly taken into consideration in public policies. For example, public transport can be encouraged by making transport pricing reflect the full environmental costs of roads.

<u>System for the long-term perspective: resource allocation for the environment</u>

The benefits of environmental protection often materialize only in the long run while there are many pressing economic and social needs demanding resource allocations. Investment in environmental research and development often can only be done in the long run and lacks commercial viability. This is why environmental research and development must often be supported by public funds, as in the case of renewable energy.

Government and the public sector need to bridge the gap between long-term social benefit and short-term commercial benefit in order to promote the active participation of the private sector in the area of environmental research and development.

<u>International system to support Green Growth in developing countries and level playing fields</u>

Not only developed countries but also developing countries and economies in transition need to actively take part in, and benefit from, shifting to more eco-efficient production and consumption patterns. In order to facilitate upgrading of environmental regulations and standards, there should be international harmonization and coordination to create a leveled playing field so that the countries concerned do not have to worry about losing their national competitiveness.

As many developing countries in the early stages of economic development lack the financial resources and technological capacity to initiate pollution control and eco-efficiency measures, the international community needs to provide support for developing countries to pursue Green Growth. For global environmental issues, such as climate change and ozone depletion, support for their participation is even more critical.

Rapid diffusion of clean technologies and eco-efficient production patterns into developing countries is vital in order to ensure global sustainability. Regional environmental technology partnerships and innovative financing mechanisms are necessary to support the promotion of the Green Growth paradigm in the region.

5. Concluding Remarks

Asia and the Pacific is a vast region covering 40 per cent of the world territory, and is home to 61 per cent of the world's population. Dramatic economic growth has enabled the reduction of poverty and social progress in many parts of the region. However, the rapid increase in industrial and agricultural production, as well as rising levels of consumption are exerting increasing pressure on the ecological carrying capacity and hence environmental sustainability of the region.

Nonetheless, Asia and the Pacific is home to two thirds of the world's poor. An increase in the total population of the region of some 676 million persons by 2020 is projected. About 712 million persons in the region, or about 65 per cent of the global total and 22 per cent of the region's population, are estimated to live on less than $1 per day. An estimated 545 million people in the region are still undernourished, comprising 65 per cent of the world's ill-fed (FAO, 2004). Therefore, the need for continued economic growth is enormous, given the continuing high poverty levels, population growth and a nutritional status that is still far from satisfactory in many countries

The region needs to continue its economic growth. Unless economic growth is properly monitored, however, the ecological carrying capacity for future generations will be seriously compromised. This is especially so because the carrying capacity is relatively more limited in the Asia-Pacific region than in other regions of the world. The challenge is to achieve economic growth which is environmentally sustainable, as the Millennium Declaration calls for ensuring environmental sustainability as No. 7 of the Millennium Development Goals. For environmental sustainability to be obtained, economic growth should not incur an increase in the overall use of resources so as to ensure that the use of natural resources is in line with the region's carrying capacity. The link between economic growth and the use of natural resources and of environmental services needs to be broken.

This requires the region to embrace the new paradigm of Green Growth, which was endorsed by the 5th Ministerial Conference on Environment and Development held in Seoul in March 2005. It is emphasized that Green Growth comes through increasing the eco-efficiency of consumption and production patterns, and creating synergy between the environment and the economy.

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[1] On the contrary, for purposes of game and range management, carrying capacity is usually defined as the "maximum population" of a given species that can be supported indefinitely in a defined habitat without permanently impairing the productivity of that habitat. However, because of our seeming ability to increase our own carrying capacity by eliminating competing species, by importing locally scarce resources, and through technology, this definition seems irrelevant to humans (Rees, 1996). Therefore we define carrying capacity not as a maximum population but rather as the maximum load that can safely be imposed on the environment by people.

[2] Among the 53 ESCAP member countries, France, the Netherlands, the United Kingdom, and the United States are excluded here because they are not located in Asia and the Pacific.

[3] In the world, Australia ranks the fourth, following United Arab Emirates (9.9 hectares), Kuwait (9.5 hectares), and United States (9.5 hectares).

[4] This pattern is described as the EKC, following the original Kuznets curve, which was an inverted U-shaped relationship between average income and inequality. The earlier studies on the empirical pattern of the EKC include Grossman and Krueger (1991, 1994) and the World Bank (1992).

[5] They include Selden and Song (1994), Stokey (1998), Andreoni and Levinson (2001), and Brock and Taylor (2004a), among others. See chapter 2 of Copeland and Taylor (2003) and Brock and Taylor (2004b) for a comprehensive review.

[6] Esty, D. C., M. A. Levy, T. Srebotnjak, and A. de Sherbinin (2005), *2005 Environmental Sustainability Index: Benchmarking National Environmental Stewardship*, New Haven, Connecticut, United States, Yale Center for Environmental Law and Policy.

[7] This section summarizes the basic findings of Lee, Chung and Koo (2005) presented at Eminent Environmental Economists Symposium, the 5th Ministerial Conference on Environment and Development for Asia and the Pacific, held in Seoul in March 2005. Original paper conducts some rigorous regression analyses, but presented here are only simple graphic results of the paper.

[8] Thus, 10 indicators in the 2005 ESI report are excluded from this study. They are excluded because they are social-issue related (VUL_HEA, STR_POP, VUL_SUS), uncontrollable natural disaster related (VUL_DIS), too broad a measure of political and governance system (CAP_GOV), or too broad a measure of technology (CAP_ST). The instrumental capacity variables such as CAP_GOV and CAP_ST are important to fix problems of and improve environmental sustainability over time, and hence are determining factors, not the environmental sustainability itself. Some variables (CAP_PRI, GLO-COL, GLO_TBP, SYS_WQN) are excluded because they do not fall into either category of pollution or eco-efficiency measures of sustainable environment.

[9] The 2005 ESI report names CAP_EFF as "Eco-Efficiency", which in fact refers to energy efficiency, while eco-efficiency used here is a broader concept involving most fundamental measures of environmental sustainability. Therefore, it is replaced with the name "Energy Efficiency".

[10] World Commission on Environment and Development (Brundtland Commission), *Our Common Future*, Oxford, New York: Oxford University Press, 1987.

[11] See Moore and Miller (1994) and Annandale et al. (2005) for such examples.

[12] WBCSD suggests that in simplest terms, it means creating more goods and services with ever less use of resources, waste and pollution (WBCSD, 2000). It focuses on business opportunities and allows companies to become more environmentally responsible and more profitable (WBCSD, 2000, p.4).

[13] As a matter of fact, there is a wide variety of terminology referring to eco-efficiency. The term "eco-efficiency" used here is an overarching general concept, with variants residing under this umbrella.

[14] Some reports (for example, APFED, 2005) use "paradigm shift" in place of "system change". In the present report, the two concepts are used interchangeably.