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Authors: Cole, Victoria, and Sinclair, A. John

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Victoria Cole and A. John Sinclair

Measuring the Ecological Footprint of a Himalayan Tourist Center

Finding ways to assess and measure the impact of tourism and its associated development on sustainability is critical to developing long-term sustainability plans for regions such as the Indian Himalayas. Among the methods proposed is ecological footprint (EF) analysis or appropriated carrying capacity analysis. EF analysis estimates the area of productive land and water ecosystems required to produce the resources that a population consumes and to assimilate the wastes that the population produces in supporting itself. This study used EF analysis to quantify the sustainability of Manali, a rapidly growing tourist center in Kullu District, Himachal Pradesh, India. It considered the changes in the size of Manali's footprint since the advent of mass tourism in the early 1980s, the direct impact that tourists are having on the size of the footprint, and the challenges of applying this analysis in a developing world context. Data regarding land use, goods and services, and population were collected through local interviews and available data. The results indicate that between 1971 and 1995, the overall EF of Manali town grew from 2102 to 9665 ha, an increase of over 450%; the EF of Manali is now 25 times greater than its size. This indicates that Manali is increasingly relying on outside ecosystems for its sustenance. The article highlights areas of focus for future sustainability planning, including waste management, decreasing fossil fuel dependence, ecofriendly tourism, and creating greater environmental awareness, particularly among tourists.

Keywords: *Sustainability; ecological footprint analysis; mountain development; mountain tourism, India.*

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Introduction

High mountain areas cover almost one-quarter of the land surface of the globe, are home to about 10% of the world's population, provide fuel, fodder, timber, energy, agriculture, minerals, or recreation for another 40% or more of the world's population, and according to recent estimates, provide water for multipurpose uses to about 50% of the world's population (Eckholm 1975; Singh 1998). Given their clear significance to a large percentage of the human population, the accelerating environmental degradation of these areas should be of global concern. Many observers point to population growth, urbanization, tourism, commercial forestry, and economic development as the causes (Bahuguna 1989; Allen 1995; Rawat and Sharma 1997; Kayastha 1998; Misra 1998). Although the magnitude of these human activities is often small relative to that in the surrounding plains areas, the unique features of mountain environments make them sensitive to even small disturbances (Qasim 1996; Berkes and Gardner 1997).

Mountain tourism is of particular concern because it is frequently espoused as a means of community development that can provide alternative livelihood opportunities, diversify local economies, promote population growth, and address problems of poverty (Singh 1989; Sharma 1998; Sinclair and Ham 2000). In India, both state and central governments have declared tourism to be an industry and have provided the tourism sector with the same concessions and incentives given to the industrial sector. At a meeting of the Coordination Committee on Himachal Tourism in India, 1 member insisted that tourism become the mainstay of the primarily mountainous state of Himachal Pradesh and that all planning be based on the development of tourism, an industry that "…would provide adequate employment potential and would create economic activity in places where manufacturing and mining are not available" (HPTD 1993). Such confidence in the benefits of tourism is not uncommon. However, Sharma (1995) has compared the development of tourism in India to fire, "which can be a creator if properly managed, and a destroyer if allowed to take its own course."

Finding ways to assess and measure the impact of tourism—and the accelerated urban development it can precipitate—on sustainability is critical to developing long-term sustainability plans for regions such as the Indian Himalayas. Although much qualitative work has been done, few quantitative measurements exist. One of the more interesting techniques to emerge as a sustainability indicator is ecological footprint (EF) analysis or appropriated carrying capacity analysis (Levett 1998). Developed by William Rees and Mathis Wackernagel, this technique measures the land and resources a society consumes to sustain itself. Rather than asking, "What population can the land and resources available support indefinitely?," EF analysis asks, "How large an area of productive land is needed to sustain a population indefinitely at current levels of technology and consumption, wherever that land may be located?" (Rees 1996).

The purpose of this research was to use EF analysis to examine the sustainability of Manali, a rapidly growing tourist town located in the Kullu District of Himachal Pradesh, India. The primary objectives of the research were:

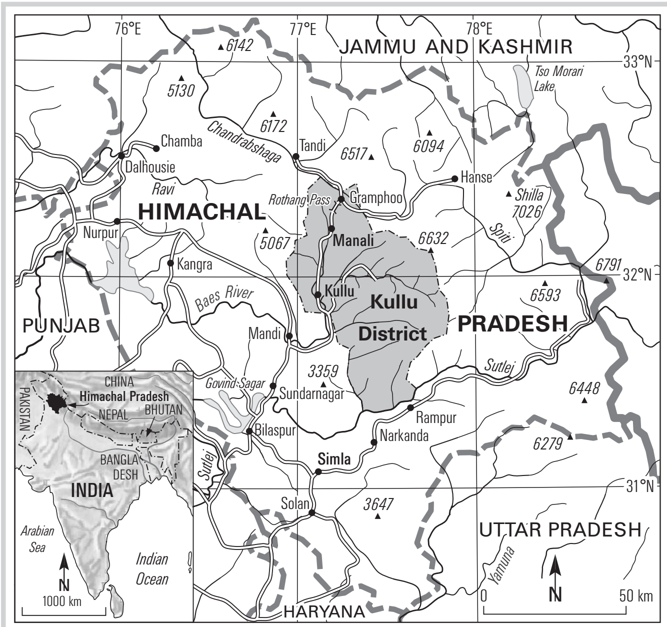


FIGURE 1 The study site: Manali, Kullu District, Himachal Pradesh, India. (Map by Andreas Brodbeck)

- To quantify and assess the differences between the historical EF of Manali (before the town became a major tourist destination) and the current EF of Manali.
- To assess the utility and practicality of EF analysis in measuring sustainability in developing countries, particularly in smaller urban centers within these countries.

The study site

The study took place in Manali in the Kullu Valley, Kullu District, Himachal Pradesh, India (Figure 1). Manali is the main tourist destination in the Kullu Valley. Sited at an elevation of 2050 m in the Pir Panjal Range of the Western Himalayas, Manali is well known because of its status as one of the scenic and cultural–historic gems of the Himalayas (Chetwode 1972; Berkes and Gardner 1997).

In addition to its unique scenery, Manali has a number of other attributes related to its mountain context. The glaciers of the region are the source of freshwater for the Beas River, which has its headwater just upstream of the town. The Beas is a typical glacial torrent that transports water through Manali to the Indus River watershed, critically important to the northern plains regions. In a country losing forest cover very rapidly (Agarwal et al 1982), the health of the reserved and demarcated village forests in Manali and area has stood in stark contrast to that of the rest of the country. The high mountain alpine tundra and meadow accessible from Manali are the basis of a traditional transhumance livestock economy and home to many alpine plant species. At lower elevations around the town and surrounding villages, there are well-developed soils that have supported paddy cultivation and orchardry activities (Berkes and Gardner 1997). These features make Manali an excellent case study for the impacts of tourism and associated urbanization on sustainability in a mountain environment.

Manali functioned as a small, relatively unknown service center until 1958 when independent India's first prime minister, Jawaharlal Nehru, visited the region. The Himachal Government capitalized on the media publicity surrounding the visit and began a program to develop tourism infrastructure in the region. Development proceeded at a steady, slow pace until the late 1970s, but from that point onward, major changes in the shape and size of Manali began to take place. Small, orchard-based guesthouses were replaced by a myriad of hotels ranging from economy to luxury accommodations. The Himachal Pradesh Tourist Development Corporation, along with other tour operators, began to develop and market package tours to the Manali area (Singh 1989; Berkes and Gardner 1997). By 1981, the village had been declared a town, becoming 1 of only 3 urban centers in the Kullu Valley. In 1997, the local government became an elected *Nagar Panchayat*—a form of local government, which, according to the Indian Constitution, is reserved for an area "in transition from a rural area to an urban area" (Bakshi 1998).

Despite Manali's relatively small area and permanent population, it has developed into a full-blown tourist resort. In 1975, there were only 2 hotels/guesthouses in the Manali area; by 1998, there were 693 and by 2000, there were over 725 (Singh 1998).

Calculating the EF of Manali

The EF of Manali was calculated for the years 1971 and 1995. The year 1971 was chosen because data were readily available and because it predates the modern acceleration in tourism development (Singh 1989). The year 1995 was chosen because it was the most recent year for which a full data set was available, and it was current enough to reflect the situation following the development of large-scale tourism. In 1971, approximately 1800 persons lived in Manali, and the town was visited by about 18,500 tourists—17,745 domestic and 555 foreign (Director of Census Operations, Himachal Pradesh 1971; Singh 1989). In 1995, the resident population of Manali was about 2609. (This figure, generated by the Town of Manali in 1995, is conservative, at approximately half of the estimated 5000 people quoted in other studies. Tibetan refugees are not included in the calculations.) The town was visited by 382,569 tourists—370,514 domestic and 12,055 foreign. The floating population during the tourist season in 1995 appeared to be approximately 10,000 individuals at any one time (Singh 1989; Town of Manali 1997; HPTDC 1998).

TABLE 1 References for the data used to calculate Manali's basic EF.

Data required	Data sources used (see References)
Population	
India	FAOSTAT Agriculture Database. On the Internet at apps.fao.org
Himachal Pradesh	Central Statistical Organization Department of Statistics (1997).
Kullu District	DES (1976, 1997).
Manali Town	Director of Census Operations, Himachal Pradesh (1971, 1997) Town of Manali (1997)
Land use	FAOSTAT Agriculture & Forestry Databases. On the Internet at apps.fao.org
Built-up area	Central Statistical Organization Department of Statistics (1997).
Forests	Central Statistical Organization Department of Statistics (1997) WRI (1999).
Sea area	Roy (1999).
Foods	FAOSTAT Agriculture Database. On the Internet at apps.fao.org
Other crops	FAOSTAT Agriculture Database. On the Internet at apps.fao.org
Rubber consumption	UNCTAD (1995).
Wool productivity	Wackernagel et al (1993).
Cotton productivity	Wackernagel (1998).
Timber	FAOSTAT Forestry Database. On the Internet at apps.fao.org
Energy consumption	United Nations (1976, 1997a), WRI (1999).
Commodity trade	United Nations (1974, 1997b).

Estimating EF is a multistage process. In theory, EF is calculated by estimating the area of productive land and water ecosystems required on a continuous basis to produce the resources and services that a population consumes and to assimilate the wastes that it generates. In practice, however, it is difficult to account for all the different consumption items and waste types. For this reason, consumption items are classified into major categories accounting for the bulk of energy and material flows, and only those categories of waste for which assimilative land/water surface can be estimated are included (Wackernagel et al 1993; Wackernagel and Rees 1996; Wackernagel 1998). Care is taken to avoid overlap and double counting. For example, leather goods are by-products of meat production, so the leather footprint is assumed in that for meat. Similarly, if domestic animal wastes are composted and recycled onto agricultural lands, then the nutrient waste footprint is coincident with cropland or pastureland and need not be included as a separate category. Calculations in this study relied on a spreadsheet model developed by Mathis Wackernagel, Lillemor Lewan, and Carina Borgstrom Hansson.

EF analysis accounts for productive land/water in the following standard categories: arable land (cropland); pastureland; woodlands and forests; and productive ocean (continental shelves and estuaries). Urbanized land and other once-productive land sterilized by human activities are also included where relevant. Deserts, other barren lands, and icefields are not considered to be bioproductive for the purposes of the EF analysis (Rees 1996; Wackernagel and Rees 1996).

The first step in estimating an EF is determining the per capita EF of the region's residents and, in this case, its tourists. We began with an estimate of the average person's annual consumption of particular items. For Manali residents and tourists, this was done by calculating the per capita consumption of an average Indian citizen because data were not available to make the footprint more specific to Manali. The items included in the analysis reflected those used in readily available international data, primarily compiled by United Nations organizations such as the Food and Agricultural Organization (Table 1). In all categories where trade data were available, trade-corrected consumption was assessed by subtracting exports from the sum of production and imports (Wackernagel and Rees 1996).

The next step was to estimate the land area appropriated per capita for the production of each major consumption category. This was done by dividing the average annual consumption of a particular consumption category (in kilograms per capita), as calculated in the previous paragraph, by its world average annual productivity or yield (in kg/ha) correcting for trade where possible (Rees 1996, 2001; Wackernagel and Rees 1996). (World average yields are used in basic EF analysis to facilitate international comparisons and to simplify calculations where trade obscures the origin of the items. For some EF studies, production is adjusted using local yield equivalency factors [eg, see Wackernagel et al 1999].) For example, in the case of pork meat, the Equation was

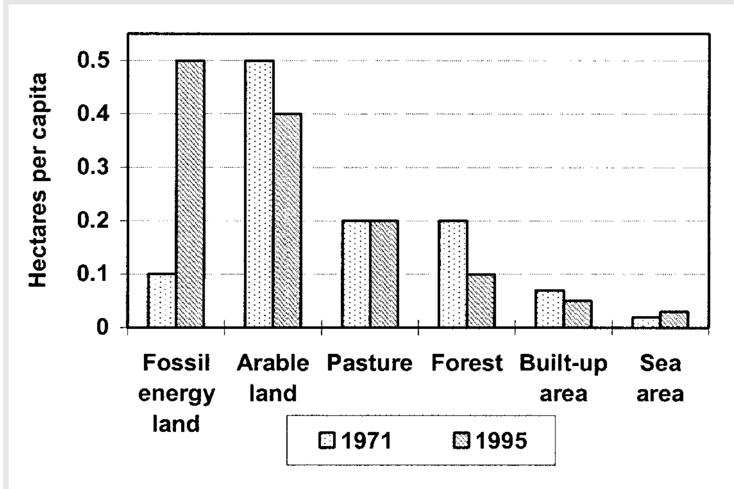
$$EF_{pork} = \frac{(Production_{pork} + Imports_{pork} - Exports_{pork})/Population_{India}}{Yield}$$

The total EF for the average Indian was then estimated by summing the ecosystem areas required to produce each category of purchased consumption goods and services on an annual basis (Rees 1996, 2001; Wackernagel and Rees 1996).

The total EF of Manali was calculated by summing the average per capita EF of every resident, seasonal worker, and tourist in Manali (Wackernagel and Rees 1996). For the purposes of this research, it was assumed that all had the same per capita EF as the average Indian; however, the EFs of tourists and seasonal workers were adjusted for the estimated amount of time spent in Manali—about 2 months for seasonal workers and 3 days for tourists. The per capita footprint of tourists and seasonal workers and the time spent annually in Manali were also used to estimate changes in the monthly distribution of Manali's EF.

Personal interviews were also conducted with Manali residents, hotel and restaurant operators, and shopkeepers to validate and enhance the findings of the EF calculations. In total, 106 people were interviewed, of whom 44 were hoteliers, 22 were restaurateurs, 17 were shopkeepers, 3 were the owners or employees of local scrap shops, and 20 were other individuals who lived and worked in Manali.

FIGURE 2 Changes in the per capita EF of the average Indian between 1971 and 1995.



Manali's growing EF

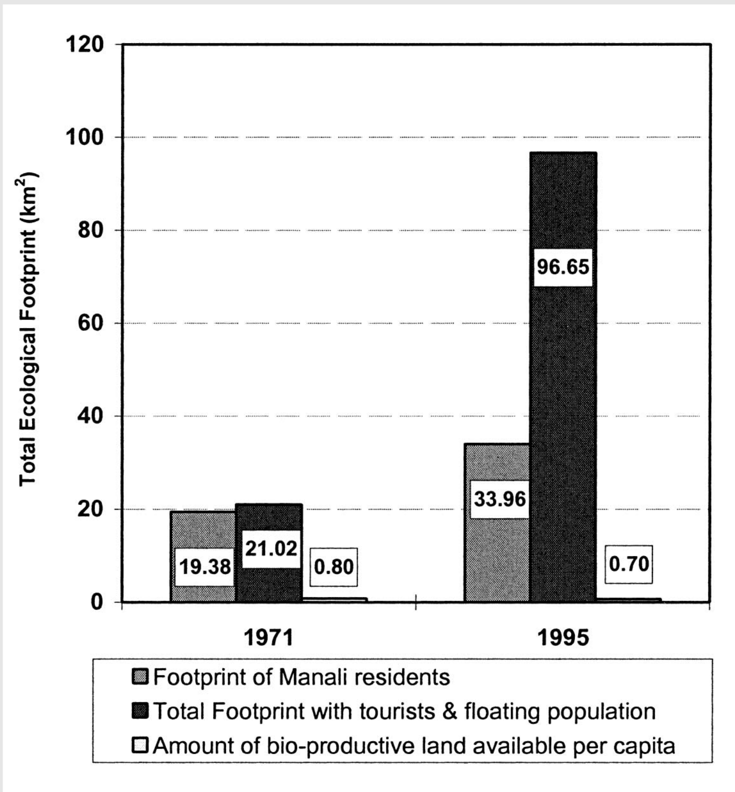
Changes in the EF of Manali: National data

Between 1971 and 1995, the per capita EF of the average Indian resident increased from 1.1 hectares per capita (ha/capita) to 1.3 ha/capita, a 19% increase (Figure 2; Table 2). In the town of Manali, this increase was combined with an increase in the number of residents, seasonal workers, and tourists and led to a substantial increase in the total EF. In 1971, Manali's total EF was 21.02 km^2, about 12 times greater than its 1971 town area of 1.8 km^2. Of this, residents created a footprint of 19.38 km^2, and tourists created an overall footprint of 1.64 km^2, with 1.59 km^2 attributable to domestic tourists and 0.05 km^2 to foreign tourists. By 1995, the total EF of Manali had risen almost fivefold to 96.65 km^2—an area almost 28 times greater than the

TABLE 2 Per capita EF for the average Indian by land type, 1971 and 1995.

	1971		1995	
Land type	**Per capita EF (ha/cap)**	**Per capita land available in India (ha/cap)**	**Per capital EF (ha/cap)**	**Per capita land available in India (ha/cap)**
Fossil energy land	0.1		0.5	
Arable land	0.5	0.5	0.4	0.4
Pastureland	0.2	0.2	0.2	0.2
Forest	0.2	0.2	0.1	0.1
Built-up area	0.1	0.1	0.05	0.05
Sea area	0.02	0.1	0.03	0.1
Total per capita EF	1.1	0.8	1.3	0.7

FIGURE 3 Changes in Manali's EF, 1971 and 1995.



town's 1995 area of 3.5 km^2. Residents created a footprint of 33.96 km^2, seasonal workers created a footprint of 21.76 km^2, and tourists had a combined footprint of 40.93 km^2, with 39.64 km^2 from domestic tourists and 1.29 km^2 from foreign tourists (Figure 3).

The monthly EF of Manali also changed over the 24-year period from 1971 to 1995. In both years, the monthly EF of Manali peaked in May and June and again in September and, to some extent, in October. May and June are the best months for snow viewing at the Rohtang Pass, the second-highest mountain pass in the world, located about 40 km from Manali. This is the time when most domestic tourists come to Manali. September and October are the best months for trekking and other outdoor activities; most foreign tourists visit in these months (Singh 1989; Kumar 1996). Figure 4 indicates that in 1995 the sizes of the monthly footprints were larger and that the differences between the tourist and nontourist months were much more dramatic.

Local variations and their impact on the EF

Per capita, the Indian EF grew primarily because of a growing reliance on imported fossil fuels. In 1971, the bulk of the fossil energy footprint could be attributed to coal, with the average Indian having a coal consumption footprint of 0.06 ha. By 1995, this had tripled to a footprint of 0.2 ha. Equally dramatic were the per capita increases between 1971 and 1995 in liquid fuel consumption from 1.3 to 2.7 Gj/y and in gaseous fuel consumption from 0.21 to 0.77 Gj/y—two- and fourfold increases, respectively. Perhaps, the most astonishing change was that for energy embodied in net imported goods, which rose from an annual consumption of 0.4 to 14.61 Gj/capita—a 36-fold increase.

It could be argued that the fossil energy footprint of Manali residents may be lower than for individuals from other parts of India because state energy production and consumption in Himachal Pradesh in 1995 came from hydroelectric sources. Offsetting any gains, however, is a constant stream of power outages during which local residents use fossil fuel-powered generators as their primary source of electricity, many of which are old and inefficient. Also, during the winter months, some Manali residents heat their households with kerosene lamps and coal or wood stoves.

There is other evidence to suggest that the patterns of fossil energy consumption occurring in Manali are the same as those occurring elsewhere in the subcontinent. For example, the number of vehicles registered in Kullu District rose from 128 in 1971 to 616 in 1997 (DES, Himachal Pradesh 1976, 1997). Local residents have also noted a significant increase in the number of tourists arriving in their own private vehicles rather than on local buses. Between 1969 and 1994, there was a substantial increase in the number of vehicles passing through Manali—from 82 to 205,185—and it is likely that this number has increased in recent years (Pandey et al 1998). Interviews held with local business owners indicate that most of the goods being consumed in the Kullu Valley are being imported, which would also serve to increase the footprint for the energy embodied in such goods.

EF analysis is naturally limited by the data available. In Manali, the unaccounted-for impacts of increased fossil fuel dependence include air pollution in the form of vehicular and generator exhaust fumes, water pollution from the release of fuel into waterways, soil pollution, and the actual and potential health implications of this pollution.

Whereas the changes in the per capita energy footprint of Manali residents are relatively obvious, those in the land categories are not as straightforward. At first glance, it appears that from 1971 to 1995, there were no significant changes in the amounts of arable land and pastureland required by Manali residents. Whereas the per capita footprint presents an incomplete picture, there is an absence of data to show that Manali residents have changed their diets, presenting no reason to expect an increase in their food footprints. The use of fertilizers and pesticides has, however, increased. In Kullu District alone, the consumption of fertilizers has

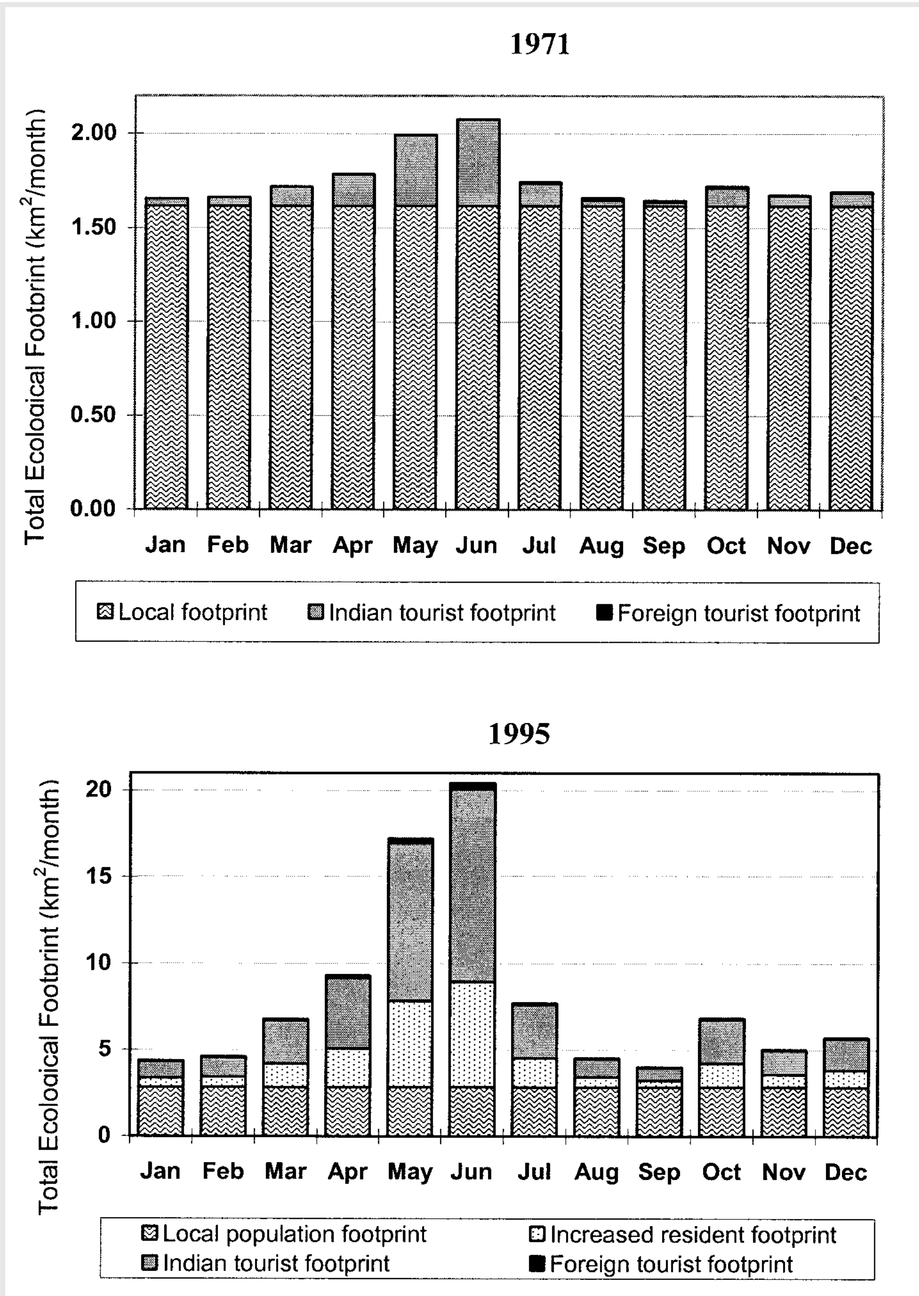


FIGURE 4 The monthly EF of Manali, 1971 and 1995.

increased from 611.6 t in 1971–1972 to 1822.74 t in 1994–1995 (DES, Himachal Pradesh 1976, 1997). Apple crop failures that occurred in 1991 and 1997 were blamed by locals on the lack of pollinating bees as a result of pesticide use. The manufacture and transport of these fertilizers and pesticides would increase the total footprint.

Modern farming also consumes an enormous amount of water, another factor not included in the EF of food production. In Kullu District, the amount of irrigated land has actually declined from 2482 ha in 1971 to 2232 ha in 1995 (DES, Himachal Pradesh 1976, 1997).

With respect to forestland, the amount of land required per capita in India has actually decreased by 50% over the 24-year study period, from 0.2 to 0.1 ha/capita. This does not mean that Indians are now consuming fewer forest products. In fact, consumption per capita over the study period has actually increased from 0.18 to 0.21 t/y. One of the more common environmental complaints of those interviewed in Manali concerns the sale of illegally felled trees in the black market.

Manali's shrinking land base

Although the per capita EF of Manali residents is still just within the 2 ha/capita available worldwide (Wackernagel et al 1999; Rees 2001), the amount of land available per capita in India and Himachal Pradesh has actually decreased. In 1971, the land available per capita was 0.8 ha, as compared with an EF per capita of 1.1 ha. By 1995, the land available per capita in India had shrunk to 0.7 ha, whereas the EF per capita had grown to 1.3 ha. In general, such changes indicate greater competition for land and resources among India's residents. However, because of its lower population density, Himachal Pradesh still provides enough land per capita for its residents, with 2.3 ha of land available per capita in 1995.

There were no data available to adequately estimate the land available per capita in Manali itself. However, literature and interviews with local residents indicate that it has decreased substantially over the last 24 years. Most notable is the loss of arable land and pastureland to the concrete, biologically unproductive landscape of hotels, restaurants, and roads. The development of hotels in villages adjacent to Manali, such as Aleo and Prini, has also claimed once-productive land areas.

The tourist footprint

For both 1971 and 1995, the per capita footprint of foreign and Indian tourists was assumed to be the same as that of the average Indian. Although this assumption is more realistic for Indian tourists than it is for foreign tourists, there is significant evidence to suggest that the per capita footprint of all tourists is actually much higher. When tourists come to Manali, all of them stay in hotels and most of them eat in restaurants. Providing these amenities requires, among other things, the mining of stone, the cutting of trees, and the consumption of available land in the Kullu Valley. Many of the products used in these facilities, from food to sheets, come from outside the Kullu Valley, increasing the influence of imports in the real footprint of the average tourist.

Many of the activities that the tourists engage in also deplete natural resources. Most Indian tourists come to Manali to visit Rohtang Pass, whereas foreign tourists come to the mountains for trekking. Although different, both activities have a significant impact on the environment and on the footprint of tourists. Trips to Rohtang Pass require buses and private vehicles, and tea stalls and other food shops line the route to the pass. These establishments use kerosene and wood fuel for their operations, and visibly worse, the food sold here is usually served in disposable packaging, most of which ends up as litter strewn throughout the pass (Figure 5).

The increase in vehicles primarily to serve tourists is quite startling. There were 91 buses operated by the Himachal Pradesh government in 1997 in addition to tour buses and transport trucks from other parts of the state, which operated in the Kullu Valley (DES, Himachal Pradesh 1997). In the spring of 2000, there were over 75 local private buses in addition to the Himachal Pradesh government buses, 700 taxis, and 350 autorickshaws operating from Manali. Interviewees complained of the inconvenience of large traffic jams in the peak tourist season and the amount of air and noise pollution.

Summary and conclusions

The increase in the per capita footprint of Manali residents and tourists, as well as the sheer number of tourists now visiting Manali each year, significantly increased the overall footprint of Manali town. Had the Tibetan refugees living in Manali been included in the calculations, the footprint would have been even larger. The calculations still indicate a fivefold increase in the total EF of Manali town, of which 80% can be attributed to tourism. Whereas the total EF of Manali residents increased by 1393 ha, that of tourists and seasonal workers rose by 7563 ha over the 24 years of study. This means that in 1971, the footprint with tourists was about 10 times greater than the size of Manali, and by 1995, even with the growth in area of the town, this footprint had expanded to almost 25 times the area of Manali. Such a substantial increase is a sign that Manali is moving away from, rather than toward, sustainability. It also highlights the magnitude of the impact of tourism in Manali, despite what is in all likelihood a gross underestimation of that impact in the calculated values. All the unique mountain attributes, the Beas River, forestlands, productive soils, native vegetation, etc, are being affected.

One of the more beneficial aspects of EF calculations revealed through this study is the ability to isolate those consumption items and waste types that have the greatest impact on the footprint and, hence, on the sustainability of the area under study. In an area where demands on scarce resources are escalating, the analysis also identifies the primary resource needs of the local economy. In doing so, it provides an opportunity to compare these resource needs with the productivity of the resource stocks available and to determine whether the stocks will be able to meet the area's needs in the future. The results indicate that officials in Manali, the Kullu Valley, and Himachal Pradesh should be focusing

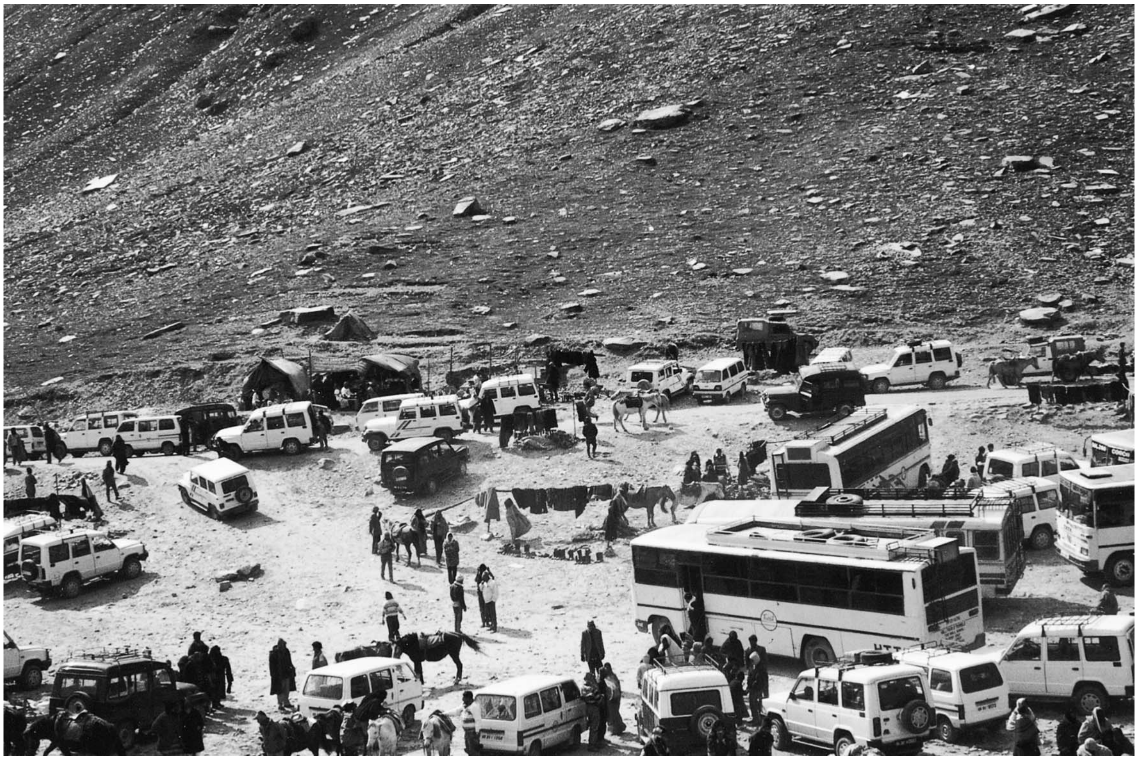


FIGURE 5 Tourists at Rohtang Pass have led to the development of tea stalls and, in the process, the generation of litter throughout the area. (Photo by Victoria Cole)

on waste management, decreasing fossil fuel dependency, protecting forests, promoting ecofriendly tourism, and increasing the environmental awareness of both tourists and residents.

The calculations showed that Manali residents ought to assess whether additional tourist income is substantial enough to warrant the environmental costs. They must also decide whether they are willing to allow tourists, particularly wealthy Indian outsiders and foreign tourists, to continue consuming the lion's share of resources in the Manali area. Spending by a tourist couple of up to double the average annual salary of a local resident is not uncommon in a 4-day trip to the Manali area. Tourist consumption that exceeds the per capita availability of the local resources simply limits or excludes the use of those resources by others, most notably the local Manali residents (Wackernagel et al 1993).

Regional dependency on outside sources of fossil fuels to operate taxis, etc and on arable land and pastureland to feed tourists has increased dramatically. In Manali itself, residents and tourists alike have become increasingly dependent on imported food, energy, housing materials, and other consumption items. Such dependence places the people of Manali in a precarious position because they are relying on resource flows over which they have little control. The region is also very vulnerable to supply disruptions because of the unreliability of the transportation system. Road access to and from Manali, particularly during the monsoon season, is under constant threat (Berkes and Gardner 1997).

Unfortunately, it also appears that the least advantaged individuals in Manali suffer the most from the environmental impacts of overconsumption. Interviews with local residents indicate that the younger generation seems intent on adopting the lifestyles of tourists, but because of the lack of financial resources to do so, many are dropping out of school to start earning an income. One interviewee described a "taxi culture" of young people eager to get a taxi or rickshaw and start making fast money. There are also complaints of young people becoming involved with illicit drugs, mimicking the behavior of tourists.

The EF analysis indicates substantial negative changes to Manali's sustainability, which is useful in providing direction for long-range planning. There were, however, many deficiencies to be overcome and assumptions to be made in carrying out this analysis. The scarcity of reliable regional data meant that the per capita EF of Manali residents had to be calculated using national statistics. It was assumed, therefore, that the consumption patterns of Manali residents were the same as the average for the rest of India. Given the wide disparities across the subcontinent in, among other things, climate, resources, and culture, this assumption is likely inaccurate. Moreover, because Manali residents were assumed to act like average Indians, many of the unique conditions found in the Kullu Valley are not reflected in the results of the footprint calculations, although this was partially compensated for by conducting numerous personal interviews.

The analysis failed, for example, to account for the impact that the large number of hotels and restaurants are having on the region. The number of hotels alone has increased 145-fold in the last 25 years. Local residents and government officials attribute much of the deforestation of the last decade to the illegal felling of trees, which are sold in the "black market" for the construction of hotels and other tourism-related developments. Much of this new hotel development has also occurred on productive agricultural lands and in marginal areas that have been traditionally avoided because of the risk of floods and landslides.

The atmospheric and noise pollution created by autorickshaws, taxis, and buses was likewise not accounted for. A recent study by the G. B. Pant Institute found that during the peak tourist season, there is a sharp increase in suspended particulate matter in Manali, to levels that are up to 18 parts per million greater than the prescribed level of 100 parts per million (Lohumi 1998b). Further, once the tourists have traveled to the most popular destinations, such as Rohtang Pass and Hadimba Temple, there are physically tangible impacts caused by the trampling of fragile native vegetation (Gardner et al 2002).

Personal water consumption was also not accounted for and is on the rise in Manali as the number of tourists multiplies. Many of those interviewed complained that throughout the tourist season there is a shortage of water during certain peak hours, and when it is available it is often "dirty," a condition that was extremely rare before the development of tourism in the area. Individuals also mentioned that the quality of drinking water had degraded to the point where even "Indian tourists get sick drinking it." New studies indicate that the "A" quality water entering Manali degenerates to "B" and "C" quality as it passes through the town (Lohumi 1998b). Moreover, residents expressed concern about the impact of sewage waste from so many hotels because it is piped directly into the Beas River in this headwater region.

The lack of an adequate accounting for solid wastes in Manali's EF is another omission that has serious implications for sustainability. Over the last 25 years, waste has increased substantially in the Manali area and in all of the Kullu Valley. In the early 1970s, wastes consisted primarily of food, much of which was fed to cows and other domestic animals. By 1998 the situation had changed dramatically with enough recyclable garbage in Manali to support 3 scrap-dealing operations. Interviews with local hotel operators indicate that the bulk of the garbage at their hotels consists of wastes that are not readily biodegradable, primarily packaging. Restaurant operators advise that the bulk of their garbage is food, but many of them also pointed to plastic water bottles, most favored by tourists, and papers as forming the remaining refuse. Overall, approximately 3000 kg/d of solid waste are produced in Manali.

The problems encountered in applying EF analysis to Manali and its mountain environment are by no means unique to Manali. Before there can be accurate analyses, there have to be accurate data, and in copious amounts. Production, imports, exports, and embodied energy values are needed for all the consumption items. Many countries do not collect these types of data at the national level. In India the data that were available were often quite unreliable. Regional or town data were even rarer than national data and, again, unreliable. For example, statistics reported in the *Statistical Abstract for Kullu District 1997* indicate a greater amount of forested land in the district than can possibly exist naturally.

Even if the data required for footprint calculations were collected on a regular basis in the Manali area, actually obtaining these statistics would still be difficult. The data used in this report that were collected by the local government were difficult and frustrating to acquire. Government workers were hesitant to give out any information about the country, especially to foreigners, for fear of losing their jobs. These fears are heightened in Manali because of its proximity to Kashmir and the presence of an army base in the nearby village of Palchan. Not even the Kullu town planner has access to a reliable map of Kullu District for "security reasons."

With respect to the study area, though, there is no discounting the general trend, even if quantifying it is extremely difficult. The chaotic, unplanned nature of Manali's development, combined with the speed at which it has occurred, has placed the town in a situation where it now faces serious environmental problems (Berkes and Gardner 1997; Kayastha 1998; Lohumi 1998a; Pandey et al 1998). Pandey et al (1998) have gone so far as to suggest that the "quality and quantity of hotels and guest houses have reduced [Manali] from a tourist destination to an urban slum without adequate water or sewerage facilities."

Local residents are acutely aware of these problems. The following quote captures the sentiment of many of the local residents interviewed: "The only thing that could save Manali is a crash in the tourism industry." Partly in response to local concerns, the High Court passed a complete ban on further tourist development in the Manali area in 2001. After the completion of this study, the results were taken back to Manali and residents were shown the graphs indicating what had occurred in Manali's EF over the study period. On seeing the data, people immediately and instinctively identified some of the things that have occurred in Manali to cause such profound change. This bodes well for any local action that might be taken and indicates the prime benefit of EF analysis—a visual depiction, however generalized, of the changes occurring in the sustainability of a particular area. As the old saying goes, "a picture is worth a thousand words."

AUTHORS

Victoria Cole and John Sinclair
Natural Resources Institute, University of Manitoba, 200 Dysart Road, Winnipeg, MB R3T 2N2, Canada.
vcole@intergroup.ca (V.C.) and jsincla@ms.umanitoba.ca (J.S.)

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