Paper presented in

Seventh Biennial Conference

Indian Society for Ecological Economics (INSEE)

Global Change, Ecosystems, Sustainability

Host:
Tezpur University

Cohost:
OKD Institute of Social Change and Development

December 4-8, 2013

International Equity in Sustainable Development

An approach for sharing global environmental resources

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Few issues in the history of humankind have seized global attention at the scale comparable to the current concern for environmental sustainability. Sustainable development is critical to the Post-2015 global development agenda. However, the international environmental negotiations are making little progress in addressing the key issue of equity which is fundamental to sustainable development. The principle of equity focusses on determining historical responsibility for environmental deterioration and distribution of global natural resources amongst the countries. Both these aspects remain as challenges at the negotiating platform. The developed and less developed countries are divided over the matter as it is expected to involve heavy economic cost. Most indicators of sustainable development fail to either define concrete goals for the future or determine the share of each nation of the global environmental commons under the constraint of their limited availability. There is an urgent need to develop methodology that can overcome such limitations faced by the available indicators and integrate equity in environmental sustainability. Increasing anthropogenic impact is an imminent threat as it is expected to inevitably deteriorate the regenerative capacity of natural systems.

Measuring environmental sustainability

Leading economists suggest that the natural resources should be perceived as *natural capital* which constitutes the productive base for development (see Dasgupta 2007a; Dasgupta 2007b). It should be treated at par with the manufactured capital (see Dasgupta 2007a; Dasgupta 2007b). Pearce et al. (as cited in Pearce 1993) note that aggregate capital stock of a nation which is passed from a generation to its successors “comprises a ‘mix’ of man-made, human and ‘natural’ capital”. As per the former, the overall capital stock should remain constant whereas the composition of the mix can vary i.e. natural capital can be substituted by the other two. However, in the latter, the magnitude of the environmental stocks should remain intact while the countries attempt to augment man-made and human capital. There is a deeper theoretical discourse behind such popular stands on environmental resource use.

Amongst these, two critical approaches have attained received significant scholarly attention. The first one is the *ecocentric* approach which advocates in favour of preservation of nature and against limitless consumption of natural resources to meet human needs. It criticises the current economic paradigm which promotes unending and spiralling economic expansion. The contrary view, namely the *technocentric* approach, is held by the supporters of a free market economy. They believe that any aberrations in the earth system which may surface in this process of economic growth are temporary and can be overcome through technology. The former school of thought promotes strong sustainability while the later supports weak sustainability.

Under each of these approaches, the degree of natural resource utilisation, which is sustainable, varies significantly. While these approaches present starkly different solutions to the problem of environmental deterioration, neither of them advocates completely refraining from consumption of natural resources. However, measurement of the available magnitude of the resources, the rate of

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Acknowledgement: I would like to acknowledge the contribution of Dr. T.Jayaraman and Ms. Tejal Kanitkar at the School of Habitat Studies, TISS to this research work.

their regeneration, and their current and projected future consumption is integral to both. Such assessment will determine the threshold of resource consumption by humans, at present and in the future, which could promote sustainable development.

The indicators for sustainable development should be driven by two primary motives. The first aim is to ascertain the present level of environmental sustainability and development within nations and across the globe. The second purpose, which is equally crucial, is the projection of the future of anthropogenic impact on nature. Until the latter goal can be met by using an indicator, it cannot suggest ways to attain sustainability in the future. At present, most indicators are ex-post facto measures of environmental deterioration. They can either not be used for future projection due to methodological limitations or the results attained from them obscure the scope for actions which should be taken by the nations to improve their sustainability. The last but probably one of the most important aspects in the work towards sustainability is the focus on equity issues in sustainable development.

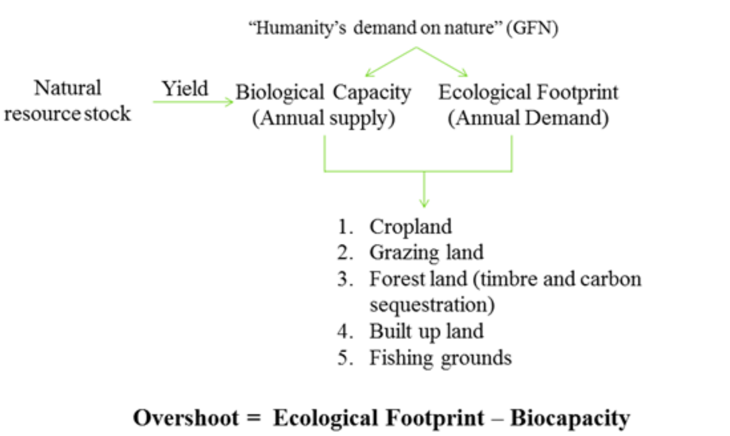
Environmental sustainability also cannot overlook the need for equity amongst nations. Upon placing sustainable development in the historical perspective, it is evident that each nation’s impact on and benefit derived from the nature varies significantly. The problem of an unsustainable anthropogenic impact has a long history which cannot be denied. A few countries have consumed much greater magnitude of environmental resources than others who still do not have the potential to use the available resources to meet their needs. The challenge of ensuring equity is one of the biggest impediments to attaining a consensus at the international climate change negotiations and conventions.

Assessment of Sustainability Indicators

In the present economic system where growth is one of the most important factors driving the use of resources, the GDP is the most significant indicator of such growth. However, critics (Arrow et al., 2004; Dasgupta, 2007a) raise doubts about its suitability as a measure of sustainable development since it evaluates only current well-being. HDI also suffers from the same limitations in this context. A large set of monetary indicators such as green net national product, genuine savings, indicator of sustainable economic welfare (ISEW), sustainable measure of economic welfare (SMEW) and green HDI were also suggested in the last few decades to measure sustainability. These indicators, which emerge from the mainstream economics, mostly on the economic valuation of depreciation in the environmental wealth, discount rates etc. which are at best based on assumptions. They fail to provide any assessment of environmental damage or resource depletion.

There are few other indicators such as Environmental Sustainability Index (ESI), Environmental Performance Index (EPI), and Ecological Footprint Indicator which evaluate the biophysical aspects of the environment to adjudge sustainability. Due to the methodology followed, these indicators seem more suitable to assess the problem at hand. However, they also do not account for equity in distribution of natural resources, which is an essential aspect of sustainable development.

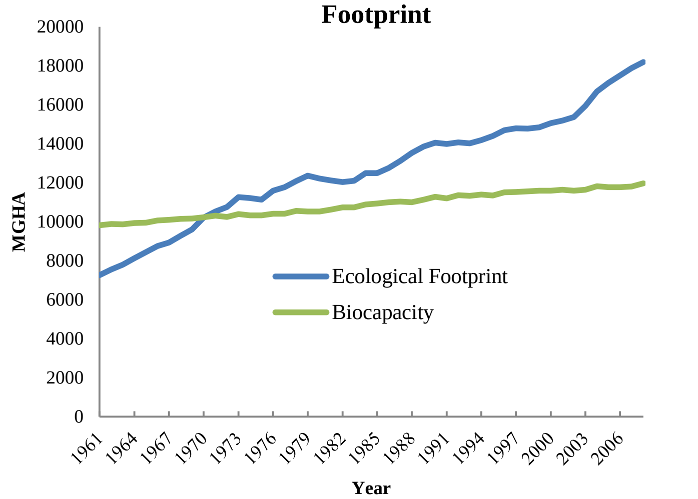
Figure 1: Ecological Footprint Indicator



Ecological Footprint Indicator

For the purpose of this paper, Ecological Footprint indicator was chosen to evaluate the current consumption and future availability of natural resources. This indicator, developed by Malthis Wackernagel and William Rees, measures "humanity's demand on nature" (Global Footprint Network). The two main components of the indicator are *biological capacity* and *Ecological Footprint*. The biological capacity (or biocapacity) reflects the supply of ecosystem services by nature. On the demand side, the Ecological Footprint is a measure of the biologically productive area required to generate the magnitude of ecological services demanded by humans. The evaluation of Ecological Footprint includes six human activities which consume biologically productive area (as given in Wackernagel et al. 2002), namely agriculture, animal grazing, timber harvesting, infrastructure, combustion of fossil fuels, and fishing.

Figure 2: Global Biocapacity and Ecological Footprint



On the basis of these, land and water area is divided into 5 categories – cropland, grazing land, forests land (for timber and carbon sequestration), built up land and fishing grounds. Each of these resources has a specific regenerative capacity which also determines its potential yield i.e. the amount of natural resources regenerated annually which the humans can extract per unit of biologically productive area (GFN).

The excess of annual demand for natural resources (Ecological Footprint) over their annual supply (biological capacity) shows the deficit or overshoot. Hence, the overshoot of various countries in each year can be compared. The yield of each land type is evaluated in Global Hectares (GHA) which is based on an equivalence factor of the average yield in each country. Simultaneously, the indicator also uses an inter-temporal yield factor to determine the changes in the yield of the same type of land type over a span of time. Figure 2 depicts both biocapacity and Ecological Footprint. It highlights that the earth's carrying capacity is overshot significantly since 1970.

The environmental budget approach

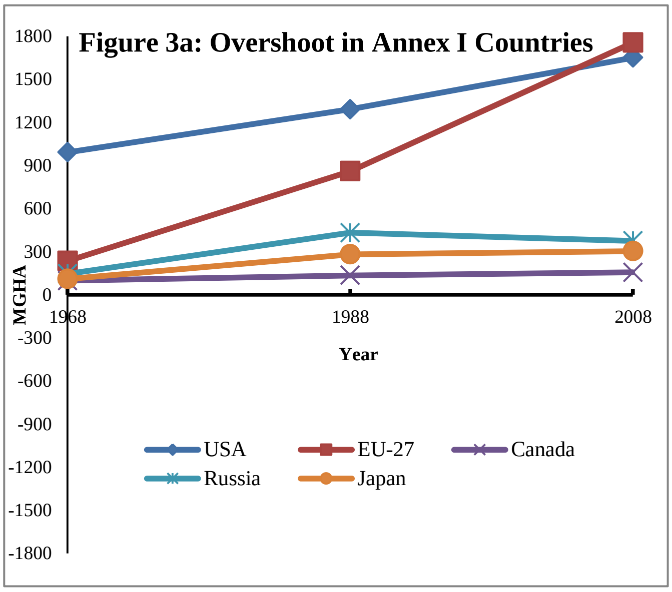
Each nation is endowed with a set of natural resources which can be used as per its need. However, a neat distribution of natural resources on the basis of territorial boundaries is not feasible. The environmental goods such as atmosphere and oceans are *global common goods* available equally to all the countries irrespective of their geographical location and national boundaries. Such global commons are *non-excludable but rivalrous*. Such 'open (access) resources' (Gordon 1954) have a tendency to be over-utilised and, therefore, destroyed.

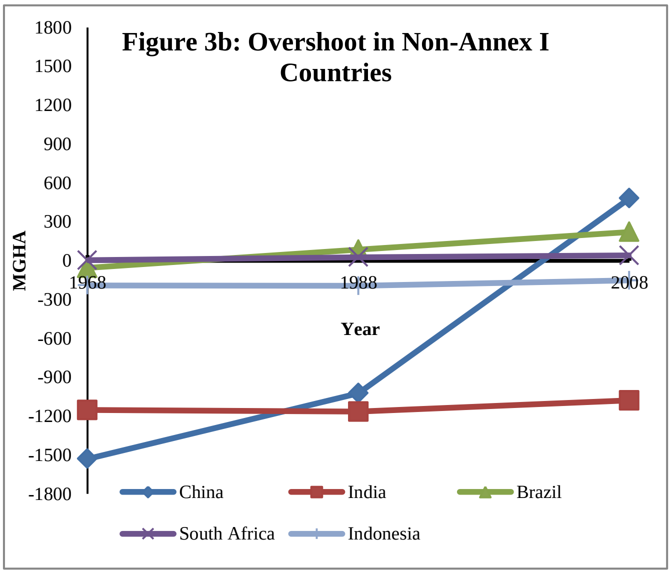
Additionally, environmental resources are available both as stocks and flows of resources. The size of resource base, i.e. the stock, and the rate of replenishment determine the flows or the annually available magnitude of resources. It is crucial to maintain the stocks of resources intact in order to preserve the natural resource in the long term. Excess consumption of flows threatens to deplete the resource base which could eventually exhaust the resource itself. Hence, to ensure environmental sustainability, it is crucial to maintain a balance between the short term (flow) and the long term (stock) utilisation of the natural resources. In such a situation, the idea of a global budget to determine national entitlement to global resources becomes important. A top-down approach will promote equitable access to resources despite national endowments.

Equitable distribution of global resources

When looked at from the equity point of view, EF indicator suffers from a critical limitation i.e. it does not account for environmental resources as global commons. Each country's supply of resources is limited to its national biocapacity and the imports. It is essential that a top-down approach is integrated with the Ecological Footprint indicator to represent the problem more appropriately.

For this purpose, I introduce the concept of national biocapacity entitlement which is the entitlement of each country to the global environmental resources. This approach privileges the idea of equal per capita biocapacity entitlement across all nations. The national biocapacity is, thereof, substituted by national biocapacity entitlement which is the product of the global per capita biocapacity entitlement and each nation's population. Based on the entitlement approach, the overshoot for a country is evaluated by deducting nation's biocapacity entitlement from the national Ecological Footprint. Figure 3a and b depict the overshoot calculated in this manner. Evidently, all annex I and most non-annex I countries, from the limited set considered in this study, exceed their natural resource entitlements. This implies that the continuous excess consumption of flows is drawing from the stocks of resources, though currently there is no clear measure of such stocks.





Projecting the future

In order to have a sustainable environment, the annual global Ecological Footprint must equal annual global biocapacity. To attain this goal, each country must reduce its demand for natural resources to the magnitude of its biocapacity entitlement. Hence, at the global level, each country must contract and converge with the global per capita biocapacity, which is equal to 1.8 GHA. In this paper, the trajectories for each country under this scenario are projected with a CAGR model. Some of the realistic assumptions made in the model are:

1. 2008[2] is the base year and 2050[3] is the target year.
2. Population and biocapacity are held constant at 2008 level.
3. The rate of growth of Ecological Footprint is evaluated on the basis of the trends in 20 years preceding the base year.
4. The countries considered for this model are :

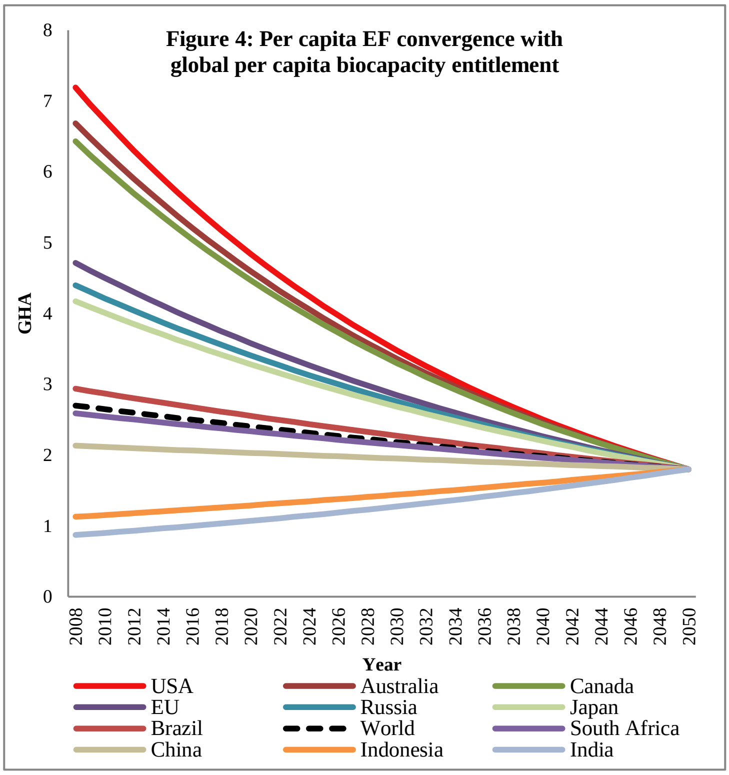
[2] Latest EF indicator data is available for 2008.

[3] Based on scientific evidence for carbon concentration.

a. Annex I countries: Australia, Canada, European Union (27 countries), Japan, Russia, USA and other Annex I
b. Non-Annex I countries: Brazil, China, India, Indonesia, Mexico, South Africa, South Korea and other emerging economies.

Figure 4 depicts the rates at which the EF will have to be reduced at national and global levels. Some of the countries such as USA and Australia will be expected to follow a negative growth rate of more than 3 per cent per annum, which is much higher than the global requirement of 1 per cent of annual negative growth rate. However, India and Indonesia can increase their Footprint by about 1.1 and 1.7 per cent per annum.

The above assessment leads to a bigger question of the trajectories to be followed to ensure zero overshoot in each of the countries considered in this research. The situation can be seen as an optimization problem, whereby national trajectories are determined within the constraint of an overall global budget of natural resources. The mathematical form of the constrained optimisation problem solved to attain the results of this study is given below.



Constraint 1: Deviation between regional Biocapacity and respective Ecological Footprint

DEV(R,T) = BCE2008(R) – EFP(R,T) … (1)

where R is the region and T is the year. DEV(R,T) is the deviation for each region in each year which is calculated by reduction of Ecological Footprint for each region in each year EFP(R,T) from the biocapacity entitlement for the region in 2008, which is represented by the constant BCE2008(R).

Constraint 2: Deviation between global EF and biocapacity

DEV1(T) = ABCW(T) ─ ∑(R, EFP(R,T)) … (2)

where ABCW(T) is the maximum allowed annual global Footprint to contract to 2008 biocapacity level by 2050. DEV1(T) represents the difference between this figure and the sum of Ecological Footprint of each region in each year i.e. ∑(R, EFP(R,T))

Constraint 3: Growth Rate

EFP(R,T+1) < = EFP(R,T) * (1 + GR(H))

EFP(R,T+1) > = EFP(R,T) * (1 - GR(L)) … (3)

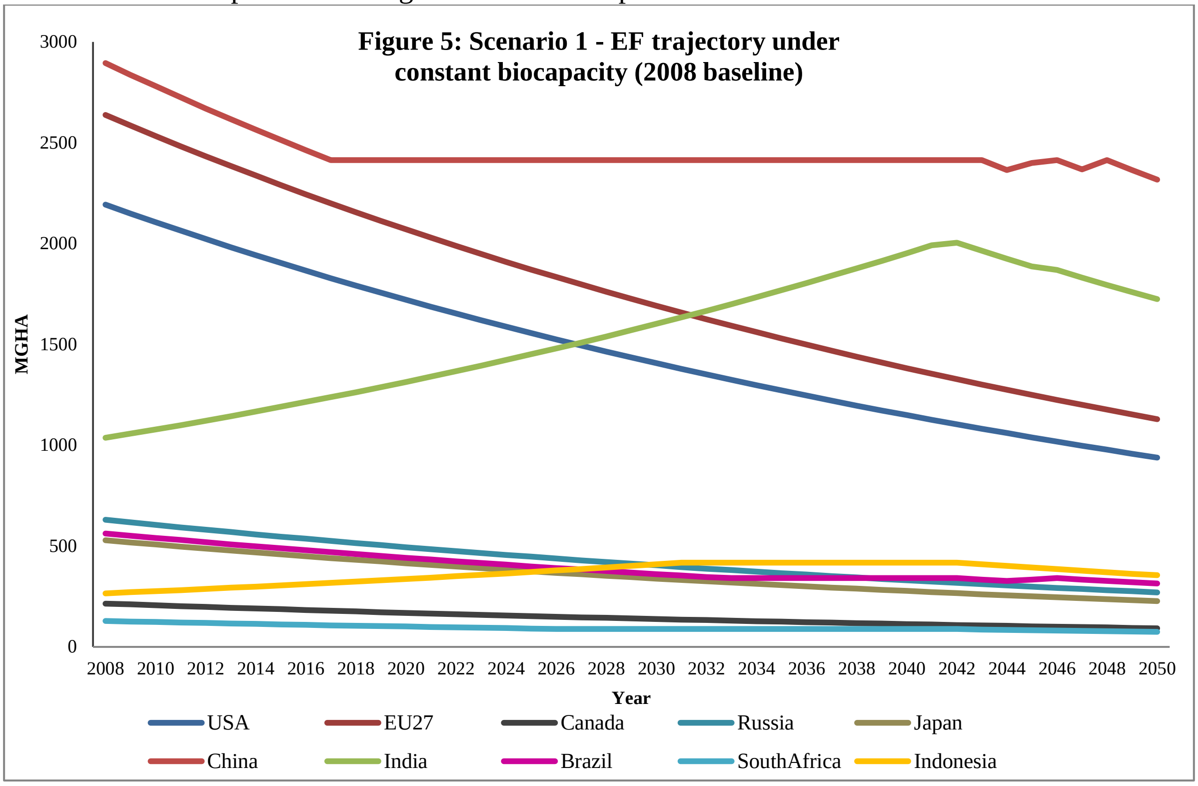
where EFP(R,T+1) is the Ecological Footprint in each succeeding year for each region. It is calculated by multiplying previous year's Footprint in the region, EFP(R,T) with a growth rate ranging between an upper and lower limit of growth rates. The upper limit is defined by the variable GR(H) and the lower limit by GR(L).

Optimisation function:

In this problem, the negative deviations from the biocapacity entitlements at the global and the regional level are penalised. P(R) is the penalty for the region and P(W) for the world. These penalties are multiplied with the sum of deviations. The objective function must minimise such penalties within the three constraints mentioned above.

Minimize OBJ = P(R) * ∑(R, ∑(T, DEV(R,T)) + P(W) * ∑(T, DEV1(T)) … (4)

General Algebraic Modelling System (GAMS) is used to generate the results of optimisation. Another additional assumption is made, whereby growth rate of EF varies only between +2 and -2 per cent per annum. Scenario 1 presented in figure 5 shows the optimisation solution.

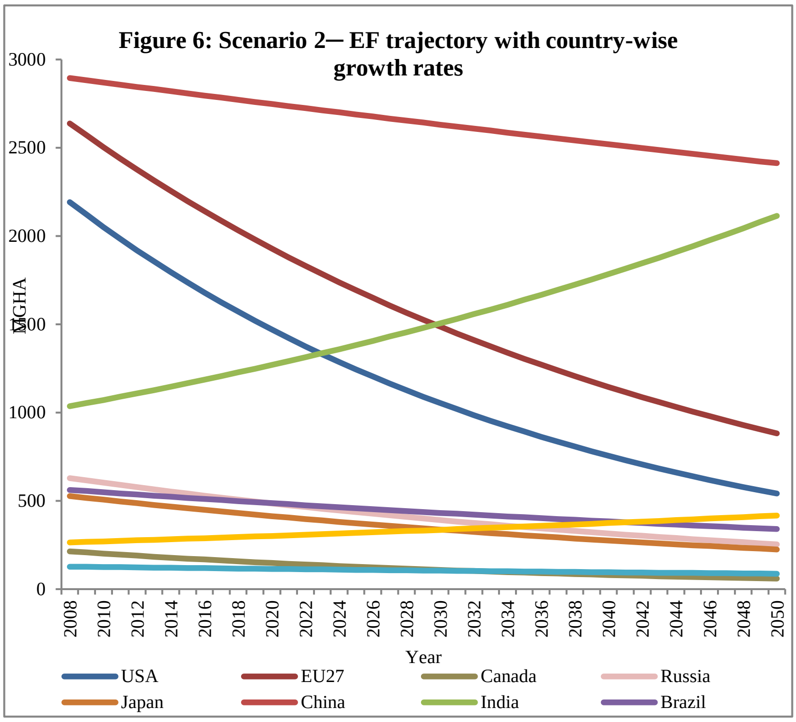


A significant observation in this scenario with the constraint of growth rate is that USA and EU27 are not able to reduce their Footprint to match their biocapacity entitlement by the target year. Hence, non-Annex 1 countries such as India, China, and Indonesia will have to bear excess burden to achieve the globally targeted reduction.

Alternate scenarios with relaxed assumptions

Most assumptions of the model can be relaxed or removed completely to increase the scope of the model. As is observed in the real world, the rate of natural resource consumption varies significantly amongst nations. Hence, they may also undertake reduction of their Footprint at variable rates. In this situation, the trajectories for each country would vary from those depicted in Scenario 1. This is a more likely situation and provides greater possibility to formulate national policies commensurate to country's developmental needs and sustainability targets. However, since the constraint of overall global budget remains intact in the model, the goal of zero overshoot would still have to be achieved by the target year.

The figure 6 depicts the trajectories for various countries with country-specific reduction rates. This scenario is ideal since it does not shift the burden to less developed countries as each country attains its requisite reduction by following a consistent growth rate. Other scenarios can also be generated by modifying the assumptions. For example, biocapacity could increase or decrease. Similarly, the world population is expected to grow further, which can be incorporated in the model by changing the base year.



Key findings

The study highlights that the present scale of natural resource utilisation is unsustainable at both the global and the national levels. Categorisation of countries in developed and developing groups clearly shows that the environmental impact of the former group is considerably greater than the latter, in terms of magnitude and the time span. While ex-post facto analysis is presented by many other studies conducted in the field of environmental sustainability, the current research advances to determine the future sustainability. The projection under the business-as-usual scenario depicts a wider gap between the demand and supply of natural resources in the future. This implies a rise in the anthropogenic impact on nature. The research suggests an alternate scenario which could support the goal of sustainable development within the limits of environmental space and on the basis of the equity principle. It projects the need for continuous reduction of the global demand for environmental resources. In addition, the evaluated national trajectories highlight significant variation in the actions required by various countries to attain sustainability.

Some of the key results attained from the empirical analysis in this research are given below.

1. The developed countries are required to decrease their Footprint at a much higher rate than the developing ones.
2. Only few nations have excess entitlements to environmental resources and can increase their demand of natural resources, given that other countries reduce their impact on the environment.
3. If the required reduction is not achieved by nations with overshoot of biocapacity, then the entitlements of the less consuming countries will be reduced further.

Conclusion

The research has some limitations owing to the limited scope of the EF indicator, which includes only 5 categories of resource use. Further, the yield factor is an overall average of resource yield throughout the world. The model is also based on certain assumptions. However, these limitations can be overcome through further research to increase data availability across a wide range of environmental resources.

However, at this juncture, the present study and similar works play a critical role in the discourse on sustainable development. They highlight the potential negative environmental impact associated with the present level of economic growth. The likelihood that a path to sustainable development is pursued through relevant policies relies on factors beyond the empirical analysis. Such analysis provides clarity and defines specific goals for sustainability. Such studies attempt to operationalize the idea of sustainable development by defining concrete targets and alternative trajectories through empirical analysis. It is true that physical science which forms the basis of such models cannot suggest a universal solution with complete certainty. But such uncertainty can be reduced eventually with the expansion of knowledge. The level of uncertainty must not lead to deferment of the actions towards environmental sustainability. Under the aegis of the precautionary principle, the suggested measures should lay the ground for environmental policy and implementation. Such actions must be undertaken urgently due to the irreversibility and enormity of the problem of environmental degradation.

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