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ANALYSIS

Beyond "more is better": Ecological footprint accounting for tourism and consumption in Val di Merse, Italy

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ABSTRACT

Habits of conservation, consumption and recycling are important determinants of economic throughput. Provincial governments interested in tourism's role in a diverse, steady-state economy may wish to orient tourism development around the tourist segments with less intensive consumption habits. We estimate consumption of energy and materials by tourists vacationing in Val di Merse, a rural region of Tuscany, Italy. We compare tourists and their host population by means of a consumption based indicator, the Ecological Footprint. Conclusions for planning and management are explored. While the average tourist is often thought to consume more on vacation than at home, and often more than local residents, our estimate of the tourist footprint as an equivalent resident (5.28 gha) is similar to that estimated for residents (5.47 gha), excluding arrival transport. In total, the tourist population (685 equivalent residents) in Val di Merse contributes an ecological footprint of 13,500 gha annually, compared to 74,500 gha due to local residents (pop. 13,624). Both levels are lower than the average 6.74 EF estimated for the tourist countries of origin. Arrival transport contributes an additional 32.8 gha per tourist equivalent resident, and accounts for 86% of the total tourism impact. Infrastructure, information provided, and traditional knowledge are discussed as possible ways Provincial governments can maintain or grow tourism flows while maintaining low ecological footprint, and while raising economic turnover relative to material and energy throughput.

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1. Introduction

Ecological economics has drawn special attention to economic throughput which exceeds sustainable scale (Daly, 1991). Many contest the neoclassical growth theory (Ramsey, 1928; Cass, 1965) assertion that utility monotonically increases with consumption and, as a consequence, with monetary wealth. Criticised within ecological economics (Max Neef, 1995; Van den Bergh et al., 2000; Siebenhüner, 2000) and beyond, numerous studies contradict the positive association between wealth and satisfaction (e.g., "happiness studies" by Kahneman et al., 2004; and by Cantril, 1965; Easterlin, 1974; Argyle, 1987; Veenhoven, 1993; as cited by De la Croix, 1998). Yet if neoclassical theory lacks justification of why economic growth should be strictly accelerated, ecological economics while effectively reporting on why it shouldn't (Daly, 1996; Jacobs and Ropke, 1999; Jacobs, 1991; Myers, 1997; Norgaard, 1994; Redclift, 1996), has possibly found redesigning the process of needs-satisfaction to be a daunting overhaul (Jackson, 2002).

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Changes in consumer behaviour has increased material throughput through the world economy (Jackson and Marks, 1999; Fine and Leopold, 1993; Goodwin et al., 1997; Rosenblatt, 1999) at increasing rates (Douglas and Isherwood, 1980). The problems presented by excessive throughput are especially relevant to tourism, considering shared trends of tourism, consumption and globalization (Britton, 1982; Shaw and Williams, 1994; Mowforth and Munt, 1998; as cited by Hughes, 2002; Gössling, 2002; Gössling et al., 2002). Social science in particular has focused on the impacts of tourism on consumption in the host community. Studies of the "demonstration effect" suggest that in some host populations, local fashions and consumption patterns follow those demonstrated by the norms of visiting cultures (Cole and Sinclair, 2002; McElroy and de Albuquerque, 1986).

Tourism is the world's largest industry, and as a globally pervasive, rapidly growing phenomenon–consumption trends in this sector exert a notable pressure on almost all areas of the planet (Gössling, 2002). Hunter (2002) notes: "global capitalism and its disposition tend to expand, rather than moderate tourist consumption." Luxurious holiday images often suggest that abundance, material fulfillment of desires, even excess are primary motivators for tourists. Tourists are often thought to consume more on vacation than they would at home and more than the (per capita) host community (Cole and Sinclair, 2002; Akama, 1999). However, little quantitative attention has been given to tourist destinations thought to be of a quiescent, less-consumptive nature.

1.1. *Market segments and tourism impact management*

"Travel styles" have been found useful to the identification and management of type-specific demands and resulting destination impacts (Becken and Gnoth, 2004). Tourist preference for a particular travel style can be in part explained by country of origin, socio-political differences, geographical distance from the destination, cultural values, length of statutory holidays (ibid). Whether tourist choices (and thus the resultant impacts of those choices) are due to the tourists' preference, or the constraints and incentives they face upon arrival, is difficult to discern (Becken et al., 2003). However, studies of a particular tourist segment can reveal information useful in marketing efforts, prediction/management of tourist impact and efforts to increase the eco-efficiency of destinations (Kelly et al., in press; Becken and Gnoth, 2004). Rural tourism market segments are less well understood than other forms (Kastenholz et al., 1999). Similarly, the Tuscan market segments of coastal, mountain, spa and urban tourism are better understood than the rural segments of which 80% are oriented around home stays or agrotourism (APT, 2000).

Developing a sustainable tourism requires specific targets and planning, which may include modification or control of tourist activities offered, or quantitative guidelines within which to define upper bounds for visitation levels (Ashforth, 1992). While civil statistics of energy, material, resource use, infrastructure and waste production are common tools for municipal planning, local governments lack estimations of the relative contribution of tourist activity to civic totals. Planning, investment and marketing to a particular tourist segment (i.e., "ecotourists", or "agrotourists") is less likely to have the desired environmental benefit when quantified information about the impact of those market segments isn't available. This paper applies the ecological footprint methodology to the task of benchmarking consumption and waste production for residents and tourists in a manner that allows for easy incorporation into municipal planning efforts.

2. Ecological footprint and tourism

The Ecological Footprint (EF) method is a tool of increasing prominence among sustainability indicators (Wackernagel

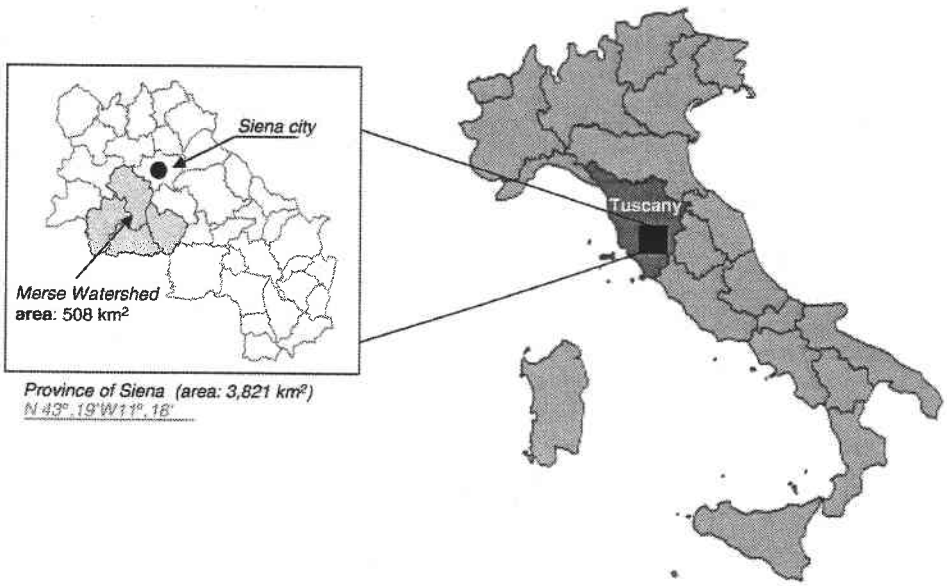

Fig. 1 – A map of Val di Merse.

and Rees, 1995; Wackernagel et al., 1999; Monfreda et al., 2004; Rees and Ecological Economics, 2000). EF reports, in an aggregate estimate, on the quantity of productive land necessary to support per capita rates of consumption and waste generation of a population. While the methodology requires simplifying assumptions (Troell et al., 2002) and can be difficult to standardize and compare among studies (Footprint Forum, 2006), EF applications in the literature are growing in number and diversity of application. In sustainable tourism assessment this consumption based method is cited as a key environmental indicator (Hunter and Shaw, 2007), with several pioneering works extending its application (Gössling et al., 2002; Bagliani et al., 2004; Cole and Sinclair, 2002; Hunter, 2002; Peeters and Schouten, 2006).

Recent efforts have been made to standardize the application of the ecological footprint, thereby increasing the practicality of cross-case and cross-scale comparison, and individuation of economic sectors (Footprint Forum, 2006). Most efforts have focused on a given residential population over a finite extent of time, however tourism activity is often excluded because leisure travel of those residents occurs outside the bounds of the study area. This study reports on a detailed accounting assessment designed to allow the ecological footprint of area tourism to be accounted within a civil footprint accounting framework.

Tourism certification entities (Synergy and WWF, 2000; Best Foot Forward and WWF-UK, 2002) and researchers (Gössling et al., 2002, 2005; Peeters and Schouten, 2006) have performed ecological footprint analysis for tourists. Cole and Sinclair (2002) documented the increase in EF of a tourist destination over a 20-year period. EFA efforts for tourism destinations, often complicated by a lack of available statistics, may derive consumption estimates from other sites or models. The resulting variation in aggregation among impact categories, may inhibit straightforward comparison among studies. Conversion and equivalence factors are updated frequently (WWF, 2002, 2004) and can also affect the comparability among EF estimates. For the above reasons, comparisons among EF studies should be made only with attention to detail of EF calculation methods and documentation. This paper presents an articulated approach to ecological footprint accounting for tourism, and provides the means for comparison with future studies of similar format.

3. Site description

3.1. *The Val di Merse area*

Located in the West of the Province of Siena (3821 km^2, population 250,000), Tuscany Region of Italy, four municipalities (Sovicille, Chiusdino, Monticiano, and Murlo) form the forested and agrarian watershed (508 km^2, population 13,624) known as Val di Merse (Fig. 1). As part of a UNESCO Cultural Heritage site certification plan, an Agenda 21 report drew attention to three of Siena's challenges: congestion in the province's historical center, a lack of rural employment opportunities, and inefficient resource use (Tiezzi et al., 2002).

Tourism arrivals to the Province have grown over 150% in the past 10 years, with most tourists motivated by artistic attractions (54%) and thermal spas (29%) (APT, 2000). With over 70% of tourist visitation concentrating in the historical center of the Province, only 50 km away the Val di Merse (13% of the Provincial land area) attracts only 3.5% of provincial visitors. Val di Merse is 'off the beaten path', in that its location is not listed in the majority of sources tourists use to plan their travels. Business travelers or day tourists are infrequent. The tourism market segment which travels to Val di Merse is characterized by "alternative tourism" (e.g., nature, ecotourism, agrotourism[1], distinct from mass tourism), and is motivated primarily by desires to experience nature, relaxation, gastronomy and local cultural activities (APT, 2000). This area was proposed as an area to disperse tourism from the historical center—over space and time; yet provincial officials have lacked a quantified means to assess whether the environmental commitments of Agenda 21 would be met. Environmental benchmarking efforts, such as an ecological footprint analysis, can be used to monitor progress toward these goals.

4. Methods

4.1. *Use of the ecological footprint*

EFA accounts for energy (including for transport), raw materials, water, foodstuff use, wastes production (including carbon dioxide from fossil fuels) and the loss of productive land associated with buildings, roads and other aspects of the built environment. Six types of ecologically productive areas which provide resources and waste assimilation: fossil energy land, cropland, grazing land, forests, built-up land and fishing ground. The productivity differences among land uses and between local and global productivity within a given land-use category were considered via use of equivalence and yield factors respectively (WWF, 2002; Wackernagel et al., 2002; Monfreda et al., 2004). The results were weighted ecological surfaces stated in "global hectares" (termed as gha[2]) rather than simple hectares (which refer to actual surface area).

The ecological footprint is an accounting model of resource consumption and waste production, and relies on comprehensive and reliable data sources available at the relevant scale. Typical data sources are official and civil estimates, which rarely provide information about the margin of error of the data. In the absence of this information, confidence intervals for the ecological footprint cannot be quantified (see Monfreda et al., 2004; Wackernagel and Rees, 1995). The power of EF common denomination and insights increases with direct data collection, and the transparency of the ecological footprint model being used. The various methods, equivalence and conversion factors used in EF studies, though routinely peer-reviewed (WWF, 2002) and updated (Footprint Forum, 2006) increase the difficulty of comparison among

[1] Agrotourism is defined by its rural agriculture nature. In Italy at least half of the agrotourism structure's revenue must come from agricultural sources, and products must be served to tourists along with typical dishes of the region.

[2] The gha unit in ecological footprint methodology represents standardized average productive hectares with the potential to produce usable biomass equal to the world's potential average of that year.

studies. Details of our accounting method, equivalence and conversion factors, are described in this section.

To assess the annual Ecological Footprint of the entire (resident plus tourist) population, we estimated the average number of tourist individuals (equivalent residents) present on in the area using bed-nights divided by days in a year. The "equivalent residents" represent an additional percentage over the registered population, who consume resources, create waste, and have not received formalized attention in civil planning efforts. Equivalent residents are considered in terms of annual average, but cannot account for impacts (e.g., strains on power infrastructure) or efficiencies (e.g., a full flight reduces impact per passenger) due to seasonal peaks in visitation.

EF categories for consumption were divided according to available data. Tourist or "equivalent resident" consumption was divided into arrival transport; local transport; accommodation (including land, energy, water, and heating fuel use); food and fiber consumption; waste production; and activities (e.g., entertainment activities and souvenir products). The resident EF followed standard consumption categories: food and fiber consumption; housing; local transport; civil services; other consumed goods and waste production. Consumption statistics of each of the four municipalities were weighted by municipal population in order to reach average per capita consumption for the Valley (Tiezzi et al., 2002; Bagliani et al., 2003).

4.2. *Data collection*

Data for resident ecological footprints were derived from civil assessment sources. Land cover data from CORINE (Amministrazione Provinciale di Siena, 1996), data for resident food consumption (ISTAT, 1999), electricity (GRTN, 2000; PEP, 2002), heating oil and resident automobile fuel (DGERM, 1999; Tiezzi et al., 2002), waste (Sienambiente, 2002), water (Acquedotto del Fiora, 2001), and consumer prices (Tiezzi et al., 2002), were cited as close as possible to reference year 2003.

To estimate consumption by tourist "equivalent residents", 220 tourists and 20 lodging providers were interviewed at the gateway site of the Merse valley, Abbadia of San Galgano (Chiusdino), June through August of 2003 (Patterson, 2005). Respondents declared their country of origin as Italy (62), France (42), Netherlands (31), Germany (20), Great Britain (16), Sweden (11), United States (9), Belgium (9), Denmark (8), Other (5), Norway (4), Austria (2) and Canada (1). The average respondent was 46 years of age, married with one child, traveling in a group of 3. Interviews were conducted in Italian, Spanish, English and French. Queries established age, country of origin, group size, mode of arrival transport, daily travel distance, accommodation site, daily meal provision (bag lunch, bar or restaurant) and purchases. Tourists were presented a map and list of activities and asked to identify day-trip destinations and activities by day. Data on energy, water use and waste production were estimated by lodging providers within 15 km of the site, and assigned a percentage of Provincial assessment data (CST, 2004).

4.3. *Arrival transport*

Data for arrivals to the Val di Merse were collected from CST (2004). Three principal modes of transport were used: car, train or coach and air. For flights, the shortest circular distance was calculated roundtrip from the capital city of the country of origin to Pisa, the airport most typically used for arrival to Val di Merse. Airline fuel usage/emissions were determined via use of an online emissions calculator, using assumptions of round-trip economy class ticket for a Jumbo 747 with 80% occupancy (Chooseclimate, 2005). The total airline distance traveled was multiplied by a 2.7 CO_2 conversion factor to account for additional radiative forcing resulting from either airline emissions at altitude (Wackernagel et al., 2002; IPCC, 1999), a standard modification (Gössling et al., 2002; Peeters and Schouten, 2006). Conversion factors for car, train/coach, long haul (>2000 km) flight and short haul (<2000 km) are reported in Table 1. For all non-automobile arrivals, 300 km of roundtrip automobile travel per arrival were added to account for the distance from Pisa to Val di Merse. Additional ground transport within Val di Merse is considered within the category *local transport*.

4.4. *Food and fiber consumption*

Tourists to Val di Merse typically eat in the Tuscan style, and attend local food festivals (APT, 2000; Patterson, 2005). While some studies (Gössling et al., 2002) have associated tourists' food consumption with the food EF of their countries of origin, given the prominence of Tuscan foods, we based our food EF on an Italian diet. EF factors for energy of restaurant and bar use modified according to tourist interview responses. Resident estimates for the typical diet of central Italy, based on data of National Statistic Yearbook (ISTAT, 1999) were applied to an EF formulation (Bagliani et al., 2003) updated with 2002 conversion factors.

4.5. *Accommodation, land use, utilities and waste*

Tourist accommodation refers to the built-up area required for rooms, apartments, activities, roads and the energy land to account for energy use (electricity, heating gas), water consumption and waste production. 20% of lodging facilities in Val di Merse are categorized as hotel, with the remainder categorized as forms of home stays or agrotourism (APT, 2000). Estimates informing the EF for accommodation estimates were based on responses from 20 lodging providers within 15 km of the interview site. Data for land use was analyzed via CORINE land cover analysis (Amministrazione Provinciale di Siena, 1996) of tourist structures. Prior studies have based accommodation EF estimates on a graduated "star" hotel

Table 1 – Conversion factors for transport mode

	Conversion factor ha/year per 1000 km/person	Radiative forcing factor	Occupancy assumption
Car	0.06		2.5 persons
Train or coach	0.03		–
Air			
Long haul (>2000 km)	0.09	2.7	80%
Short haul (<2000 km)	0.06	2.7	70%

Table 2 – Tourist equivalent residents in Val di Merse, by country of origin

Country of origin	Number of arrivals	Percent of total	Bed nights	Equivalent Residents
Italy	14,716	31	45,151	124
Germany	10,467	22	75,044	206
United Kingdom	5231	11	27,146	74
Netherlands	4666	10	34,130	94
United States	2226	5	12,838	35
Other European	8065	17	50,216	138
Rest of the world	1420	3	25,515	15
Total	46,791	100	250,113	685

Source: CST, 2004.

system (Gössling et al., 2002), or on model estimates/data transfer and may include EF for meals (Peeters and Schouten, 2006).

4.6. *Local transport*

Our EF for local travel consists of two values: fuel usage and rental car. Local travel is the principal entertainment in Val di Merse (e.g., visiting local villages or rural attractions). Respondents were presented a map to indicate itineraries and driving distance, information which was compared against responses from car rental companies, the result informed fuel estimates. EF for rental car was estimated from spending values which included minimum insurance and was converted to EF equivalent hectares using household auto values (1.35 gha equivalence factor) as estimated by Chambers et al. (2001).

4.7. *Activity*

Energy and materials for entertainment and souvenir purchases have been cited as an important contributor to tourism impact (Becken and Simmons, 2002; Peeters and Schouten, 2006). We assigned energy values from the literature to activity categories for museum visits 10 mJ/tourist (60% electric, 40% gas), farm visits 7 mJ/tourist (70% electric, 25% petrol, 5% gas), tourist shopping 0.8 mJ/tourist (60% electric, 40% gas), and horseriding: 0.6 mJ/tourist (15% electric, 80% petrol, 5% gas) (Becken and Simmons, 2002). Conversion factors assigned to electricity, petrol and gas were 0.05, 0.016 and 0.011 ha/GJ respectively. Interview responses documented types of typical products[3] purchased (Patterson, 2005), and generalized tourist expenditure data informed our quantity estimates (APT, 2000). EF values were then assigned according to equivalence factors for the products (Tiezzi et al., 2002).

[3] A *typical product* is produced in a regulated manner in accordance with how it is typically produced in a given region. This is in contrast to a *traditional product* must be produced according to artesianal standards which have historical precedent.

5. Results

Tourists in Val di Merse have a high average length of stay (5.3 days) with respect to other Italian destinations, sourcing their day-visits from a single place of lodging (CST, 2004). With a total of 250,115 bednights, we estimate 685 "equivalent residents" for the Val di Merse, which represents an additional 5% over the registered population (Table 2). Beyond the use in ecological footprint accounting, this data is of use to civic planners, in estimating resource consumption, waste production and urban development consideration.

We estimated the EF for the tourist equivalent resident population to be 5.28 gha/year per capita, for a total of 3617 gha/year for all 685 tourist equivalent residents. This compares to 5.47 gha/year/capita for the resident population of 13,624, for a total of 74,523 gha/year (Fig. 2). This result cannot be directly and reliably compared with the EF results from other studies of tourist EF without background information on calculation model, data collection methods, equivalence and conversion factors, and impact category aggregations. However, EF figures and estimates of tourist equivalent resident populations are presented for summary purposes (Table 3).

5.1. *Arrival transport*

This category refers to the total roundtrip distance of visitors to Val di Merse. The EF for arrival transport Val di Merse totaled 0.48 gha per arrival, which translates to 32.8 gha per equivalent resident (or 86% of the total impact) (Fig. 3). This confirms air travel as the largest impact category, a conclusion also drawn by Gössling et al. (2002), Gössling et al. (2005), Hunter (2002), Peeters and Schouten (2006). Most visitors to Val di Merse originate in Italy (31%), followed by Germany (22%), Great Britain (11%), the Netherlands (10%) and the United States (5%). The remaining 20% come from other European countries (17%) with only a 3% traveling from other areas of the world (CST, 2004) (Table 2). Italian tourists traveled on average 780 km with 83%, 17%, and <1% arrived by car, bus/train, and air, respectively (APT, 2000). Of the foreign visitors, 34% of foreign tourists arrived to Italy by air travel, traveling an average estimated distance of 7315 km, emitting 2.6 tons of carbon dioxide per trip, and accounting for 1.86 gha per arrival. Of the remaining

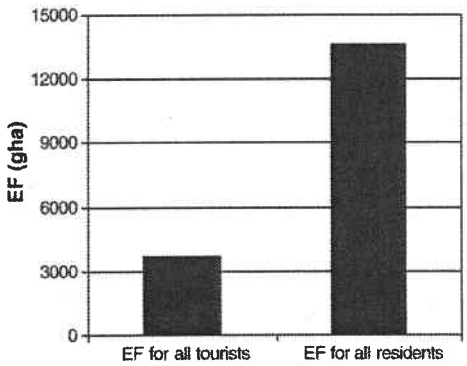

Fig. 2 – Total annual EF contribution of all tourist equivalent residents and residents, in gha. Arrival transport is excluded.

Table 3 – Study summary of host population, tourist arrivals, length of stay, tourist equivalent resident population, EFs, and % impact attributed to arrival transport, by study

Study citation and site	Resident population	EF per resident	Total tourist arrivals (data year)	Average length of stay	Tourist equivalent resident population	EF per equivalent resident (arrival transport excluded)	Impact attributed to tourist arrival transport
		Gha/capita/year		Days		Gha/capita/year	%
Cole and Sinclair, 2002 Himal Pradesh, India	2609	1.30	382,569 (1995)	3	3144	3.07	n/a
Gössling et al., 2002 Seychelles	n/a	n/a	117,690 (2000)	10.4	3353	5.70	91%
Peeters and Schouten, 2006 Amsterdam	n/a	n/a	8,038,800 (2001)	3.7	81,489	4.77	70%
Patterson et al., (this study) Tuscany	13,624	5.47	46,791 (2003)	5.3	685	5.28	86%

66% of foreign visitors not arriving by air, 50% arrive by car, 16% by bus or train travel to Central Siena. The average distance traveled by car was estimated at 2480 km accounting for 0.08 gha per arrival, or 1278 gha total. Of those traveling by train, the average distance was also estimated at 2480 for 0.10 gha per arrival and 532 gha total for all arrivals.

5.2. *Lodging*

Accommodation accounts for 3% of our tourist EF, or 1.05 gha/year per tourist equivalent resident. This compares to 0.69 gha/year/capita estimated for local residents. 84% of respondents lodged within the Val di Merse (of which 74% were in agrotourism structures and 26% in rented apartments). No responses indicated friends or hotel as their place of lodging. Of the 16% of tourists that lodged outside the Val di Merse: 54% lodged in agrotourism structures, while 20% lodged in a hotel, 17% lodged in rented apartments, 9% with friends. Total hectares of urbanized land were assessed from CORINE landcover to be 269 ha, or 0.019 ha per resident/equivalent resident. Per capita consumption of electricity (GRTN, 2000), municipal water (Acquedotto del Fiora, 2001) and production of waste were estimated by lodging providers to be similar to resident household estimates. Home stay and agrotourism structures often collect linens on a weekly, rather than daily basis, and many forms of energy conservation were reported, such as pay-per-unit heating.

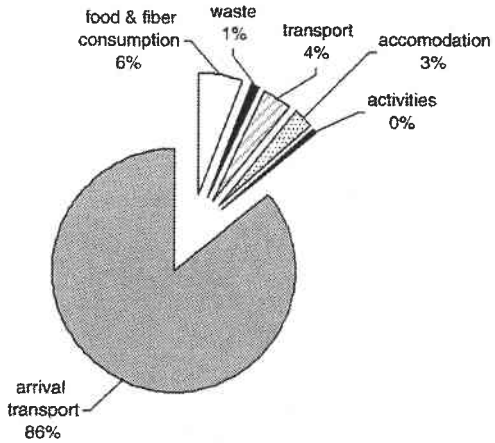

Fig. 3 – Study summary of host population, tourist arrivals, length of stay, tourist equivalent resident population, EFs, and % impact attributed to arrival transport. As methods varied (see section 2), comparison should not be made between studies.

5.3. *Waste*

Waste EF totaled 1% of the total tourist footprint, or .045 gha/year per tourist equivalent resident. While tourists are typically estimated to produce less daily waste than residents, with high waste production on checkout day (Rhyner et al., 1995), local models of waste production have not determined that Siena's tourists produce waste in different quantities than residents (Gambassi, 2003). We estimated proportional responsibility for the total 5908 tons of waste per year for the Val di Merse area (ibid).

5.4. *Food and fiber*

Food and fiber consumption contributed 6% to the total tourist equivalent resident EF, or 2.22 gha/year/capita. This is slightly

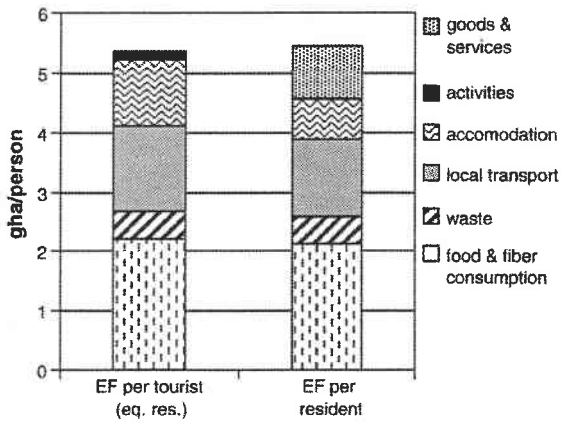

Fig. 4 – Annual EF tourist (equivalent resident) and EF for resident, arrival transport is excluded.

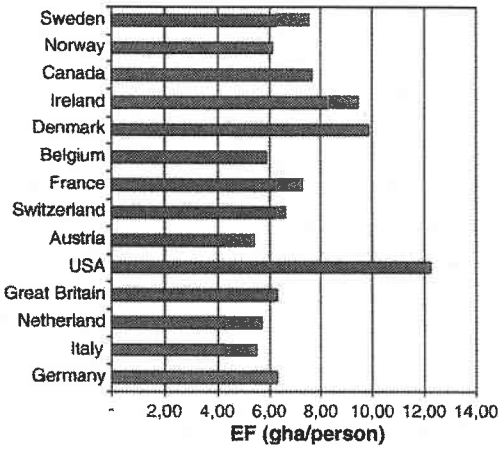

Fig. 5 – National rankings of ecological footprint, by country (WWF, 2000).

higher than the 2.13 gha/year/capita estimated for resident EF accounts. The difference can be explained by the high use of restaurant structures by tourists. Tourists responded that they ate "out" twice as often as reported in resident estimates (APT, 2000; ISTAT, 1999; Patterson, 2005). Breakfasts were most frequently reported at the place of lodging (83%) with the remainder at a "cafe". Lunch was nearly evenly distributed between "cafe" (36%) "restaurant" (25%), and "bag lunch" (39%). Dinner was taken more commonly at "restaurant" (74%) than "place of lodging" (26%). Thus conversion factors for restaurant and bar use were doubled for equivalent residents to reflect these responses.

5.5. *Local transport*

Activity was not an assessment category for local residents. The ecological footprint for tourist equivalent residents was estimated to be 1.57 gha/year (or 4%) of the total, of which nearly all was due to EF assigned for energy use (0.46 gha/year for local transport, 0.12 gha/year for activity and souvenir shopping, and 0.99 gha/year for car rental). Reported average daily travel distance for tourists was 75 km/day, although interviews with car rental companies and responses to other queries suggested that 100 km/day was more realistic as a conservative estimate. Conversion coefficients for car travel (Chambers et al., 2001) were weighted by 2.5 to reflect the respondent's average car load (Patterson, 2005). Souvenir purchases were weighted in the EF according to average daily spending data of 6.0 euro/day for food items and 7.0 euro/day for traditional artesian products. EFs were then assigned weights according to an equal division among wine, olive oil, cheese, and meat products for the food items and an average goods and services EF value to account for the artesian products. EF accounted for souvenir products was negligible.

Excluding arrival transport, the EF of a tourist equivalent resident is only slightly higher than that of local residents 5.28 gha/year as compared to 5.47 gha/year (Fig. 4). Differences between impact categories may be an artifact of accounting. For example, activity was not assessed for local residents, while similar entertainment consumption registers in the local resident's goods and services category. Meanwhile civic goods and services (e.g., government infrastructure such as street lighting etc.) benefit both residents and tourists, but is attributed only to local residents. Fig. 5 illustrates the average EF inhabitants of the tourist country of origin. A weighted EF for a tourist equivalent resident who maintained home country consumption habits abroad would register on the Ecological Footprint index at 6.74 gha/year.

6. Discussion

Understanding of tourist segments has been under-utilized in predicting, managing, and positively influencing the trajectory of tourism development. Numerous approaches can be taken to reduce tourism impacts at the destinations, and incorporate this "invisible population" into civil planning efforts. Transportation options, solid waste management, renewable energy options, recreation management, green-space protection options and local product development are all options to reduce energy and material throughput while maintaining the positive utility tourists receive on their visit (Kelly et al., in press).

Tourism is generally viewed as a highly consumptive industry with a substantial share of destinations operating at less desirable eco-efficiency values than the global average (Gössling et al., 2005). This is also the case for the Val di Merse when international arrival travel is included in the calculation. The tourism market segment to Val di Merse is oriented around agrotourism, low-energy intensive activity, and locally grown and organic agricultural products. The tourist equivalent resident EF for the agrotourism market segment may be compared against other market segments to verify environmental gains of orienting tourist offerings around this market segment. Opportunities to compare our EF calculations against tourist EFs in the literature are somewhat limited, due to differences in method, impact category inclusion/aggregation, and available information.

The ecological footprint, as an environmental indicator, has advanced conceptually as well as methodologically from its early applications. Challenges for the future are to make commonplace the standards formulated by the ecological footprint network, to assure quality and transferability of results for comparison among and within studies. Sector-specific examination can lend clarity for those sectors which include mobility beyond the bounds of the study area; for material, energy, or even people as is the case with tourism. Another challenge for future research involving the ecological footprinting will be the scalability of results. Transparent accounting and use of an agreed-upon format can help to bring this about.

This study collected data directly from tourists, which revealed more detailed data on tourist behavior than what could have been achieved by assigning an arbitrary percentage of energy, material, or waste values. The accounting framework was structured in a way to allow ecological footprint estimation in comparison with that of local residents. Civic planning efforts can use this information to predict more accurately the needs of the tourist and resident populations. In this case, from an ecological footprint perspective,

assuming seasonal impacts are negligible, increasing the tourist population in the future may have physical impacts similar to increasing a resident population.

Tuscany's environment and infrastructure may moderate tourist demand for energy and resources, regardless of tourist inclinations. Tuscany's climate is known for its ambient temperatures, and thus requiring less temperature control energy than those with climatic extremes. Built infrastructure moderates tourist energy demand, as traditional architecture in Val di Merse consists of stone houses with thick walls and small windows. Traditional knowledge is part of the agrotourism experience and daily home economy governs habits, for example, diurnal opening and closing of window covers. Meanwhile, local, traditional, and organic agriculture products form a key attraction to the Tuscan table—and few other meal alternatives exist. Lastly, information supplied to tourists may play a part in moderating their demand, for example, feedback in the form of a pay-per-unit of heating and electric gauges. The Province of Siena has made a targeted effort to increase itineraries, structures, and signage for activities which are of low energy and environmental impact such as walking, biking, agricultural tours and horseback riding.

The market segment attracted to rural Tuscany may be less inclined toward material consumption and waste production, may appreciate activities of a quiescent nature, and may value locally produced organic agriculture souvenirs. However, nearly all of the overnight tourists to Val di Merse use an automobile within the valley, traveling around 100 km a day. Arrival transport creates an environmental impact not often accounted when one conjures images of agrotourism and the marketing of its conceptual links to environmental quality and sustainable lifestyle.

7. Conclusion

Planning and targets for specific activities are important to sites, towns or regions in developing a sustainable tourism. The ecological footprint provides a framework for assessment of civil and industry capacity for tourism growth, and a benchmark against which to set goals for the future impact of tourism in the host community. Quantified information can provide a host community a tool against which to weigh decisions such as modification/control of tourist activities offered, or limits to visitation levels.

Cole and Sinclair (2002) documented a Himalayan case in which tourist and resident EF suggested very different consumption patterns, suggesting that tourist EF was having a disproportionate impact on the destination's total environmental pressure. In contrast, our study documents Val di Merse tourist equivalent resident and local resident EF are of similar levels, with both levels lower than the weighted average EF from tourist country of origin. This finding, and the use of the tourist equivalent resident approach can be of use for local planning efforts. Municipal planners may seek to anticipate civil needs for water, energy, and waste for the growing tourism population to Val di Merse. The EF figures can also be used as a benchmark against which to measure tourism sector progress against the Agenda 21 goals endorsed by the Province.

Economic throughput and consumption are important topics to ecological economic study. The study of tourists and residents, side-by-side, allows us a test case against which to compare theories of cultures of consumption (Urry, 1990). These unique circumstances allow us to explore of culturally determined "wants" versus universal "needs". Max-Neef (1991) in attempting to re-characterize fundamental human needs stressed the importance of "distinguishing between needs and satisfiers" the former which are universal and finite, the latter which vary widely and are potentially infinite in time and across cultures.

There is perhaps an infinite number of ways by which we might pursue satisfaction through the consumption of goods. And there are a precious few occasions, environments, and situations which encourage us to slow down, consume less, and control wastes. Should we be fortunate enough to find ourselves in such situations, may we be mindful of what is inspiring us in that moment, and may we apply that knowledge as we redesign our theories of how a steady-state economy may come to pass. The use of environmental indicators such as the ecological footprint can assist in confirming or rejecting the assumptions we make of environmental impact, provide common denomination for comparisons among populations, and help to establish benchmarks against which to improve.

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REFERENCES

Acquedotto del Fiora, 2001. Water Consumption. Personal Communication, Siena, Italy.

Akama, J.S., 1999. Marginalization of the Maasai in Kenya. Annals of Tourism Research 26 (3), 716–718.

Amministrazione Provinciale di Siena, 1996. Land Use by Corine Land Cover, Siena, Italy.

APT, 2000. Azienda di Promozione Turistica. Economia e Marketing del Turismo per il Territorio della APT di Siena. Mercury SRL, Florence, Italy.

Argyle, M., 1987. The Psychology of Happiness. Methuen, London.

Ashforth, G.J., 1992. Planning for Sustainable Tourism. Town Planning Review 63 (3), 325–330.

Bagliani, M., Contu, S., Coscia, I., Tiezzi, E., 2003. The evaluation of the Ecological Footprint of the Province of Siena (Italy). In: Tiezzi, E., Brebbia, C.A., Usó, J.L. (Eds.), Ecosystems and Sustainable Development. WIT Press, Southampton, pp. 387–396.

Bagliani, M., Da Villa, E., Gattolin, M., Niccolucci, V., Patterson, T., Tiezzi, E., 2004. The ecological footprint analysis for the province of Venice and the relevance of tourism. In: Marchettini, N., Brebbia, C.A., Tiezzi, E., Wadhwa, L.C. (Eds.), The Sustainable City III. WIT Press, Southampton, pp. 123–131.

Becken, S., Gnoth, J., 2004. Tourist consumption systems among overseas visitors: reporting on American, German, and Australian visitors to New Zealand. Tourism Management 25, 375–385.

Becken, S., Simmons, D.G., 2002. Understanding energy consumption patterns of tourist attractions and activities in New Zealand. Tourism Management 23, 343–354.
Becken, S., Simmons, D., Frampton, C., 2003. Segmenting tourists by their travel pattern for insights into achieving energy efficiency. Journal of Travel Research 42 (1), 48–56.
Best Foot Forward, WWF-UK, 2002. Holiday footprinting—A Practical Tool for Responsible Tourism. Downloaded from: http://www.wwf.org.uk/filelibrary/pdf/holidayfootprintingfull.pdf.
Britton, S., 1982. The political economy of tourism in the third world. Annals of Tourism Research 9, 331–358.
Cantril, H., 1965. The Pattern of Human Concerns. Rutgers University Press, New Brunswick.
Cass, D., 1965. Optimum growth in an aggregative model of capital accumulation. Review of Economic Studies 32, 233–240.
Chambers, N., Simmons, C., Wackernagel, M., 2001. Sharing Nature's Interest, Ecological Footprints as an Indicator of Sustainability. Earthscan, London.
Chooseclimate, 2005. http://www.chooseclimate.org/flying/mapcalc.html%20downloaded%2012/04.
Cole, V., Sinclair, A.J., 2002. Measuring the Ecological Footprint of a Himalayan Tourist Center. Mountain Research and Development 22 (2), 132–141.
CST, 2004. Centro Studi Turistici. Statistical Reports from the Osservatorio Economico Provincia di Siena. Downloaded from http://osservatorioeconomico.provincia.siena.it.
Daly, H.E., 1991. Steady-State Economics, Second Edition. Island Press, New York.
Daly, H.E., 1996. Beyond Growth: The Economics of Sustainable Development. Beacon Press, Boston. 253 pp.
De la Croix, D., 1998. Growth and the relativity of satisfaction. Mathematical Social Sciences 36 (2), 105–125.
DGERM, 1999. Direzione Generale dell'Energia e delle Risorse Minerarie. Combustibles Consumption: Time Series. Web site: http://dgerm.attivitaproduttive.gov.it/dgerm.
Douglas, M., Isherwood, B., 1980. The World of Goods. Towards an Anthropology of Consumption. Penguin Books, London.
Easterlin, R., 1974. Does economic growth improve the human lot? Some empirical evidence. In: P.D., Reder, M. (Eds.), Nations and Households in Economic Growth. Academic Press.
Fine, B., Leopold, E., 1993. The World of Consumption. Routledge, London.
Footprint Forum, 2006. Footprint Forum: Learn, Share and Connect. A Meeting of the Global Footprint Network. Siena (Italy), June 14–17.
Gambassi, R., 2003. Personal Communication. Consulent of Province of Siena, Siena Italy.
Goodwin, N., Ackerman, F., Kiron, D. (Eds.), 1997. The Consumer Society. Island Press, Washington, DC.
Gössling, S., 2002. Global environmental consequences of tourism. Global Environmental Change 12 (4), 283–302.
Gössling, S., Borgstrom Hansson, C., Horstmeier, O., Saggel, S., 2002. Ecological footprint analysis as a tool to assess tourism sustainability. Ecological Economics 43 (2–3), 199–211.
Gössling, S., Peeters, P., Ceron, J., Dubois, G., Patterson, T.M., Richardson, R., 2005. The eco-efficiency of tourism. Ecological Economics 54 (4), 417–434.
GRTN, 2000. Gestore della rete di Trasmissione Nazionale. Electricity Consumption: Time Series. Downloaded from: http://www.grtn.it/ita/statistiche/datistatistici.asp.
Hughes, G., 2002. Environmental indicators. Annals of Tourism Research 29 (2), 457–477.
Hunter, C., 2002. Sustainable tourism and the tourist ecological footprint. Environment, Development and Sustainability 4, 7–20.
Hunter, C., Shaw, J., 2007. The ecological footprint as a key indicator of sustainable tourism. Tourism Management 28, 46–57.
IPCC, 1999. Aviation and the Global Atmosphere. International Panel on Climate Change. Cambridge U. Press, Cambridge.
ISTAT, 1999. Istituto Nazionale di Statistica. I Consumi delle Famiglie, Anno 1999. Downloaded from: http://www.istat.it.
Jackson, T., 2002. Evolutionary psychology in ecological economics: consilience, consumption and contentment. Ecological Economics 41, 289–303.
Jackson, T., Marks, N., 1999. Consumption, sustainable welfare and human needs—with reference to UK expenditure patterns 1954–1994. Ecological Economics 28, 421–442.
Jacobs, M., 1991. The Green Economy. Pluto Press, London.
Jacobs, M., Ropke, I., 1999. Special issue on: consumption and environment. Perspective from ecological economics. Ecological Economics 28 (3), 363–364.
Kahneman, D., Krueger, A.B., Schkade, D.A., Schwarz, N., Stone, A.A., 2004. A survey method for characterizing daily life experience: the day reconstruction method. Science 306, 1776–1780.
Kastenholz, E., Davis, D., Paul, G., 1999. Segmenting tourism in rural areas: the case of North and Central Portugual. Journal of Travel Research 37 (4), 353–363.
Kelly, J., Haider, W., Williams P., Englund, K., 2006. Stated preferences of tourists for eco-efficient destination planning options. Tourism Management.
Max-Neef, M., 1991. Human-Scale Development: Conception, Application and Further Reflection. Apex Press, London.
Max Neef, M., 1995. Economic growth and quality of life: a threshold hypothesis. Ecological Economics 15 (2), 115–118.
McElroy, J.L., de Albuquerque, K., 1986. The tourism demonstration effect in the Caribbean. Journal of Travel Research 25 (2), 31–34.
Monfreda, C., Wackernagel, M., Deumling, D., 2004. Establishing national natural capital accounts based on detailed ecological footprint and biological capacity assessments. Land Use Policy 21, 231–246.
Mowforth, M., Munt, I., 1998. Tourism and Sustainability: New Tourism in the Third World. Routledge, London.
Myers, N., 1997. Consumption: challenge to sustainable development. Science 276, 53–57.
Norgaard, R., 1994. Development Betrayed: The End of Progress and a Coevolutionary Revisioning of the Future. Routledge, London.
Patterson, T.M., 2005. The ecological economics of sustainable tourism; differences between local and global ecological footprints of tourism in Tuscany, Italy. PhD Dissertation, Department of Marine Estuarine and Environmental Studies, University of Maryland, College Park.
Peeters, P., Schouten, F., 2006. Reducing the ecological footprint of inbound tourism and transport to Amsterdam. Journal of Sustainable Tourism 14 (2), 157–171.
PEP, 2002. Piano Energetico Provinciale Report. Electricity consumption. Amministrazione Provinciale di Siena, Siena, Italy.
Ramsey, F., 1928. A mathematical theory of savings. Economic Journal 38, 543–559.
Redclift, M., 1996. Wasted-Counting the Costs of Global Consumption. Routledge, London.
Rees, W.E., Ecological_Economics, 2000. Forum: the ecological footprint. Ecological Economics 32, 341–394.
Rhyner, C.R., Schwartz, L.J., Wenger, R.B., Kohrell, M.G., 1995. Waste Mangement and Resource Recovery. Lewis Publishers, Boca Raton, FL.
Rosenblatt, R. (Ed.), 1999. Consuming Desires: Consumption, Culture and the Pursuit of Happiness. Island Press, New York.
Shaw, G., Williams, A., 1994. Critical Issues in Tourism: A Geographical Perspective. Blackwell, Oxford.
Siebenhüner, B., 2000. Homo sustinens—towards a new conception of humans for the science of sustainability. Ecological Economics 32 (1), 15–25.
Sienambiente, 2002. Waste Production. Web Site: http://www.sienambiente.it.
Synergy / WWF-UK., 2000. Tourism Certification. World Wide Fund for Nature Downloaded from: http://www.wwf.org.uk/filelibrary/pdf/tcr.pdf.

Tiezzi, E., Bastianoni, S., Donati, A., Marchettini, N. (Eds.), 2002. An Analysis of Sustainability for the Province of Siena. SPIn-Eco Report. University of Siena and Province of Siena Triennial Project, Siena, Italy.

Troell, M., Deutsch, L., Rönnbäck, P., Folke, C., Kautsky, N., 2002. Misplaced critique: assumption and applications of the ecological footprint. Discussion Paper Series, vol. 150. Beijer Institute for Ecological Economics.

Urry, J., 1990. The Tourist Gaze. Sage Pub., Bristol, London.

Van den Bergh, J.C.J.M., Ferrer-i-Carbonell, A., Munda, G., 2000. Alternative models of individual behaviour and implications for environmental policy. Ecological Economics 32 (1), 43–61.

Veenhoven, R., 1993. Happiness in Nations: Subjective Appreciation of Life in 56 Nations 1946–1992. Erasmus University, Rotterdam.

Wackernagel, M., Rees, W., 1995. Our Ecological Footprint: Reducing Human Impact on the Earth. New Society Publishers, Gabriola Island.

Wackernagel, M., Monfreda, C., et al., 2002. Ecological Footprint of Nations: November 2002 Update. Oakland, CA, Redefining Progress, 14.

Wackernagel, M., Onisto, L., Bello, P., Callejas Linares, A., Fálfan, I.S.L., Méndez García, J., Suárez Guerrero, A.I., Suárez Guerrero, M.G., 1999. Natural capital accounting with the ecological footprint concept. Ecological Economics 29 (3), 375–390.

WWF, 2000. Living Planet Report 2000. World Wide Fund for Nature, Geneva, Switzerland.

WWF, 2002. Living Planet Report 2002. World Wide Fund for Nature, Geneva, Switzerland.

WWF, 2004. Living Planet Report 2004. World Wide Fund for Nature, Geneva, Switzerland.