# STRONG OR WEAK SUSTAINABILITY: A CASE STUDY OF EMERGING ASIA

*Anamika Barua and Bandana Khataniar**

***Sustainability can be weak or strong, depending on the nature of capital accumulation. Weak sustainability is characterized by a non-declining combined stock of capital and assumes that man-made capital can be replaced with natural capital. Strong sustainability, on the other hand, implies that natural capital cannot be replaced by any other capital. Based on this understanding, the present study analysed the growth patterns of 10 emerging Asian economies using time-series data over a 20-year period. For this purpose, the study used genuine savings as an indicator of weak sustainability and ecological footprint as an indicator of strong sustainability. The study found that the selected Asain economies, particularly the middle-income countries, are following a path of weak sustainability. While the high-income countries are gradually making an attempt, through various policy interventions, to move from a path of weak to strong sustainability, despite genuine savings having stabilized their ecological footprint per capita continues to show an increasing trend.***

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* Anamika Barua, Associate Professor (e-mail: anamika.barua@gmail.com; abarua@iitg.ernet.in), and Bandana Khataniar, Research Scholar (e-mail: bandanakhataniar@gmail.com; k.bandana@iitg.ernet.in) are from Department of Humanities and Social Sciences, Indian Institute of Technology Guwahati, Guwahati 781039, Assam, India. The authors are deeply indebted to Dr. Elias Lazarus, Research Scientist of the Global Footprint Network for helping to collect data on ecological footprints and biocapacities for the selected countries under study. The authors are also grateful to the anonymous referees of the *Asia-Pacific Development Journal* for their valuable comments.

# I. INTRODUCTION

Economic growth is considered to be a prerequisite for meeting the basic needs of a society. Nevertheless, economic growth alone is not sufficient to enhance well-being, although it plays a pivotal role in increasing the purchasing power of people and thus provides greater opportunity to raise their standard of living. Economic growth depends not only on human capital, but also on environment or natural capital.[1] Continuous economic expansion may lead to a loss of the services provided by natural capital, which in turn may place a limit on growth. However, economists, until recently, held the view that the environment is a subset of the economy and the economy can grow forever. The only role that nature plays in economic growth processes is as a source of raw materials and as a sink to absorb the waste products of economic activities. This narrow view of environment has led to the depletion of natural resources at a rate faster than the replenishment rate, generating pollution beyond the assimilative capacity of nature.

Discussions on the impact of human-led economic activities on the environment started to gain popularity in the 1960s with the works of certain scholars from interdisciplinary fields (Carson, 1962; Boulding, 1966; Daly, 1968; Ayres and Kneese, 1969; Georgescu-Roegen, 1971). Although diverse in nature, all these works suggested an interaction between the economy and the environment. Boulding (1966) pointed out that it is not possible to have limitless growth in a finite world. This is because the economy is part or a subsystem of a whole ecosystem, namely that of the environment (Daly and Farley, 1994; Getzner, 1999). Therefore, the economy cannot grow forever, as growth is limited by the availability of natural resources or the environment (Daly and Farley, 1994; Lawn and Clarke, 2010; Asici, 2013).

These studies have shown that there is reason to be concerned about the future of humankind and a need to put constraints on economic activities that stem from both human and physical interactions of the economy and the environment (Stern, 1997). Hence, sustainable development is concerned with development not only for the present generation, but also for future generations. In other words, this definition of sustainable development emphasizes that for development to be sustainable intergenerational equity is achieved when each following generation has at least as much capital at its disposal as the preceding generation (Figge, 2005). Though this idea has been widely accepted, there is a great deal of debate concerning the question of whether one form of capital (e.g. natural capital) can be substituted for

[1] Natural capital is the range of functions that the natural environment provides for humans and for itself. Traditional economists have defined capital as a produced means of production, where the term “produced” implies “produced by humans” (Costanza and Daly, 1992). Ecological economists have broadened the definition of capital to include the means of production provided by nature.

another form of capital (e.g. human-made capital). Based on this capital approach, two schools of thoughts have emerged: weak sustainability and strong sustainability. Weak sustainability, which stems from the prevailing environmental-economic theories, assumes that the total capital stock is an aggregate stock of man-made and natural capital and so there are no natural resources that cannot be replaced by other forms of capital (Stern, 1997). That is, the theory of weak sustainability is based on the market economy and the whole concept is human centric. This school is strongly opposed and challenged by the strong sustainability school of thought. This school of thought belongs to ecological economics, which does not support the concept of perfect substitutability among capitals. The school believes that substitutability among capitals, especially between natural capital and man-made capital is restricted (Daly, 1990; Gowdy, 2000).

Until now, most studies have analysed one or several countries at one point in time, taking either the weak sustainability indicator or the strong sustainability indicator. For example, Galli and others (2012) have taken the ecological footprint as a strong sustainability indicator for India and China. Lawn and Clarke (2010) used the genuine progress indicator as a weak sustainability indicator to gauge countries' sustainability. You (2011) considered genuine savings as a weak sustainability indicator to measure China's sustainability in terms of energy consumption. In this paper we concentrate on studying the sustainability of a few selected developing Asian economies by considering both weak sustainability and strong sustainability indicators. The reason for choosing both indicators is to enable us to understand the path of development followed by emerging economies. We have used adjusted net savings, also known as genuine savings, as a weak sustainability indicator and the ecological footprint as a strong sustainability indicator to understand which path the selected Asian economies are on. By conducting a trend analysis of the growth patterns using time-series data from 1990 to 2010 for the selected Asian economies, the paper seeks to understand if economic growth is putting pressure on the natural resources of those countries and if resource utilization is related to the increasing size of the economy and population.

The paper is structured as follows: section II discusses the concept of sustainable development; section III describes the study region, data and methodology used to analyse the data; section IV presents the results; and section V concludes with a discussion of the findings.

## II. SUSTAINABLE DEVELOPMENT: WEAK AND STRONG

The concept of sustainable development explains the evolution of society from a new perspective. Although the concept took shape in the 1980s, its origin predates that. Natural resources were always considered the primary elements of production and for maintaining a given level of population. However, when population increases, there is an impact on the natural resources themselves, due to increasing demand. In 1798, Thomas Malthus, discussed the effect of population increase on land in his famous book *An Essay on the Principle of Population*. He believed that an uncontrolled increase in population might hamper the development of society (Brander, 2007; Rogers, Jalal and Boyd, 2008). This belief of Malthus can be regarded as the first important step towards the concept of sustainable development. Although current discussions on sustainability are more scientific and include much more important phenomena than Malthus could have included. However, both the present concept of sustainable development and Malthus's view of population growth emphasized the fact that the economy cannot grow forever. The linkage between these two concepts is still relevant for increasing quality of life. Brander, in 2007, revisited this theory in a very scientific way while considering three important elements: the stock of environmental capital; the human use of environmental capital; and population growth. With the help of a formal model of Malthusian demography in the presence of ecological constraints, Brander (2007) concluded that the most fundamental factor in achieving sustainable development was population and the demographic transition to lower fertility.

The next important development was the book entitled *Limits to Growth*, which was commissioned by the Club of Rome and was published in 1972. In its introduction, the authors claimed that if the existing trend continued in the growth of population, industrialization, pollution, food production and resource depletion, then the limits to growth would be reached within 100 years (Meadows and others, 1972). One of the main aims of *Limits to Growth* was to bridge the gap between development and environment. In the same year, the United Nations Conference on the Human Environment was held in Stockholm. This conference turned the environment into a major international issue (Long, 2000). As the result of a recommendation made at that Conference, the United Nations Environment Programme (UNEP) was established in 1972 to focus on environmental action and to coordinate with the United Nations system. Again following the Stockholm Conference, in 1974, a symposium was held in Cocoyoc, Mexico, by UNEP and the United Nations Commission on Trade and Development (UNCTAD) to identify the economic and social factors responsible for environmental deterioration (UNEP, 2003). Right after these seminal works, the first World Climate Conference was held in 1979 in Geneva and in 1980, the World Climate Programme was established to provide a framework for international cooperation on research into important climate issues such as ozone depletion, global warming, etc.

All of the above-mentioned processes increased the need for conservation strategies to incorporate environmental considerations into development planning. In 1980, in an effort to meet one of the objectives of the Stockholm Conference, the World Conservation Strategy was launched by the International Union for Conservation of Nature (IUCN) with the advice, cooperation and financial assistance of UNEP and the World Wildlife Fund (WWF) to address environmental issues where the term "sustainable development" was coined for the first time (Moldan, Janouskova and Hak, 2012). Furthermore, in 1983, the World Commission on Environment and Development (WCED) was formed under the chairmanship of Ms. Brundtland, the then Prime Minister of Norway. The commission published its report in 1987 as *Our Common Future*, which defined sustainable development as "the development that meets the needs of the present generation without compromising the ability of the future generation to meet their needs"(WCED, 1987). It concluded that existing decision-making structures and national-international arrangements could not cope with the demands of sustainable development (WCED, 1987). This definition means that environment[2] is a necessary condition for development. However, how to achieve sustainable development and how to decide whether the present path of development is sustainable or not are still under consideration.

There are many challenges to sustainable development as emphasized by different scholars. *Limits to Growth* identifies population, industrialization, pollution, food production, and resource depletion (Meadows and others, 1972) as some of the challenges to sustainable development. Wackernagel and Rees (1996) argued that the Earth's ecosystem cannot sustain the current levels of human demand for resources and ecological services and they identified the rising levels of carbon dioxide emissions and resource consumption as challenges to sustainable development. Various studies have established that the scarcity of natural resources poses a real constraint on lasting growth. As discussed in the introduction, sustainable development can be looked at from two different points of view. One way is to view the environment in terms of the natural resources or natural capital that are available for wealth creation, and that future generations should have the same ability to create wealth as we have. In other words, future generations will be adequately compensated for any loss of environmental amenity by having alternative sources of wealth creation (Beder, 2000) and hence growth will not stop. This is referred to as "weak sustainability". The weak sustainability concept was the extension of neo-classical theory of economic growth to account for non-renewable or exhaustible natural resources based on the assumption that natural capital can be replaced by man-made capital (Getzner, 1999). According to this view, the total stock of capital must not decline and should remain

[2] Environment refers here to the capacity to supply raw resources and to absorb the end waste products (Daly, 2005).

at least constant for development to be sustainable. The view is based on a belief in technological advancement, which offers the possibility of replacing natural capital with man-made capital. The proponents of weak sustainability looked at environment as a natural resource, which has a monetary value and can be extracted for the benefit of humankind. Economists started looking at sustainable development mostly from the perspective of weak sustainability after the works of some renowned scholars, like Dasgupta and Heal, Hartwick and Solow (see Dietz and Neumayer, 2007). In their works, the authors successfully applied the substitutability assumption of weak sustainability. Furthermore, Hartwick (1978) wrote "no generation short-changes a future generation by depleting the stock of exhaustible resources without providing the future generation with, in some sense, the depleted stock equivalent in the form of reproducible capital". Up until the 1990s, policy discussions and environmental debates focused on this simplified way of understanding economy-environment interaction, namely, that complete substitutability of natural capital with man-made capital is possible.

However, this view was greatly challenged in the 1990s by certain scholars from divergent fields who viewed the environment as offering more than just economic potential that is not substitutable by man-made wealth. They argue that future generations should not inherit a degraded environment, no matter how many extra sources of wealth are available to them. This is referred to as "strong sustainability", and is the second view. The proponents of strong sustainability, such as Daly, Georgescu-Roegen, Ekins, Pearce and Atkinson, who are ecological economists, emphasized that environment performs four categories of functions,[3] for which the total economic value is difficult to calculate. For them the economy is only a "part" of the "whole" ecosystem and hence for sustainable development, both natural and man-made capital must be preserved (Figge, 2005). In 1999, Gowdy and McDaniel (1999) established — by taking the case study of Nauru, a small Pacific Island nation — that weak sustainability is a short-run concept. Nauru has achieved good economic growth at the cost of its natural resource, phosphate. However, as a result of its mining activities, 80 per cent of the island is totally devastated, land has become unusable for habitat, many species have become extinct, many more have become endangered and the nation has become dependent on the global economy (Gowdy and McDaniel, 1999). Beforehand, Pearce (1987) had argued that none of the economic forms could guarantee sustainability. Figge (2005) proved that the theory of

[3] The functions of natural capital can be divided into four categories, namely: (a) a source of raw materials for production and direct consumption, such as food, timber and fossil fuels; (b) a sink to assimilate the waste products of production and consumption; (c) amenity services; and (d) basic life-supporting functions on which human life, as well as the first three categories of functions, depends (Pearce and Turner, 1990; Ekins and others, 2003). Hence, this fourth category is of primary value, whereas the first three categories are of secondary value.

weak sustainability would be applicable only if society were risk neutral, otherwise it would increase the risk for future generations. Dietz and Neumayer (2007) also pointed out that weak sustainability would be true only if there were an abundance of natural resources and their production could be increased by the latest technologies.

However, both the weak and strong sustainability views support the definition of sustainable development given in the Brundtland report and emphasize that development sustains; but the conditions required to achieve strong and weak sustainability are different (Nourry, 2008). The distinction between both is seen mainly in four dimensions, namely: (a) the definition of natural resources; (b) the functions of natural resources; (c) their substitutability; and (d) the relationship between development and the environment.

## III. RESEARCH METHODOLOGY

### Background of the study region

This section provides a brief discussion of Asia, the economic growth experienced by this region since 1990s and the associated environmental concerns in the region.

#### *The economic miracle in Asia*

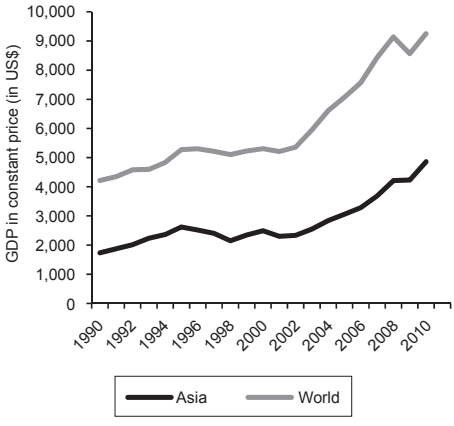
The combined economies of Asia are the third largest in the world after Europe and North America; together they represent the fastest growing region in the world (ESCAP, 2007). Since the 1970s, the economic growth strategies have been very successful in this region where the GDP growth rate over the past two decades has been higher than any other region in the world. During the period from 1990 to 2006, GDP was over $10 trillion (ESCAP, 2007). Consequently, as in 2010, the region has become the engine for global growth, with nearly 20 per cent faster growth than the next fastest growing developing region of the world, Latin America and the Caribbean, by serving as a source of demand for the goods and commodities of other regions (Miller and Plasencia, 2013). The incomparable economic upswing of the region was later referred to as the “Asian miracle” (Weber, 2009). Several factors have been responsible for this miracle (Lee and Hong, 2012), which has been explained by a number of empirical studies. These studies have highlighted factors such as exports, investment, human resources, fertility, and institutional and policy variables, such as trade and globalization (Weber, 2009; Lee and Hong, 2012; Asici, 2013). Economic policies, particularly those relating to openness, have also played a highly significant role in the region’s sustained growth (Lee and Hong, 2012).

As shown in figure 1a below, the region’s average growth rate has increased manifold since 1961, starting from 0.98 per cent in 1961 to 6.6 per cent in 2010,

defying the ongoing global financial crisis (ESCAP, 2012b). The pace of growth has been interrupted twice: in the 1997/98 Asian financial crisis and the 2008/09 global financial crisis. Nevertheless, the region has managed to rebound quickly from both (Lee and Hong, 2012).

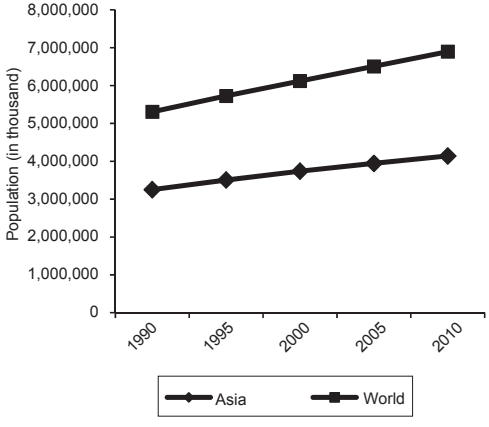
An increasing share of the world's industrial production now takes place within this region; it is also a target market of essential industrial, mining, manufactured and agricultural goods (APFED, 2005). Along with economic growth, population growth is also a major concern in Asia (figure 1b). According to the *Statistical Yearbook for Asia and the Pacific 2011*, approximately 4.2 billion people, 61 per cent of the world's population, lived in the Asian region in 2010 (ESCAP, 2011), an area accounting for only about 30 per cent of the Earth's land mass. Several of the most populous countries in the world are found in the region, including China with 1.35 billion people and India with 1.26 billion (ESCAP, 2012a), together accounting for almost 40 per cent of the world's population (APFED, 2005). According to population projections by the United Nations, a constant increase in population is expected in all subregions of the Asian region.

**Figure 1a. Comparison of the global GDP growth rate with the growth rate in Asia, 1990-2010**




*Source*: SEEA (2013).

**Figure 1b. Population growth trends in Asia and the world, 1990-2010**




*Source*: ESCAP (2011).

However, the tremendous economic development of the Asian region has largely been driven by adopting a labour-intensive, export-oriented industry development strategy, supported by heavy exploitation of human resources as well as natural resources (APFED, 2005; Jha, 2005). The huge population of the region is also a matter of concern in the region as it is also considered to be a key environmental issue in most of the countries of South Asia and South Pacific (Jha, 2005). Natural resources have been the primary element for production and also for maintaining a given population. However, when population increases, it has some effect on these resources. The "overpopulation school" regards population growth as the main factor behind overuse of natural resources, which leads to environmental degradation (Brander, 2007).

***The environmental concerns in Asia***

Many researchers, such as Callicot and Ames, Guha, and Pedersen, have established that Asian people are very attached to nature (see Yencken, 2000). According to them, eastern traditions of thought represent nature and the relationship of people to nature, in ways that cognitively resonate with contemporary ecological and environmental ideas. In spite of such a cordial relationship with nature, the Asian Development Bank (1997) claimed that the Asian region had lost half of its forest cover and countless unique animal and plant species during the period from the 1960s to the 1990s and that no other region had as many heavily polluted cities, rivers and lakes as this region had. This is because the economic growth in the region is fuelled by the region's rich natural resources and services. For example, in Thailand, economic activities such as rubber plantations, shrimp farming and cash-crops are contributing to GDP figures at the cost of natural resources, like forests and coastal ecosystems. In the Philippines, mining activities and forest conversion for agricultural expansion are two major economic activities based on its natural resources (Coxhead, 2002). China, India, Pakistan, Indonesia, the Russian Federation, Bangladesh, Thailand, Viet Nam and the Islamic Republic of Iran are the largest consumers of water resources with water withdrawal as high as 70 billion cubic meters per year (ESCAP, 2007). According to the *Statistical Yearbook for Asia and the Pacific 2012*, the region produced more energy than any other region in the world in 2009, accounting for 46 per cent of total global production. At the same time, the region accounted for 50 per cent (up from 38 per cent in 1990) of the world's total carbon dioxide emissions in the same year. China has been the single largest emitter of greenhouse gases worldwide (ESCAP, 2011, 2012a). About 75 per cent of the world's major natural catastrophes between 1970, 1997 occurred in the Asian region, mostly in poverty-ridden developing countries (ESCAP and ADB, 2000). All these catastrophes have increased its effects on the people and the environment due to several factors: high population growth and density, migration and uncontrolled urbanization, environmental degradation and possibly global climate change (APFED, 2005).

**Study site selection**

The Asian region comprises more than 30 countries. These countries were categorized according to income groups based on the World Bank classification (World Bank, 2011), which states that as of 1 July 2011 (figures for 2010):

(a) Low-income economies are ones in which average income is $1,005 or less;

(b) Middle-income economies, including both upper and lower, are ones in which average income is between $1,006 and $12,275;

(c) High-income economies are ones in which average income is $12,276 or more.

Based on the *Living Planet Report 2012* (WWF, 2012) 20 countries were selected at the first stage[4] (annex I). In the second stage, Japan was excluded since it is a developed country, and the study deals with only developing countries. The other 19 countries were ranked according to the following factors: the intensities of carbon dioxide emissions, ecological deficits,[5] population, urbanization and data availability for the period between 1970 and 2010 (annex II). The following criteria were considered in the third and final stage of selection:

(a) High economic growth rate, which accounts for about 95 per cent of GDP from developing countries in Asia (Lee and Hong, 2012);

(b) High rate of environmental degradation and carbon dioxide emissions;[6]

(c) High population growth rate, which is higher than the world population growth rate of 1.15 per cent in 2010 (ESCAP, 2011);

(d) High rate of urbanization (more than 30 per cent of the total population to be urbanized).

Lack of data for the chosen indicators was a major challenge to consider in all 19 developing Asian countries. Therefore, 10 Asian countries were chosen to take part in the analysis since comprehensive data for the chosen indicators were

[4] The ecological footprint data tables of the ***Living Planet Report 2012*** include footprint data for countries with populations greater than 1 million (WWF, 2012).

[5] Ecological deficit: the gap between 1.0 (the normalized biocapacity) and the country's ecological footprint corresponds to the country's ecological deficit (if the footprint is above 1.0) (Wackernagel and others, 2004b).

[6] For data on carbon dioxide, the ***Statistical Yearbook for Asia and the Pacific 2013*** (Miller and Plasencia, 2013) is relied upon.

available. Therefore, based on the above criteria, 10 developing countries were finally selected — China, India, Indonesia, Malaysia, Pakistan, the Philippines, the Republic of Korea, Singapore, Thailand and Viet Nam. These countries fall under the middle and high-income categories as defined by the World Bank (see above). While China, India, Indonesia, Pakistan, the Philippines, Thailand and Viet Nam are in the middle-income group; Malaysia, the Republic of Korea and Singapore fall under high-income category.

**Indicators of sustainable development**

In 1992, the United Nations Conference on Environment and Development, which was held in Rio de Janeiro, suggested that sustainable development indicators must be constructed in order to form a useful basis for decision-making (Nourry, 2008). Different scholars describe the necessity and process of measuring sustainable development through indicators. Nourry (2008) states that an indicator of sustainable development must assess human development and sustainability. Many composite indicators have been constructed to measure the sustainability of development. However, the discussion about the best aggregate indicator of sustainability is still ongoing. Until now, no single indicator has done a perfect job to reflect sustainable development (Pillarisetti and van den Bergh, 2007; Nourry, 2008).

Studies have applied various indicators for the purpose of assessing sustainability (for example, Singh and others, 2009; Lawn and Clarke, 2010). Some of the most widely used indicators on the income-environment nexus are genuine savings, otherwise known as adjusted net savings (Hamilton and Clemens, 1999; Nourry, 2008; Mota, Domingos and Martins, 2010; Asici, 2013; Kubiszewski and others, 2013; Greasley and others, 2014); green national net product (Nourry, 2008; Mota, Domingos and Martins, 2010); the system of environmental-economic accounting (Dietz and Neumayer, 2007); the index of sustainable and economic welfare (Nourry, 2008); the ecological footprint (Parker, 1998; Wackernagel and others, 2004a; Lammers and others, 2008; Nourry, 2008; Hubacek and others, 2009; Begum and others, 2009; Galli and others, 2012; Wang, Chou and Lee, 2012); the environmental sustainability index (Pillarisetti and van den Bergh, 2007; Hara and others, 2009); the environmental performance index (Yale Centre for Environment Law and Policy, 2010); the environmental vulnerability index (Kaly, Pratt and Mitchell, 2004; Barnett, Lambert and Fry, 2008), etc.

As discussed in section II, in this study we want to understand the sustainability path that selected emerging Asian economies are following — whether it is a weak sustainability path or a strong one. To do so, two indicators of sustainable development were selected: one is genuine savings and the other is the ecological footprint. The ecological footprint was selected as an indicator of strong sustainability and genuine savings as an indicator of weak sustainability. This is because all the other

indicators mentioned above are either more appropriate to measure quality of life or to assess the likelihood of potential damages caused by environmental problems, or are based on policy performance to reduce environmental stress on human health and to promote natural resource management (Singh and others, 2009). To the best of our knowledge, those two indicators have not been studied together before in any other study using time series data, specifically for the selected Asian countries, to understand the interaction between economic growth and the environment.

*Genuine savings:* genuine savings, otherwise known as adjusted net savings, were put forward by Pearce and Atkinson in 1993. It is a simple indicator to assess an economy's sustainability. Genuine savings assume that capital stock consists of produced capital, human capital (knowledge, skills, etc.) as well as natural capital (natural resources). Here, all values are monetarized and the aggregation is achieved by simply adding up. Genuine savings are based on the concept of "weak sustainability", which assumes perfect substitutability between physical, natural and human capital (Pillarisetti and van den Bergh, 2007). Out of all the indicators of weak sustainability, genuine savings received considerable recognition for the following reasons: (a) it was developed and published by the World Bank; (b) comprehensive data are available for almost all countries from 1960; (c) it is superior to other indicators in its capacity to represent more broadly the changes in environmental sustainability (Asici, 2013); (d) the natural disinvestment component of genuine savings is measured within the country where extraction/production takes place; and (e) it has considerable scope for future development (Mota, Domingos and Martins, 2010). Therefore, considering genuine savings, it is possible to observe the impact of growth on the domestic environment (Asici, 2013).

*Ecological footprint and biocapacity*: the concept of the ecological footprint first emerged in the book *Our Ecological Footprint: Reducing Human Impact on Earth*, written by Wackernagel and Rees (1996). In 1997, they attempted for the first time to calculate the ecological footprint and biocapacity systematically. Based on these assessments, an institution, known as Global Footprint Network, started a National Footprint Accounts programme in 2003 (Borucke and others, 2013), which is an accounting framework quantifying the annual supply of, and demand for, key ecosystem services by means of two measures (Wackernagel and others, 2002). The ecological footprint is based on the quantitative land and water requirements to sustain a nation's living standards. The ecological footprint assumes that human extraction of natural resources exceeds the regenerative capacity of the resources, this acts as a limiting factor to economic growth (Borucke and others, 2013). However, the ecological footprint is not a full measure of sustainability as it tracks only one aspect of it, namely: whether humans live within the earth's biocapacity budget. A footprint/biocapacity ratio greater than 1 implies that this aspect of sustainability is not met;

however, a value lower than 1 does not imply that development is sustainable. The ecological footprint has been promoted by the World Wide Fund for Nature (Pillarisetti and van den Bergh, 2007) and its data are also available in its reports. It is based on the same assumptions as the strong sustainability view point. By applying the ecological footprint over time, the progress towards sustainability, or its opposite, can be gauged (Lammers and others, 2008). Biocapacity or biological capacity is a measure of the ecologically productive land available (Ferguson, 2002). Biocapacity is the ability of an ecosystem to produce useful biological materials and to absorb the waste materials generated by humans. The biocapacity of an area is calculated by multiplying the actual physical area by the yield factor and the appropriate equivalence factor. Biocapacity is usually expressed in global hectares.

*Population*: in the study, population growth was taken as one of the indicators as it is hypothesized that when population increases, consumption also increases and as a result more pressure falls not only on natural resources, but also on human capital. This may hamper the capacity of the environment in the future. The indicator of population is taken as the annual population growth rate.

The hypothesis that this study made was that a country is on a path of strong sustainability if its ecological footprint does not overshoot its biological capacity or biocapacity. If a country's ecological footprint is more than its biocapacity, but its genuine savings indicator has a positive trend then the country will be regarded as weakly sustainable. Otherwise, it will be regarded as not sustainable at all because genuine savings are an extension of the Hartwick rule, where it is assumed that an economy will be sustainable if savings are superior to the aggregated depreciation of human, man-made and natural capital (Hartwick, 1978).

**Data and data sources**

Time series secondary data have been used in this study. Time series show trends that allow researchers to test the noise in the data (Wackernagel and others, 2004a). It also provides a comparative base for different methodological alternatives. However, in this study a simple trend analysis has been performed using the time series data for a period of 20 years to understand the growth trajectories and related environmental concerns in the selected Asian countries. Various studies have shown that weak sustainability is a prerequisite for strong sustainability (Atkinson and others, 1997; Neumayer, 2003). When a country is weakly sustainable, it has a chance to be strongly sustainable (Mota, Domingos and Martins, 2010). Therefore, the present study has a larger theoretical analysis as it considers both strong sustainability and weak sustainability indicators to understand the present path of development as well as to see whether countries can move from a path of weak sustainability to one of strong sustainability. Hence, unlike other studies we have taken both genuine savings

and ecological footprints and 10 Asian countries. We are also looking at the issues at the policy level, which decides the development path of these countries.

The time series data considered for this study are for the period between 1990 and 2010 for each of the countries under study. Secondary data are taken from the World Bank's World Development Indicators (World Bank, 2013), the Human Development Reports of the United Nations Development Programme (UNDP, 2011), the Global Footprint Network database (GFN, 2012), the Living Planet Reports by the World Wildlife Fund for Nature (WWF, 2012), the *Statistical Yearbook for Asia and the Pacific* by the Economic and Social Commission for Asia and the Pacific (ESCAP, 2007, 2012) and the Asian Development Bank (ADB) reports (ADB, 1997). As discussed in the section on methodology, the indicators considered in this study are: population growth rate, per capita genuine savings (per cent of GNI), per capita ecological footprint in global hectares and per capita biocapacity in global hectares.

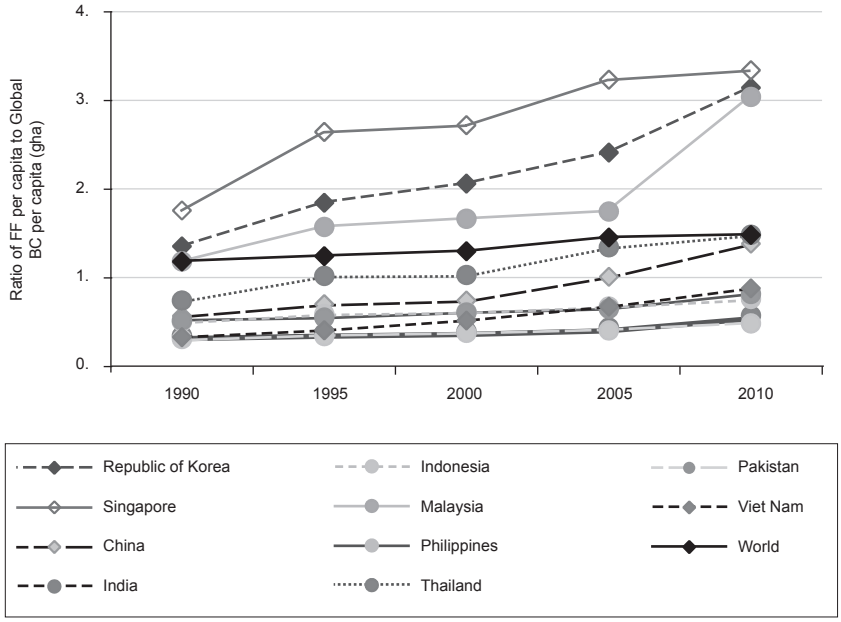
## IV. RESULTS

This section discusses the results based on the trend analysis of the secondary data for 20 years (1990-2010) for biocapacity per capita and the ecological footprint per capita for the selected emerging Asian economies. An important caveat is that the results may be biased by the availability of data and the way in which the countries were selected for the study.

### *Ecological footprint of each income group at the global level*

Figure 2 shows the ecological footprint of each country (domestic demand) in comparison with global biocapacity. While at the global level, the per capita ecological footprint has remained largely unchanged since 1990, different patterns of change were found in the two income groups. The high-income countries — Malaysia, the Republic of Korea and Singapore — have high per capita ecological footprints, that is a very high demand for global resources, compared with middle-income countries. In 1990, the average global demand per capita of high-income countries was 3.4 global hectares (gha) and 1.26 gha for middle-income countries. By 2010, the average demand for all the selected countries had increased by a factor of almost 1.5 (an increase of 47.9 per cent).

**Figure 2. The ratio of the domestic ecological footprint (per capita) to global biocapacity (per capita), 1990-2010**




The interesting thing to note here is that until 1995, the per capita ecological footprint of all the middle-income counties was below the global biocapacity. However, there seems to be a rising trend in these countries, specifically in Thailand and China, where the per capita ecological footprint has increased rapidly since 2000. It is evident from various reports of the Economic and Social Commission for Asia and the Pacific and the Global Footprint Network that the region has posted strong economic growth since 2000, lifting millions of people out of poverty (GFN, 2005; Woetzel, 2014). This holds for both China and Thailand, too. The gross domestic investment rate in Asia also increased in 2010 to 3.9 per cent, up from its negative rate in 2009 (ESCAP, 2012b). The large population and rapidly increasing levels of consumption in Asia and the Pacific make the region a significant contributor to the global ecological footprint. With more than 50 per cent of the world population, rapid economic development and large populations are increasing pressure on different ecosystems of the region, such as coastal, marine and forests. Asia's footprint occupies 40 per cent of available world biocapacity (GFN, 2005). This certainly indicates that there are further pressures on global biocapacity with these developing countries' increasing demand on nature. In short, the general trends include increasing human demand for nature and the transition of middle-income countries from low-footprint

countries to high-footprint countries. This representation also shows how many biospheres would be needed if middle-income countries follow the same pattern of resource consumption as high-income countries.

**The ecological footprint by income group at the domestic level**

Findings are discussed according to income groups — high and middle (upper and lower) — in the section below.

***High-income group***

An increase in per capita consumption is the driving variable of natural capital appropriation by high-income countries (see Galli and others, 2012). Malaysia was a middle-income country in 1990. It joined the high-income group in 2002. In 1990 in Malaysia, the ecological footprint per capita was 2.66 gha, which was below its per capita biocapacity of 3.47 gha. However, Malaysia's per capita ecological footprint has now reached 4.86 gha, an 82 per cent increase against a 25 per cent decrease in its per capita biocapacity. This has caused a per capita deficit in biocapacity of 2.25 gha. Genuine savings increased 52 per cent between 1990 and 2010, while GDP rose threefold (figure 3a). However, during the period between 2000 and 2005, Malaysia's genuine savings declined, although they recovered soon after that. The country's population growth slowed from 2.8 per cent in 1990 to 1.6 per cent in 2010. This has happened due to declining birth rates and stabilized death rates over the last two decades (ESCAP, 2007).

The rising share of average per capita ecological footprint is remarkable in high-income countries, particularly in the Republic of Korea, as can be seen from the ecological footprint per capita trend line (figure 3b). Between 1990 and 2010, the trend shifted from 3.04 gha to 4.87 gha per capita. Interestingly, genuine savings in the Republic of Korea showed a 5 per cent reduction in 2010 from its 1990 level. However, total income (GDP) increased almost threefold during the period from 1990 to 2010. In addition, declining birth rates and stabilized death rates made the population growth rate decrease from 1.14 per cent in 1990 to 0.46 per cent in 2010. The same is true for almost all the selected countries — both high income and middle income (ESCAP, 2007).

**Figure 3a. Trends of population growth and genuine savings, ecological footprint and biocapacity per capita in Malaysia**

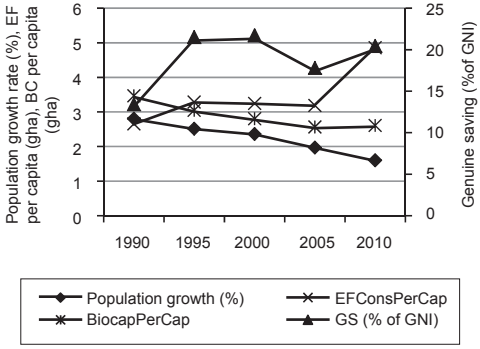
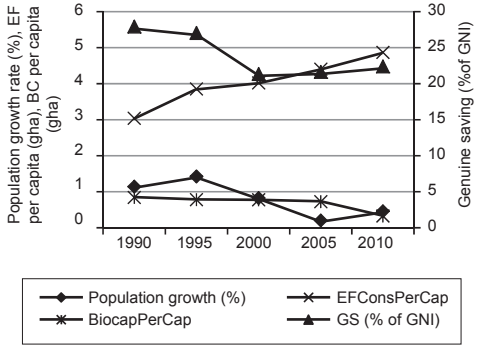
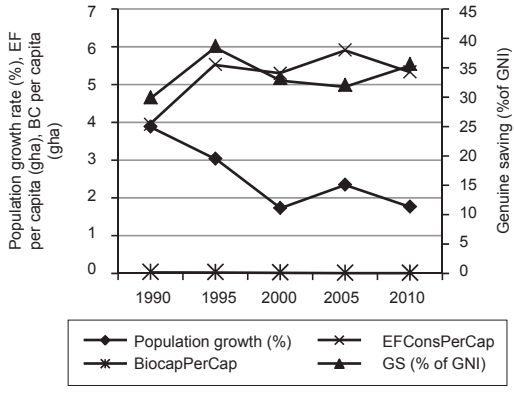



**Figure 3b. Trends of population growth and genuine savings, ecological footprint and biocapacity per capita in the Republic of Korea**




The ecological footprint of Singapore has increased from 3.95 gha (1990) to 5.34 gha (2010) per capita (figure 3c). Each individual of this country demands 4.8 gha of ecologically productive land, which is higher than the average for high-income countries, that is to say, 3.38 gha per capita (WWF, 2012). There was a 2.11 per cent decline in the overall population growth rate in Singapore during the period from 1990 to 2010. Genuine savings remained more or less steady in Singapore during the study period.

**Figure 3c. Trends of population growth and genuine savings, ecological footprint and biocapacity per capita in Singapore**



### *Middle-income groups*

All the middle-income countries selected for this study are rich in biocapacity (supply). China (9.9 per cent), India (4.8 per cent) and Indonesia (2.6 per cent) are among the 10 countries that accounted for more than 60 per cent of the Earth's total biocapacity in 2008 (WWF, 2012). The trends show that the selected middle-income countries had more or less the same amount of total average biocapacity during the period from 1990 to 2010. However, in those countries, the increasing trend of the per capita ecological footprint is a matter of real concern. Since 2005, in China (figure 4a) and India (figure 4b) both genuine savings per capita and the ecological footprint per capita have shown increasing trends. Consumption per capita, which is extremely skewed in most of these middle-income countries, with handful of people having access to most of the resources, has played a significant role in increasing the ecological footprint of these nations (Marcotullio, 2001; Galli and others, 2012).

**Figure 4a. Trends of population growth and genuine savings, the ecological footprint and biocapacity per capita in China**

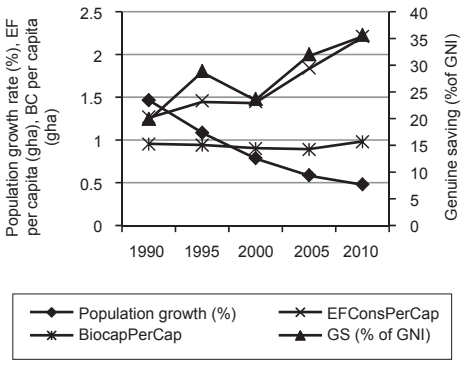
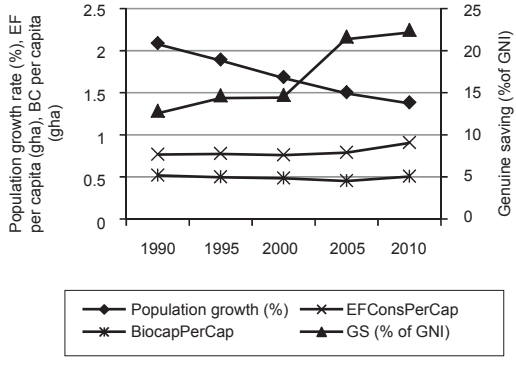



**Figure 4b. Trends of population growth and genuine savings, the ecological footprint and biocapacity per capita in India**




Indonesia (figure 4c), the Philippines (figure 4d), and Thailand (figure 4e) had very high genuine savings per capita during the period from 1990 to 1995. However, genuine savings started to decline after 1995 and continued on a downward trend until 2000. This was also the time of the East Asian crisis and most of the East Asian countries suffered economic crises. However, this changed after 2000, as all four countries have succeeded in gaining good per capita genuine savings since then. The increase in per capita genuine savings in these countries was accompanied by a significant increase in their per capita ecological footprint.

**Figure 4c. Trends of population growth and genuine savings, the ecological footprint and biocapacity per capita in Indonesia**

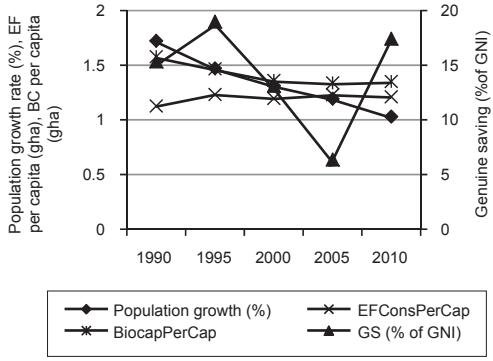



**Figure 4d. Trends of population growth and genuine savings, the ecological footprint and biocapacity per capita in the Philippines**

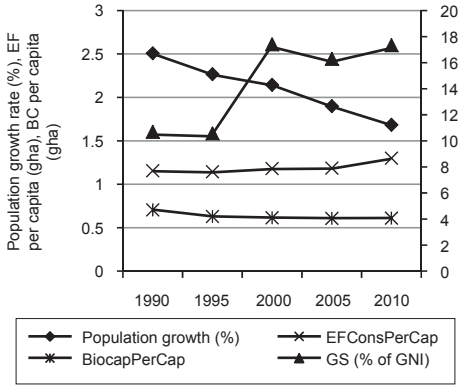
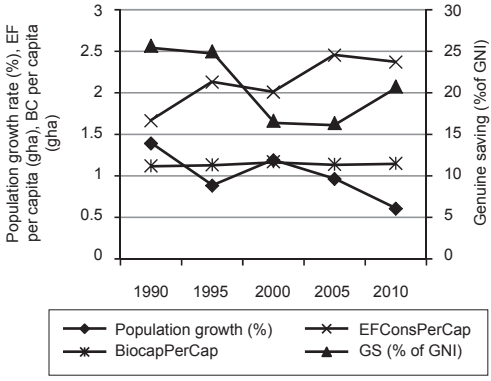



**Figure 4e. Trends of population growth and genuine savings, the ecological footprint and biocapacity per capita in Thailand**




China and India are the most populous countries among the selected Asian countries, as well as in the world. However, the good news is that population growth rate in all the middle-income countries is on a downward trend (0.86 per cent on average). Pakistan had a biocapacity deficit throughout the study period, during which it saw a significant increase in its population (9 per cent) and a 12 per cent increase in the average ecological footprint. This growing population has to cope with a fixed supply of natural resources, resulting in less available biocapacity per capita. Over the same period, GDP increased almost three times. Pakistan's genuine savings

(figure 4f) increased sharply between 2000 and 2005, after which they declined by 1.3 per cent.

In 1990, Viet Nam had ecological reserves that is the ecological footprint < biocapacity. During that time the country witnessed negative genuine savings rates. Up until this year, Viet Nam had faced a very complicated political situation, which made it difficult for its economy to move forward right after reunification in 1975 (Tho, 2003). In 1986 certain economic reforms were initiated in Viet Nam, in terms of policy measures (known as *Doi Moi*), to create a market economy (Nghiep and Quy, 2000). However, old and thorough steps were taken only after 1990 when the 10-Year Strategy for Socioeconomic Stabilization and Development was adopted for period between 1991 and 2000. Thereafter, by 1995, the country acquired positive genuine savings and gathered momentum. In 1995, the ecological footprint of Viet Nam was 0.84 gha per capita, which increased to 1.4 gha per capita in 2010. Similarly, the genuine savings figure in 1995 was 8.35 (per cent of GNI), which reached 16.3 (per cent of GNI) in 2010. This resulted in a biocapacity deficit. The country, which had a positive ecological reserve in 1990, is now left with deficit ecological reserves after just 20 years, although the country's rate of population growth is declining (figure 4g).

**Figure 4f. Trends of population growth and genuine savings, the ecological footprint and biocapacity per capita in Pakistan**

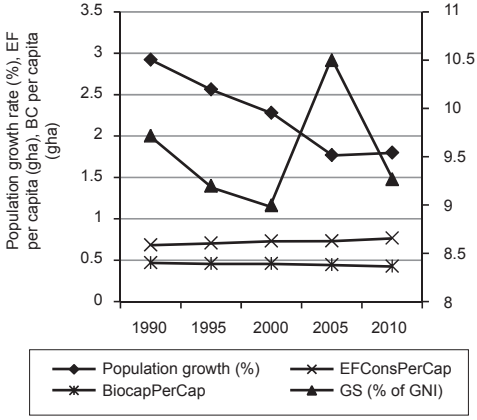
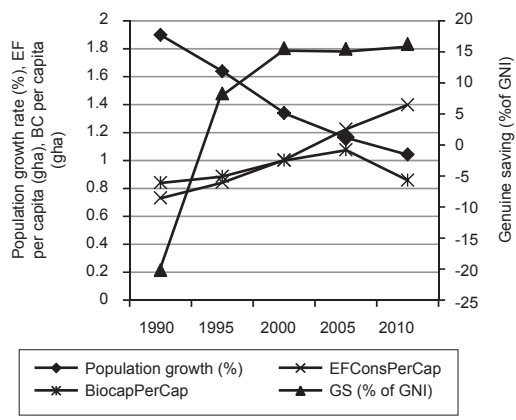



**Figure 4g. Trends of population growth and genuine savings, the ecological footprint and biocapacity per capita in Viet Nam**



It is important to note here that all the selected middle-income countries are experiencing a slow transition from agricultural economy to industrial economy. According to a recent study conducted by Srinivasan (2013) in six South Asian countries — Bangladesh, Bhutan, India, Nepal, Pakistan and Sri Lanka — during the period from 1995 to 2010, the share of agriculture in GDP declined. According to Akram (2013), there is a strong relationship between urbanization, industrialization and economic growth. Urbanization stimulates industrialization and, consequently, economic growth, and this may have a negative impact on the agriculture sector in the developing countries (Akram, 2013).

## V. DISCUSSION AND THE WAY FORWARD

Throughout the period from 1990 to 2010, the average per capita ecological footprint of all the selected developing Asian economies was higher than their average per capita biocapacity, that is, the countries had a significant ecological deficit. This is a clear situation of "overshoot".[7] However, it is important to note that although all 10 countries chosen for the analysis fall into the high- and middle-income groups (as discussed in section III), they are in a state of ecological deficit, with the performance of each group varying with respect to their population growth, ecological footprint, biocapacity and genuine savings per capita.

### *Performance based on income groups*

The high-income countries are characterized by increasing ecological footprints per capita, relatively stable genuine savings per capita, decreasing population growth rates and declining biocapacity per capita. While population growth rates in these countries have remained stable (in fact they have declined), during the study period; the high consumption per capita has resulted in ecological deficits in these countries (Galli and others, 2012). Therefore, the high per capita income of these countries has resulted in high domestic demand for nature.

The middle-income countries are characterized by lower ecological footprints per capita but they have an increasing trend, large populations (with declining growth rates), increasing genuine savings per capita and biocapacity deficits. All the selected middle-income countries, except Indonesia, are facing biocapacity deficits (biocapacity<ecological footprint). As these countries are in a phase of rapid development, mainly through industrialization and trade, they are following the same pattern as high-income countries (Galli and others, 2012). For example, demand for

[7] When the total demand for ecological resources and services exceeds the available supply for a given region, it is called an "overshoot" (Borucke and others, 2013).

nature has increased by 49 per cent, whereas biocapacity has declined by 13.6 per cent. Indonesia is an exception here since there have been increasing demands on its environment in spite of its accelerated economic development between 1990 and 2010. Its genuine savings trend declined (-12.7 per cent) between 1995 and 2005, mainly due to the economic slowdown in recent times. The country is also blessed with large biocapacity (WWF, 2012). However, Indonesia's demand for natural resources since 2005 has started to increase gradually, thus putting pressure on the domestic biocapacity. In 2005, the carbon footprint of the country was 0.09 gha per capita, now it is 0.23 gha per capita, a 156 per cent increase in the last five years, which is definitely a matter of concern (see Weber, 2009; Shrestha, 2013). Shrestha (2013) found that Indonesia had been following an almost market-based economic transformation path and therefore it had been able to reach middle-income status within a short period of time. Pakistan experienced steady growth in genuine savings per capita until 2005 and then a sharp decline between 2005 and 2010. This could be due to the internal conflicts and political instability in this country (Shrestha, 2013). Overall, the trends show that the middle-income countries are currently trying to catch up with the high-income countries; they are also undergoing an economic transformation.

***Inferences based on weak and strong sustainability***

Based on the time series trend analysis of the variables under consideration (population growth rate, and ecological footprint, genuine savings and biocapacity per capita), it can be claimed that the negative ecological reserves of all the selected countries —high-income and middle-income — make them, in environmental terms, "weakly sustainable nations". It is important to note here that the high-income countries started on a path of weak sustainability by replacing natural capital with man-made capital. This allowed the total stock of capital to grow, which is reflected in increasing genuine savings during the study period. However, in the last decade (since 2000) the genuine savings of these countries has almost remained stable. This could be because these countries have showed a renewed interest in preserving their natural resource base and making efforts to reduce their greenhouse gas emissions. They are working towards achieving "green growth" as they have already achieved high per capita income (ESCAP, 2012a). The Republic of Korea has established a Presidential Commission on Green Growth, which has guided the implementation of its Low Carbon Green Growth development strategy (Marcotullio, 2001; ESCAP, 2012a). Singapore has adopted a series of cleaner environmental campaigns (ESCAP, 1995). "Ecosystem management and biodiversity conservation policies are well developed in Malaysia. Under the Ninth plan (2006-2010), Malaysia has adopted a National Tree Planting Programme for Coastline Protection and some mangrove protection and action plans (Avishek, Yu and Liu, 2012). Adoption of such environmental strategies

has helped these countries in reducing the ecological footprint per capita of these high-income countries.

The middle-income countries started on the path to growth in the 1990s (Shrestha, 2013). Economic development of these countries requires measures to improve their socioeconomic status. These measures may be high investment rates, infrastructure construction, health facilities expansion, adoption of new technologies, innovative practices, job creation inside the economy, etc. (Shrestha, 2013). As such, the focus of these countries seems to be on increasing the total stock of capital, even if it is at the cost of degradation of natural capital. Ewing and others (2008) claimed that human demand had exceeded the global biocapacity in the 1980s. Hence there is a possibility that growth-oriented development of the middle-income countries under study may further widen this gap. However, as Galli and others (2012) have already pointed out, the major concern in these countries is growing population, which has a positive relationship with resource utilization. The high population pressure in these countries has continued to put pressure on natural resources. Due to the large population size these countries may take longer to reach the per capita income of high-income countries and during that time there could be irreversible damage to the natural resources of these countries. Increasing genuine savings per capita and a steady increase in the ecological footprint per capita indicate that they are following a path of weak sustainability. It remains to be seen how long these countries will continue to move on this path, as at present the economies of these countries are mostly dependent on natural resource intense sectors (see Sachs and Warner, 1997; Coxhead, 2004).

Thus, our study found that in the selected Asian countries, in their pursuit of achieving higher economic growth and standards of living, resources have been exploited at a rate much faster than the regenerative capacity of nature. When economies first began on a path of growth, mainly in a rich natural resource region like Asia, natural capital was not scarce. In this "empty world"[8] the opportunity cost of expanding economies was insignificant (Daly and Farley, 1994). However, continued growth of the physical economy into a finite and non-growing ecosystem will eventually lead to a "full world"[9] economy, in which the opportunity cost of growth is significant. It is important to realize that growth has a cost, since an economy is

[8] Empty world: relatively empty of human beings and manmade capital as Daley and Farley (1994) defined. In this situation both natural resources and natural capital were considered comparatively free of costs, except the costs of extraction. Therefore, there seems to be no constraint on the economy.

[9] Full world: in this situation, the world is relatively full of human beings (Daly and Farley, 1994). Daly and Farley wrote that "in the era of full-world economics, this threat is real and is met by liquidating stocks of natural capital to temporarily keep up the flow of natural resources that support the value of manmade capital".

not expanding into a void. Our results show that the selected Asian countries are already approaching such a full-world situation. The results essentially confirmed that the domestic biocapacity of the selected Asian countries is under pressure due to the current growth patterns. Thus, it is important for the countries to understand that human development, whether social, economic or technical, depends upon the health of our ecosystem. Thus, to achieve strong and sustainable economic growth, there is a need to shift from weak sustainability to strong sustainability.

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## Annex I

1. Bangladesh
2. Cambodia
3. China
4. Democratic People's Republic of Korea
5. India
6. Indonesia
7. Japan
8. Lao People's Democratic Republic
9. Malaysia
10. Mongolia
11. Myanmar
12. Nepal
13. Pakistan
14. Philippines
15. Republic of Korea
16. Singapore
17. Sri Lanka
18. Thailand
19. Timor-Leste
20. Viet Nam

## Annex II. Ranking of Asia-Pacific countries in various selection criteria of the present study

| Sl. No. | Country | $CO^2$ emissions (metric tons per capita) in 2010 | Rank | Demand (ecological footprint (EF)) and supply (biocapacity) of natural resources | Data availability | Total population | | Urbanization in 2010 | | Adjusted net savings | Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | EF/ biocapacity ≥ 1 | 1970-2010 | Total | Rank | (Percentage of total population) | Rank | | |
| 1 | Republic of Korea | 11.48681 | 1 | Yes | Yes | 49 410 000 | 9 | 82.933 | 2 | 21.898 | 5 |
| 2 | Malaysia | 7.667467 | 2 | Yes | Yes | 28 401 017 | 12 | 72.006 | 3 | 17.551 | 10 |
| 3 | China | 6.194858 | 3 | Yes | Yes | 1 337 825 000 | 1 | 49.226 | 7 | 34.158 | 1 |
| 4 | Thailand | 4.446856 | 4 | Yes | Yes | 69 122 234 | 8 | 33.73 | 10 | 17.600 | 9 |
| 5 | Mongolia | 4.243209 | 5 | No | Yes | 2 756 001 | 19 | 67.567 | 4 | -5.603 | 15 |
| 6 | Democratic Republic of Korea | 2.92336 | 6 | Yes | No | 24 346 229 | 13 | 60.21 | 5 | .. | - |
| 7 | Singapore | 2.663192 | 7 | Yes | Yes | 5 076 700 | 18 | 100 | 1 | 33.858 | 2 |
| 8 | Indonesia | 1.803207 | 8 | Yes | Yes | 239 870 937 | 3 | 49.924 | 6 | 23.378 | 4 |
| 9 | Viet Nam | 1.728118 | 9 | Yes | Yes | 86 927 700 | 7 | 30.393 | 14 | 11.244 | 12 |
| 10 | India | 1.666209 | 10 | Yes | Yes | 1 224 614 327 | 2 | 30.93 | 13 | 20.595 | 7 |
| 11 | Pakistan | 0.932118 | 11 | Yes | Yes | 173 593 383 | 4 | 35.882 | 9 | 4.112 | 13 |
| 12 | Philippines | 0.873148 | 12 | Yes | Yes | 93 260 798 | 6 | 48.648 | 8 | 12.618 | 11 |
| 13 | Sri Lanka | 0.621628 | 13 | Yes | Yes | 20 653 000 | 14 | 15.041 | 19 | 20.949 | 6 |
| 14 | Bangladesh | 0.371564 | 15 | Yes | Yes | 148 692 131 | 5 | 27.894 | 16 | 19.791 | 8 |
| 15 | Lao People's Democratic Republic | 0.292983 | 16 | No | Yes | 6 200 894 | 17 | 33.121 | 11 | -8.561 | 16 |
| 16 | Cambodia | 0.291013 | 17 | No | Yes | 14 138 255 | 15 | 19.814 | 17 | -4.646 | 14 |
| 17 | Myanmar | 0.173213 | 18 | No | No | 47 963 012 | 10 | 32.083 | 12 | .. | - |
| 18 | Timor-Leste | 0.171932 | 19 | No | No | 1 142 502 | 20 | 27.96 | 15 | .. | - |
| 19 | Nepal | 0.139872 | 20 | Yes | Yes | 29 959 364 | 11 | 16.656 | 18 | 26.435 | 3 |