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Ecological Footprint: A tool for measuring Sustainable development

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ABSTRACT

Ecological footprint is a tool which is used to represent the amount productive land area which may be needed to regenerate the resource which are consumed by human population and it also represent the earths ecological capacity to regenerate the natural resources. Each country have its own ecological footprint and its need of the hour to manage the same. In the recent days researchers are focussing on identifying tools and technologies that may improve the environmental conditions and in turn increase overall sustainability. For India, the ecological deficit is 0.40 (bio-capacity of 0.51 against human footprint of 0.91gha/capita). Considerable empirical evidence are available which shows that, while developing nations often are the least eco-efficient in the sense that they consume a lot of resources *per unit of GDP*, they also consume the least amount of resources in *absolute* and/or *per capita* terms. Less affluent nations, such as China and India, need to shift their development strategies away from relentless economic expansion and focus on strategies that improve people's quality of life. In the recent times, stakeholders from around the world are concentrating more on ways to promote sustainability and decrease environmental degradation. By highlighting the inequities within and between people and nations, ecological footprint provides a useful tool that can help to raise public awareness and shape a healthier and more sustainable future. This paper elucidates the importance of ecological footprint and its importance in improving the environmental standards.

Keywords: Ecological Footprint, Carbon Footprint, Sustainability, Ecological Deficit

1. Introduction

Numbering over 6 billion population and still counting, the human race is steadily depleting the most precious gift of nature, upon which it depends to survive. There is no hiding to the fact that environmental problems like global warming, large-scale deforestation, desertification, loss of biodiversity, had disturbed our ecological equilibrium of our globe. Therefore, the tracking the environmental performance of nations is highly important. There has been an considerable amount of research world over examining various factors and forces that influences our environment[1]. Various national-level environmental indicators have been examined in the environmental social science literature. However, there is no consensus across the eminent scientists regarding the substantively important or the best indicators across the nations. The indicators which have been labeled as the "best" measures of human pressure on the environment, are *total* national ecological consumption, *per capita* ecological consumption, or ecological consumption *per unit of GDP*. All these indicators can be measured directly or indirectly by Ecological Footprint (EF)[2].

The term 'Ecological Footprint' was conceptualized and coined by Wackernagel and Rees and further developed by them and others (e.g., Chambers, Simmons, and Wackernagel 2000,

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Kites et al, 2009) to assess the societal demands on the regenerative capacity of the biosphere[3-4]. Originally, in 1992, Wackernagel and Rees termed the concept as "appropriated carrying capacity", which was further renamed by Rees by the term "ecological footprint" in 1996[5-6]. In early 1996, Wackernagel and Rees published the book "*Our Ecological Footprint: Reducing Human Impact on the Earth",* after which the term got global reorganization and acceptance[7].

The ecological footprint is a tool to measure the demand of humanity on earth's ecosystems and compares such demand with earth's ecological capacity to regenerate resources[7]. It also represents the amount of biologically productive land and sea area needed to regenerate the resources which are consumed by human population and thus renders the corresponding waste harmless. Thus, the EF represents the total area required by humans for agriculture, timber production, fishing etc. combined with the area needed to absorb carbon dioxide released by burning fossil fuels. The EF is based on the principle that land is a principal factor on which all societies depend as it provides space for living, products and services to consume, and a sink for wastes. Productive land is, therefore considered as a proxy for the wants and demands of societies on the environment. Human demands can be easily calculated, which in turn can be converted into the biologically productive land areas necessary to provide these ecological services. The EF can thus be interpreted as a measure of the stress a nation or its part places on environment and ecosystem services[7].

The methods of measurement of ecological footprint vary across the nations. Various studies have been different methodology for measuring ecological footprint. The studies have used different formulas to calculate sea area, fossil fuels, and nuclear power etc. Moreover, the data sources used vary across these studies i.e. weather average global data or local data should be used when calculating EF of a local specific area. The methods for inclusion of space for biodiversity and imports/exports also differ across the studies[8-9]. However, calculation standards are now emerging to make results more comparable and consistent. In 2003, Jason Venetoulis and colleagues developed Footprint 2.0, which is theoretically and methodologically advanced over the standard footprint approach[10]. In the approach, the entire surface of the earth was consensually considered in 'bio-capacity estimates' for final calculations. Other modifications included allocation of space for non-human species, changing the basis of equivalence factors from agricultural land to net primary productivity (NPP), and changing the carbon component of the footprint, based on global carbon models.

The EF is calculated, much similar to calculation of economic consumption i.e. by adding up the various forms of consumption in a society – food, housing, transportation, consumer goods, and services along-with the waste they generate, which in-turn is converted into a common metric after adjusting for their biological productivity. But unlike economics, which uses prices as its key indicator of value, the EF uses 'productive land area' or 'global hectares' (gha) as its metric[11]. Footprint values can be further be categorized for carbon, food, housing, transportation, and goods and services. Therefore, this approach can be used to measure EF of any activity such as the manufacturing of a product, reading a book, enjoying a air conditioner, driving of a car or eating a bread loaf.

Due to its consumption-based focus, the EF places environmental responsibility on the nations where resources are consumed rather than on the ones where they are extracted. The types of consumption are generally converted into the nine types of land area, which are aggregated to arrive at the total EF. The land area types are: (1) cropland, (2) grazing land, (3) forest (excluding fuel wood), (4) fishing ground, (5) built-up land, (6) the land area required to absorb carbon dioxide emissions from use of fossil fuel, (7) fuel wood, (8) hydro-

power, and (9) nuclear power[12]. The component EF is proportionately weighted depending on level of productivity of land. For example, EF is larger for one hectare of arable land as compared to one hectare of non-arable land, reflecting relatively high productivity of arable land. Thus, nations may have footprints that are larger than their own land areas. Conversely, nations may also have footprint smaller than their own land areas.

Every year, EF of a nation is recalculated with a three year lag period due to the time it takes for the UN to collect and publish the underlying statistics all over the world. In 2007, world-average ecological footprint was 2.7 gha per person. Studies conducted shows that the U.S. footprint per capita was 9.0 gha, that of Switzerland 5.6 gha, China's 1.8 gha and India 0.91 gha per person. According to World Wildlife Fund (WWF), the human footprint has exceeded the bio-capacity or the available supply of natural resources of the planet by 20%. This means that our demands for human resources has exceeded the supply by 20%.[12] Claude Martin, Director-General of World Wildlife Fund International in Gland, Switzerland, opined that at current rates of consumption, the human "ecological footprint" will reach twice the earth's regenerative capacity by 2050, which is a matter of serious concern. With a world-average bio-capacity of 1.8 global hectares per person, this leads to an ecological deficit of 0.9 (2.7 minus 1.8) global hectares per person. For India, the ecological deficit is 0.40 (bio-capacity of 0.51 against human footprint of 0.91gha/capita). If a country does not have enough ecological resources within its own territory, then there is a local ecological deficit and it is called an ecological debtor country. Otherwise, it has an ecological remainder and called an ecological creditor country. Very few nations lie in the later categories, some of them are, Canada, New Zealand, Australia, Russia, Finland, and Brazil. Two small nations Guyana and Gabon have a very high ecological remainder of 59.75 and 27.88 respectively. In the same year, humanity's total ecological footprint was estimated at 1.4 planet Earths – in other words, humanity uses ecological services 1.4 times as fast as earth can renew them[12].

Considerable empirical evidence are available which shows that, while developing nations often are the least eco-efficient in the sense that they consume a lot of resources *per unit of GDP*, they also consume the least amount of resources in *absolute* and/or *per capita* terms[13]. The EF tool can inform policy makers by examining to what extent a nation utilizes resources than is available within its territory. The *total or absolute* EF, which threatens nature's capital and services, increased quite dramatically in almost all major nations in world between 1961 and 2003 (viz. by a factor of 3.9, 2.1, 2.9, and 2.9 in China, India, Japan, and the United States respectively), whereas, *EF per unit of GDP* has actually declined by a factor of 8.4, 3.2, 2.2, and 1.4 in these countries respectively in the same period[13-14]. These findings indicate that almost all these nations have actually expanded their exploitation of the environment, at the cost of expanding their economies, which is a matter of serious concern. The *per capita* EF is a more rigorous index from the perspective of global inequalities and social justice as it removes the effects of population, thus assuming consumption to be scaled proportionally by population size. It allows for comparison of people's demands placed on the environment thus, highlighting the substantial disparity in levels of consumption across nations. Thus, while India's per capita EF stayed roughly constant from 1961 to 2003, the per capita EF of other nations have increased many folds (approximately doubled in China, Japan, and United States). In addition to it, there is clearly stark inequality across nations in terms of per capita pressure on the environment. For example, in 2003 the EF per capita in the United States was approximately six times that of China and 13 times that of India[14]. Thus, even though China and India each have very large and growing total footprints, it is clearly not because the typical person in each of those nations places a high demand on the environment relative to people in affluent nations.

Hoping to keep the footprint in check, stakeholders from around the world are focusing on ways to promote sustainability and decrease environmental degradation. The concept of ecological footprint was highlighted in United Nations (UN) World Summit on Sustainable Development, at Johannesburg, South Africa from 26 August–4 September 2002. It was consensually decided that affluent nations, like the United States and Japan, which have exceedingly high levels of per capita consumption, need to drastically reduce their demands on the environment and transform their social, political, and economic systems to meet their people's needs without unsustainably depleting natural resources[15]. Less affluent nations, such as China and India, need to shift their development strategies away from relentless economic expansion and focus on strategies that improve people's quality of life without escalating material consumption. Such changes, however, do not necessitate inhibiting improvement of social well-being, but, in fact, helps in a healthy and sustainable environment. An ample evidence exists that there is a linkage between environmental degradation and other health related indicators like mortality and morbidity rates, women education and life expectancy. It is high time to shift the focus primarily from economic growth to better human quality of life and general well-being. We are currently facing ecological crisis, which is inarguably humanity's greatest challenge for the twenty-first century. To meet this challenge it is imperative that we move away from the unrealistically optimistic assumption that improvements in the efficiency of economies alone are likely to solve environmental problems. The current high level of health and long lives have been "purchased" at the expense of the environment[16].

A key public health priority for the twenty-first century must be to reduce the human impact on the planet in order to ensure long and healthy lives of future generations, not just in the "developed" world but also in so called developing nations. By highlighting the inequities within and between people and nations, the ecological footprint provides a useful tool that can help to raise public awareness and shape a healthier and more sustainable future. We must ask ourselves 'How long can our health be sustained if we deplete the resources and disrupt the ecosystems upon which our health and well-being are primarily based?'

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