Ecological Footprint of Production:

A tool to assess environmental impacts of tourism activity

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Abstract

Globalisation has given rise to liberal trade associated with intensive use of natural resources and subsequent environmental degradation. Although there is awareness regarding the environmental impacts of tourism, tools to quantify regional impacts are incomplete. This paper develops a new method using the concept of Ecological Footprint to assess the environmental impacts of tourism activity. It presents an approach to estimate the production footprint of tourism activity at a local level. The Ecological Footprint of Tourism (EF_T) is an impact indicator and can be used as one of the tools to gauge sustainability of development activities. It brings to light the less obvious demands placed on ecological capital. It is useful in constructing management strategies, which take into account the health of the ecosystem. It is simple to understand and can be used by policy makers.

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Introduction

Globalisation has given rise to liberal trade associated with intensive use of natural resources and subsequent environmental degradation. The rapid growth of global markets has been accompanied by a world-wide increase in inequality and environmental degradation (Borghesi & Vercelli, 2003). Tourism has developed to become one of world 's most important industrial sectors, growing twice as fast as the world 's gross domestic product (GDP) for the last 30 years (Budeanu, 2004). Further, as pointed out by Budeanu (2004), the term 'largest industry in the world' is commonly used with reference to tourism, following its recognition as the largest generator of wealth (over 11.7% of the global gross domestic product) and employment (7% of the world's jobs). The World Tourism Organization (WTO) estimates that tourism is among the top five export earners for 83% of all countries and the top source of foreign exchange for at least 38% of all countries (Budeanu, 2004). The large importance of tourism-related revenues for the world's economy, particularly for developing countries and small islands, shapes the creation of policies that support its development worldwide (Budeanu, 2004).

The tourism research community has overlooked several problems caused by tourism in relation to sustainability. Although the environmental damages caused by tourism are well accepted, not much has been done to identify tools to assess these impacts and find applicable solutions by the tourism industry and policymakers.

It seems unlikely that there exists one single measure of sustainable development, which is capable of capturing all that is meant by 'sustainability' (Hanley, Moffatt, Faichney & Wilson, 1999). Sustainability comprises four dimensions - environmental, social, economic and institutional (UNDPCSD, 1996a,b as cited in Spangenberg, 2002). A large number of indices have been developed, which capture social and economic dimensions. However, such indices communicating ecological information in a single value to the policymakers are lacking. Therefore, this paper attempts to develop a simple tool, Ecological Footprint of production related to tourism (EF_T), to estimate the ecosystem support areas required, based on a similar concept of Ecological Footprint (EF). EF_T is in fact an application of the EF concept to assess impacts of development activities such as tourism. It comprises both the direct impact of the tourists (EF_t), and the migrant labourers needed to provide services (EF_m). The EF concept was introduced by Rees and Wackernagel (1994) and has received much attention (Ferguson, 2001; Haberl & Krausmann, 2001; van Vuuren & Smeets, 2000, 2001; Wackernagel 1998, 2001; Wackernagel & Rees, 1996; Wackernagel, Lewan & Borgstrom, 1999; Warren-Rhodes & Koenig, 2001). The concept has also been used for sustainable seafood production (Berg, Michelsen, Troell, Folke & Kautsky, 1996; Deutsch, Jansson, Troell, Fonnback, Folke & Kautsky, 2000; Folke & Kautsky, 1989; Folke, Kautsky, Berg, Jansson, & Troell, 1998; Kautsky, Berg, Folke, Larsson & Troell, 1997; Kautsky, Folke, Ronnback & Troell, 1998; Larsson, Folke & Kautsky, 1994; Naylor *et al.*, 2000; Troell, Folke & Kautsky, 1997). While Rees and Wackernagel (1994) use consumption footprints, and a global budgeting approach dividing the total productive area between the existing population, Folke *et al.* (1998) use the EF approach to estimate the ecosystem area required for the generation of essential ecosystem services. Rees and Wackernagel's (1994) approach estimates the relative share of global resources appropriated per capita basis by any particular region or nation.

The present paper (EF_T) presents a different approach, using EF to assess the environmental impact of tourism. It gives a rough estimate of ecosystem support area required to earn Rs. (Indian rupees) 1000 through tourism activity. This is the production footprint of tourism activity, which corresponds to the ecological functions and services required to generate a population's income. Estimation of production footprints has been strongly advocated by Wackernagel (2001). EF_T, as presented in this paper, assesses the resource use and waste assimilation due to tourism activity at a very local level. However, it does not take into account the resilience of the ecosystem. Though it still has some limitations, it can be used to create awareness as well as for policy making. Such application of the EF concept to development activities can be used to compare the impacts of various development activities and to address conflicts of interest between the multiple uses of a geographical area such as the coast. It helps improve environmental management and contributes to efficient use of ecosystems.

The method: Ecological footprint of tourism activity

The impacts of tourism on the coastal environment, as evident from an extensive literature survey presented in TERI (1999) and Sonak, Abraham and Kazi (2000, 2001), are mainly connected with increased:

1. Demand for food, fibres, and energy,
2. Demand for water,
3. Demand for land (infrastructure), and
4. Waste generation to support tourist population (Figure 1).

Tourist activities impact directly and indirectly on ecosystems. Linkages between tourism and demand for food are established by Torres (2003). Demand for food accounts for approximately one-third of expenses (Torres, 2003). Water use by tourists should also be seen as an important issue (Gossling, 2002), because many regions face water scarcity. Tourism often seems to accelerate existing problems because tourists shift their water demand to other regions, often water scarce areas like coastal zones. Furthermore, they seem to use substantially more water on a *per capita* basis than at home, thus increasing global water demand (Gossling, 2002). The use and conversion of lands is central to tourism (Gossling, 2002). Gossling (2002) further points out that apart from the construction of accommodation establishments, large areas are used for tourism infrastructure and recreational activities. Tourism draws precious land and labor resources away from agriculture (Torres, 2003). Energy use for transport is another most important consequence of tourism (Gossling, 2002). This can be divided as

1. transport from the country of origin to the destination, and
2. energy use within the country of destination.

This paper does not consider the first type as it mainly affects the global level and not the local level. Hence it need not be incorporated into policymaking and planning at a local level. Similarly other environmental impacts, which have only global consequences, are not considered here.

The present method (EF_T) assesses the total ecosystem support area required under each of the above four categories as explained in the next section. It attempts to develop a method to assess the impact created by human activity on the ecosystem resources, using an example of tourism activity in Bardez *taluka* (*Taluka* is an administrative unit

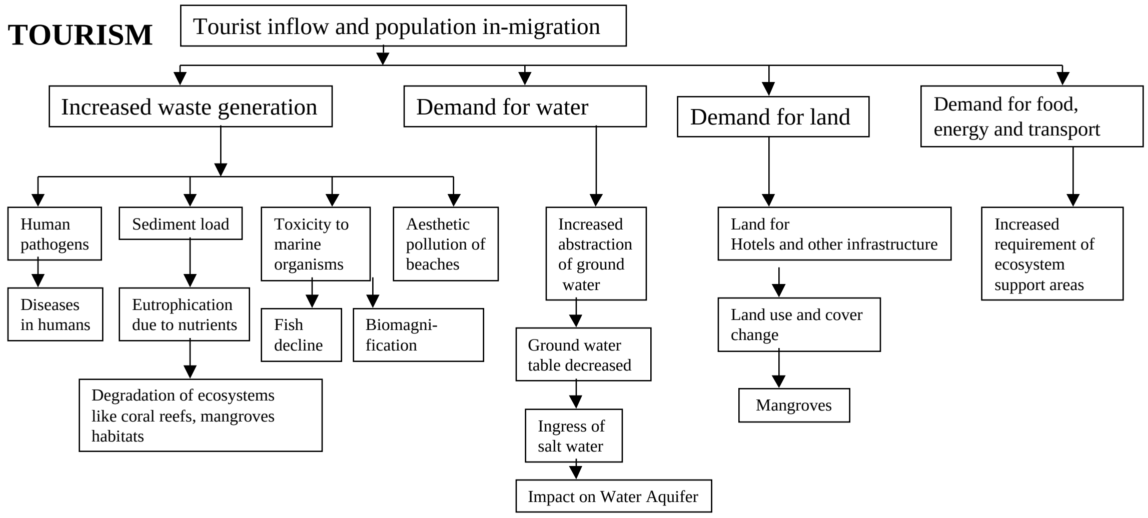

Figure 1: Major impacts of tourism activity

in India, which is made up of many villages). Bardez *taluka* is in Goa State, which is situated on the West Coast of India (14º 53' 57" - 15º 47' 59" North and 73º 40' 54" - 74º 20' 11" East). This area supports extensive tourism activity. The additional pressure created by the tourists and the other activities in support of tourism, on the coastal resources of this area, can be assessed using the ecological footprint of production (EF_T).

Using the method to assess the impact of tourism

To estimate the impact of tourism activity in the study area, the total number of days (T) spent by tourists in the host destination in a year i.e. length of stay of tourists in the study area, was required. For the domestic tourists, average length of stay in the host destination was taken as five days and for foreign/ international tourists nine (Tourists' Statistics, 2000). There were 116,344 international tourists and 187,432 domestic tourists in the study area for the year 2000 (Tourists' Statistics, 2000). The annual time (i.e. the total number of days in a year, T_a) spent by tourists was calculated individually for foreign and domestic tourists, by multiplying the number of tourists (T) by 9 for foreign tourists and by 5 for the domestic tourists (1).

T_a=T(domestic)*5+T(international)*9-----------(1)

The total number of days spent by the 303,776 domestic and international tourists in a year is 1,984,256, giving a mean stay of 6.53 days.

In order to assess the ecosystem support areas required to support:

1. demand for food, fibres and energy
2. demand for land (infrastructure),
3. demand for water, and
4. assimilate waste generated,

the land required under each category of demand by tourists as well as migrant workers associated with tourism activity was calculated.

Land required to support demand for food, energy and fibres

• For tourist population

The study area largely supports middle budget tourism, which has similar consumption patterns as average Indians (Based on hotel room tariffs, verbal conversations with hotel managers and owners and visual observation). This is unlike many other parts of Goa, which support high budget and luxury tourism. The consumption pattern is best classified here as low, middle, and high budget tourism rather than domestic and international tourists, as it is commonly found that even among international tourists, there are some that support low budget tourism (backpackers have footprints lower than locals) and some that support middle budget tourism (having footprints similar to average Indians). The study area supports mainly middle budget tourism.

Since the land required for these services is already calculated for most of the countries (Wackernagel, 1997; WWF, 2000, 2002), the same EF values were used. These are consumption footprints; however for the purposes of this study they are equal to production footprints. The numbers were taken from WWF, 2000, and not WWF, 2002, since data on tourists was not available for 2002. The EF values were converted to local hectares (equations 2 and 3), as this (expressing in local hectares) was thought to be more useful for policy making at local level.

Cropland Footprint (FP) = 0.46 gha/cap.
1ha of cropland = 2.64 gha.
So in local terms
FP area = 0.46 / 2.64 = 0.174 ha.

Grazing land FP= 0.15 gha/cap.
1ha of cropland = 4.25 gha.
So in local terms

FP area = 0.15 / 4.25 = 0.035 ha.

Forest FP= 0.12 gha/cap.
1ha of cropland = 2.30 gha.
So in local terms
FP area = 0.12 / 42.30 = 0.052 ha.

Built-up land FP= 0.01 gha/cap.
1ha of cropland = 2.64 gha.
So in local terms
FP area = 0.01 / 2.64 = 0.004 ha.

So total FP for food and fibres (EF ff), in local area terms, =

0.174+0.035+0.052+0.004 = 0.265 ha/cap ------ (2)

Since built up land is assessed independently as the land under infrastructure, this FP (0.004) is subtracted from the above figure.

0.265 – 0.004 = 0.261 ha --------------------------- (3)

In order to express the impact per tourist in terms of years, the number of tourist days in a year was divided by 365 (4).

1,984,256/365 = 5436 tourist years -------------- (4)

Ecological footprint of tourist population (EF_t) is calculated as

5436 *0.261 = 1419 ha ------------------------------- (5)

- For migrant population

The tourism activity in the study area also attracts a number of workers from other areas. EF of total migrant population (EF_m) supporting tourism activities was calculated from the number of seasonal workers. Total number of rooms accommodating tourists in the study villages is 4536. Assuming that one worker is employed per room, the number of seasonal workers in the study area is 4536. 70% of these workers (3175) are migrants from other states and the average length of stay in a year of each migrant is 210 days, the total annual length of stay of all migrants in study area is 1826 migrant years (6) (Government of Goa ; TERI, 2000a).

EF of migrant population will be 477 ha (7), using the average per capita EF for India as expressed in local terms

EF_m = 3175*210/365 = 1826 years -------------- (6)
1826*0.261 = 477 ha -------------------------------- (7)

Land required for infra-structure development (LI)

Since accommodation would be one of the requirements of the tourists, to assess the impact of tourism, the land required for infrastructure was estimated as an impact of tourism. According to the study conducted by TERI (2000a), land required for infrastructure per tourist is 21 sq.m. for high budget, 15 sq.m. for middle budget, and 6 sq.m. for low budget. Since the study area supports mostly middle budget tourism, this figure (15 sq.m.) was used to calculate the area under infrastructure for tourism.

Total number of tourists visiting the study area during the year is 303,776.

303,776*15 = 4,556,640 sq.m. = 456ha --------- (8)

The area required to provide infrastructure for these tourists is 456ha (8).

Land required for waste assimilation (LWA)

Assuming that the average land required for the waste-water assimilation per tourist per day is 0.25 m^2 (Khanna & Mohan, 1995) with the existing Indian treatment systems, the total land required for assimilation of sewage generated by tourists is calculated. Our field observations and interviews with key informants confirmed this assumption. Total number of days spent by all the tourists visiting the study area is 1,984,256.

Land required for waste assimilation by these tourists is

1984256*0.25sq.m.= 496,064sq.m.= 49.6 ha -- (9)

Land required for waste assimilation by migrant population =

3175.2*210*0.25 = 166,698 sq.m. = 16.7 ha - (10)

L_{WA} = 49.6 ha + 16.7 ha = 66 ha --------------- (11)

Land required for water consumption (LWC)

The water requirement for migrant population is assumed to be 100 litre *per capita* per day (lpcd), which is minimum water required (Pachauri & Sridharan, 1998) and for tourist population 250 lpcd (Chachadi & Raikar, 2000). Total number of days spent by tourists is 1,984,256, as calculated above.

Considering that each hectare of land in India can yield 11 million litres of rainwater (Agarwal & Narain, 1997), [These figures were also confirmed to be valid for our study area by our partners working on ground water, Dr A G. Chachadi and Dr. J. Lobo-Ferreira (TERI, 2000b)], the land area required for water consumption by tourists (12) is calculated as

LWC(t)=1,984,256*250 /11,000,000=45 ha -- (12)

The land area required for water consumption by migrant population $L_{WC(m)}$ in support of tourism (13) is calculated as

LWC(m) = Total migrant population (3175) * average length of stay (number of days in a year) of migrant population (210) * water required *per capita* per day (100 lit)/11,000,000 =

3175*210*100/11,000,000 = 6 ha --------------- (13)

$L_{WC} = L_{WC(t)} + L_{WC(m)}$

L_{WC} = 45 + 6 = 51 ha ------------------------------ (14)

Ecosystem support areas required for tourism activity

(L_T) is the sum of EF of tourists (EF_t) (eq.5) and EF of migrants (EF_m) (eq.7) supporting tourism activity, land under infra-structure for tourism (eq.8), land area required for waste assimilation (eq.11) and land area required for ground water consumption of tourists and migrants (eq.14).

$L_T = EF_t + EF_m + L_I + L_{WA} + L_{WC}$
= 1419 + 477 + 456 + 66 + 51
= 2469 ha -- (15)

Ecosystem Impact Factor

Ecosystem Impact Factor (EIF) of tourism activity is then calculated as a function of total ecosystem support area required for the tourism activity in the study area and the total geographical area.

EIF = Ecosystem support area required for the tourism activity/ total geographical area

EIF gives an idea of the additional pressure placed by the development activity on the local ecosystem. In the present case, total area is 8337 ha. This is the bioproductive land and built-up land. Area in local hectares is used to determine the Ecosystem Impact Factor, since all the above impacts are calculated in local hectares. This is more acceptable for policy making at local level.

EIF = 2469/ 8337
= 0.3 -- (16)

EIF of tourism activity in Bardez *taluka* is 0.3 (16). This is the pressure placed by the tourism activity on the local ecology. Note that this is an underestimate as full account of energy has been omitted.

In order to further help decision-making, ecosystem support area required per thousand Indian rupees earned from tourism activity was calculated (17). This is hoped to help in making choice between the different development activities in any particular region.

Ecosystem support areas required per thousand Indian rupees earned from tourism activity (EF_T)

Total state revenue earned due to tourism activity in Bardez *taluka* is Rs. 20,487,466 (Total revenue earned for the state of Goa appropriated to the Bardez *taluka*, Statistical Handbook for Goa, 2000; Tourists' Statistics, 2000). Total ecosystem support area required for tourism activity in tourist villages of Bardez is 2469 ha.

Ecosystem support areas required per thousand Indian rupees earned from tourism activity (EF_T) is calculated as

Total ecosystem support area /1000 Rs.
= 2469*1000/20,487,466
= 1.18ha -- (17)

Total ecosystem support area required to earn Indian Rupees 1000 by tourism activity in tourist villages in Bardez *taluka* is 1.2 ha.

While EIF gives an idea of the additional pressure placed by the tourism activity, total ecosystem support area required to earn Indian Rupees helps policy makers in decision making between tourism activity and any other activity.

Discussion

Trade can be a subtle mechanism, which preserves ecological sustainability in some countries by means of importing biomass and sink-capacity from other countries. International trade, although balanced in monetary terms, may be unequal in terms of the exchange of biomass and sink-capacity (Andersson & Lindroth, 2001). The concept of sustainable development as originally suggested by the Brundtland Commission is based on an ethical principle of equity in the distribution of income, wealth and control of resources between generations that must logically be extended to the distribution within each generation (Borghesi * Vercelli, 2003). Since then, sustainable development has been the focus (of attention) of many national governments.

There is a large and growing literature on different types of indicators for sustainable development. These indicators attempt to capture important aspects of the broad concept of sustainable development. It seems unlikely that there exists one single measure of sustainable development, which is capable of capturing all that is meant by 'sustainability' (Hanley *et al.*, 1999). Some very good indices have been developed for social and economic dimensions. Such indices for ecological system are lacking.

The notion of value in ecosystems and the separability of economic and ecological systems in valuation analysis have been explored by Limburg, Robert, O'Neill, Costanza & Farber (2002). A number of indicators and approaches have been proposed, which attempt to quantify human use of nature. These include carrying capacity, Limits of Acceptable Change (LAC), ecological debt, eco-space, Index of Sustainable Economic Welfare (ISEW), Genuine Progress Indicator (GPI), Green Net National Product (NNP), and genuine savings. The carrying capacity concept assumes that ecosystems and populations have only a limited capacity to cope with environmental stress. This necessitates that the limits of the ecosystems be identified. Although many support this concept, the instruments and methods to identify the thresholds or limits of ecosystems are not easily available (de Graaf, Musters & ter Keurs, 1996). It cannot be easily incorporated into policymaking. Limits of acceptable change (LAC) represent a different way of conceptualising problems compared to the carrying capacity approach. It incorporates ecological as well as social concerns. However, LAC provides only a framework for identifying appropriate management actions. There is still a need for scientific expertise. The most obvious criticism, which can be leveled at both ISEW and GPI, is that they essentially amount to a series of *ad hoc* adjustments to an already imperfect measure. Secondly, both measures, like green NNP, are based on current flows rather than stocks and thus do not really address the maintenance of capacity, which some would argue is at the heart of sustainability (Hanley *et al.*, 1999). Genuine savings as proposed by Pearce and Atkinson (1993) is a measure of weak sustainability, which suggests that total amount of capital, both man-made and natural, should not decline. The main weak points of this method are:

1. Measuring depreciation of natural capital is empirically difficult as many resources such as biodiversity, water quality, wilderness have no or imperfect market values (Hanley *et al*., 1999), and

2. There is a concern that countries which import natural resources can encourage exporting countries to behave unsustainably (Atkinson & Hamilton, 1996).

Environmental space is a tool for exploring sustainable development benchmarks on a sound scientific basis, and it is helpful to derive indicators of sustainable development for different applications on the macro as well as on the micro level. However, the environmental space concept expresses no preference regarding the structure of the economic system, as long as the environmental and social benchmarks are respected, nor does it suggest specific economic sustainability indicators (Spangenberg, 2002).

Andreasen, O'Neill, Noss and Slosser (2001) while evaluating the usefulness of a terrestrial index of ecosystem integrity (TIEI) in environmental decision making point out that multiple levels of information are needed to make effective decisions and the ideal indicators for measuring eco-system integrity will incorporate information from multiple dimensions of the ecosystem. An index - periphyton index of biotic integrity (PIBI) - is proposed by Hill, Herlihy, Kaufmann, DeCelles and Vander Borgh (2003). Indicators for institutional sustainability have been proposed by Spangenberg, Pfahl and Deller (2002). A sustainable development index is proposed by Barrera-Roldán and Saldivar-Valdés (2002). However, these indices cannot be used to explain the impacts of tourism activity on ecological systems. Socio-economic impacts of enclave tourism in Botswana are documented by Mbaiwa (2004). Similarly, socio-cultural impacts of tourists and refugees are discussed by Russel (2003). A number of indicators of visitor impacts in natural areas have been presented by Leung and Marion (2000) and Newsome, Moore & Dowling (2002). Newsome *et al.* (2002) present a wealth of indicators, e.g., those used in multiple indicator systems by rating (Table 7.4, p. 270) and measurement (Table 7.5, p. 272); monitoring techniques for trails (Table 7.6, p. 277) and gravel roads (Table 7.7, p. 281); as well as visitor data monitoring (Table 7.8, p. 284) and techniques (Table 7.9, p. 286); and standards for social and biophysical indicators (Table 7.10, p. 295). However, for decision-making, the indicators need to communicate a single value to the policy makers. They need to integrate useful information into one composite indicator.

Arguably, the indicators which are most useful to policy makers provide a single value integrating an array of information.

Ecological systems are composed of complex biological and physical components that are difficult to understand and to measure. However, effective management actions and policy decisions require information on the status, condition, and trends of ecosystems (Andreasen *et al*., 2001). A challenge in developing and using ecological indicators is determining which of the numerous measures of ecological systems characterise the entire system yet are simple enough to be effectively and efficiently monitored and modeled (Dale & Beyeler, 2001). Further, indicators ought to be useful at a number of different levels and for different communities, at local, national and international levels and for the research community, the policy community, and industry as well as for the local community/general public. Clearly, the criteria for an indicator to be useful to these different groups are different. Negotiations about sustainable development can only be realised if all the stakeholders know and have the same information at their disposal and are able to interpret this information (de Graaf *et al*., 1996). An indicator that is easily understood and can communicate information to most stakeholders is preferred. National governments are constantly searching for sustainability indicators at the local and regional levels of scale. The governments of individual countries want solutions for themselves. However, most indicators and approaches do not inform policy makers how the proposed approach can be incorporated into decision-making, especially at a local (micro) level (de Graaf *et al*., 1996).

The present approach i.e. Ecological Footprint presents information in a way that can be easily understood and used by policymakers. It is a composite ecological indicator, which incorporates an economic dimension. Although it does not include societal and institutional dimensions, it is useful for environmental decision-making. It is necessary to focus on the environmental impacts that best explain the system and embrace a wide canvas. Choice of ecological indicators is confounded in management programs that have vague long-term goals and objectives. Management and monitoring programs often lack scientific rigor because of their failure to use a defined protocol for identifying ecological indicators (Dale & Beyeler, 2001). Through a limited set of figures, environmental issues can be effectively communicated, environmental conditions effectively monitored and results of policy and management be measured (Niemeijer, 2002). Hence development of the tool (EF_T) has focused on the environmental impacts of tourism activity most evident from the existing literature.

Natural capital is emerging as a major bottleneck to economic growth today and more liberal trade is perceived as the best way to overcome related local limits (Catton, 1980). Trade and globalisation encourage extensive use of resources by providing a market for all local resource stocks. This results in over-consumption of resources by importers and overexploitation of stocks by exporters. Most of the countries run ecological deficits on account of ecologically unbalanced trade. In the light of this, the consideration of biophysical limits imposed by natural capital in the form of finite resources and sinks for national economy and international trade has become a necessity. The concept of ecological footprints assists the interpretation of the sustainability implications of international trade (Wackernagel, 2001). This paper presents a method, EF_T, which indicates ecological consequences of global economic integration on the local environment, using a case study of tourism activity in Bardez *taluka*. It gives the production footprint of tourism activity in Bardez *taluka* and estimates ecosystem support area required to earn Indian Rupees 1000 through tourism activity. Ecological Footprint of tourism in Bardez *taluka* indicates that the tourism activity places considerable stress on the study villages. If ecological services required for the host population are taken into account, then the region is unsustainable and has to import ecological services from other areas.

The method (EF_T) assesses the resource use and waste assimilation by the activity at a very local level. As stated above, some of the limitations of the method are that

a) it does not include certain impacts such as air travel to the destination from country of origin,

b) it does not take into account the complex, dynamic nature and resilience of the ecosystem,

c) it does not take into account some impacts and hence underestimates the total impact,

d) the area calculated may not be totally mutually exclusive and some part of it may be multifunctional.

For example, there may be double counting of appropriated ecosystem areas for resource production and waste assimilation. This is an issue in most such footprint analysis (Folke *et al*., 1998). As mentioned earlier, the tool developed in the present paper assesses impacts of the activity on the local ecosystem only, the aim being to help local policy makers make a better choice between tourism and other development activities. Hence the impacts of transportation from the country of origin to the country of destination, i.e. India, are not considered. Such impacts are at the global level and need not necessarily be considered for assessment exercises and policy making at the local level.

EF_T can be used as one of the tools to gauge sustainability, despite the above limitations. It brings to light some non-obvious demands on the ecological capital. Such ecosystem appropriation by any particular activity is seldom addressed in policy. EF_T can create awareness amongst the stakeholders of the activity as to the impact caused, which would otherwise be regarded as unused or free and directed for other purposes. It addresses important questions, often asked by a local community - 'what is the hidden environmental cost (impact) involved in the income generated by the activity? Is tourism activity beneficial compared to the other activities in a particular area?'

There are ongoing debates about the use of ecological footprint (EF) for policy making (Ecological Economics Forum, 2000). The tool developed here, i.e. EF_T, provides a rough estimate of ecosystem support area required to earn 1000 rupees and can be used for decision-making. As Templet (2000) points out about EF, EF_T is also transparent and understandable to public (local communities) and policy community, major stakeholders, that need to be involved in decision making about public resources and commons issues. Like EF (Rees, 2000), it highlights the critical importance of natural capital to economic development. Ecological indicators need to capture the complexities of the ecosystem yet remain simple enough to be easily and routinely monitored (Dale & Beyeler, 2001). Effective environmental policy requires that the condition of complex environmental systems be captured in one or more simple figures or indicators understandable to policymakers and the general public. The present tool is simple to understand and captures the required impacts on the ecological system.

EF_T can be used to compare the activities and to address conflict of interest between the multiple uses of a geographical area such as the coast. EF_T is a composite indicator, an aggregated index. Such a defined computation of an index, which can be easily calculated and understood, will reduce subjectivity involved in evaluation of impact of any development activity. These inputs may make the choice of use of any location, for any particular type of activity, easier for the policy makers and help sustainable development of a region. Hidden cost, ecological subsidies offered and the environmental externalities, which are accounted in EF_T, may help in policy making. It can also be used to monitor progress towards reducing the impact of the activity. Though EF_T does not take into account the complex, dynamic nature and resilience of the ecosystem, it is useful in constructing management strategies, which take into account the health of the ecosystem. However, it can be further refined to include more impacts, better suit specific locations and thus better inform decision-making.

EF_T can also be used to reduce environmental impacts of the development activity. Since the method gives a clear picture of the environmental impacts of various components, it is possible to target any of these and try to reduce the footprint of production. For example, using better technology for sewage treatment by hotels will reduce ecosystem support area required for sewage waste. Similarly, having better water conservation methods will reduce ecosystem support area required for water abstraction.

Quantifying the environmental impacts of tourism activity provides an orientation towards future planning and makes human environment interactions more understandable. Such measurements are critical steps towards an understanding of human impacts on environment and will help to provide solutions to develop the concepts of sustainable development. EF_T can be used as a tool, which provides information to avoid overexploitation of nature and plan towards sustainable management. It helps awareness raising as well as policy making. The inconclusiveness of current knowledge, failure of indicator research to evaluate the ecological impacts of tourism, environmental shortcomings of sustainable tourism and lack of a regulatory regime for effectively managing the environmental impacts of tourism have all been discussed by Hughes (2002). It is hoped that this tool, EF_T, will help more efficient environmental decision-making and tourism management.

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