Ecological Footprint analysis

San Francisco-Oakland-Fremont, CA

Global Footprint Network
Advancing the Science of Sustainability

In collaboration with: SPUR SAN FRANCISCO PLANNING + URBAN RESEARCH ASSOCIATION

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Cover images (clockwise from top): San Francisco Sunset. BG[3]Photo; San Francisco City Hall 1. Marshall Astor; Homeless Couple with Dog in San Francisco. Franco Folini.

The Ecological Footprint

Natural resources are an essential component of a sustainable future. Global Footprint Network (Oakland, CA) develops and maintains an accounting metric known as the Ecological Footprint, which assesses humanity's pressure on natural resources and situates consumption levels within the Earth's ecological limits. The Ecological Footprint is widely recognized as an excellent measure of environmental sustainability and is used by governments and institutions worldwide.

The Ecological Footprint is a resource accounting metric that answers the research question, "how much of the regenerative capacity of our planet do we use?" by quantifying the demand that human consumption and waste generation place on the biosphere. The measure of biocapacity complements the Ecological Footprint, and tracks how much natural productive capacity is available to meet demand.

These two measures, taken together, provide a partial ecological balance sheet for the world. If the Footprint is larger than biocapacity at the global scale, it means that humanity is using more than can be regenerated, and therefore must be drawing down the standing stock of resources or causing an accumulation of wastes that must be processed by the biosphere. Climate change is an example of the effect of exceeding the waste assimilation capacity of our global ecosystems. The Ecological Footprint and biocapacity are measured in global hectares, an area that is weighted according to the average productivity of biologically productive land and water in a given year to make different land-use types comparable at the global scale.

The consumption Footprint of people in a particular geographic area, such as Norway, or New York City, sums the cropland, grazing land, forest land, fishing ground, built-up land, and carbon uptake land (for the carbon Footprint) required to produce the food, fibre and timber it consumes, and to absorb the carbon dioxide waste it creates. Of course, international trade allows populations to consume resources from all over the world, and thus the Footprint of a product produced in China but consumed in San Francisco is allocated to San Francisco. For a national analysis, the Footprint of consumption is calculated as the Footprint of domestic production plus the Footprint of imported goods and less the Footprint of exported goods.

About the San Francisco Footprint Project

In the summer of 2010, Global Footprint Network and SPUR, the San Francisco Planning and Urban Research Association, teamed up to explore the Ecological Footprint of San Francisco (see figure 10, page 10, for the geographic boundaries considered). The goal of our joint project was to expand the thinking around urban sustainability: to include all of the ecological impacts of residents' consumption of goods and services. Global Footprint Network (GFN) is an international environmental think tank committed to helping nations, regions, cities, and individuals understand sustainability through use of the Ecological Footprint tool. SPUR is a member-supported, nonprofit organization that promotes good planning and good government through research, education, and advocacy. SPUR works primarily on local and regional land use issues, housing, transportation, and economic and sustainable development.

SPUR and GFN believe that individuals and institutions worldwide must begin to recognize ecological limits. One of the most important places to begin transitioning towards more resilient, low-resource lifestyles is within our cities. The infrastructure that is built today will last for 50 to 100 years, and the design of a city dictates roughly three quarters of the average American Footprint. In order to operate competitively in the coming century, cities will have to understand what resources their citizens use today, and be able to adapt new city planning and policy decisions to allow residents to live well in a resource-constrained future.

The study utilizes the standards-compliant methodology used by Global Footprint Network on city Footprint work around the world, most recently in Footprint studies conducted for Calgary, Canada and Quito, Ecuador. Global Footprint Network provided expertise and data on the Ecological Footprint, while SPUR and Global Footprint Network worked together closely to identify city-specific supporting data. SPUR also convened a small group of key stakeholders to calibrate the model, and which identified more in-depth research questions.

Our Footprint analysis was generously supported by the Wallace Alexander Gerbode Foundation.

Limits to the Footprint Model

Although the Ecological Footprint is the best measure we have to comprehensively understand the resource impacts of consumption, it is a conservative underestimate of human demand on the environment. As an accounting metric, the Ecological Footprint utilizes publicly available data on resource production, trade, and consumption. It focuses at the national level on using widely accepted datasets such as those provided by the United Nations and the International Energy Agency. There are a number of specific ways the Ecological Footprint underestimates the total impact of human activity:

• The Footprint does not track all of the wastes generated by human activity, only those that can be absorbed by the biosphere and transformed back into biological resources in human time scales. At this time, the only waste directly tracked by the Ecological Footprint is carbon dioxide emitted into the atmosphere, using data on carbon dioxide emissions from the International Energy Agency. The Footprint does not track depletion of non-renewable resources or inherently unsustainable activities such as the release of toxic chemicals into the environment, nor does it directly track water use.

• Because the calculation of biocapacity does not set aside land specifically for conservation or use by wild species, it generally overestimates the amount of regenerative capacity available to humans for specific uses.

• Biocapacity does not immediately capture ecosystem degradation, such as soil erosion. The Ecological Footprint and biocapacity are snapshots of the conditions prevailing during the year in question; therefore, one may expect degradation of natural services in one year to translate into decreased biocapacity in future years.

The Ecological Footprint is an anthropocentric measure, meaning that it does not take into account the "value" of natural ecosystems or biodiversity in an explicit way. In fact, with current data limitations, the biocapacity of a single species, intensively farmed piece of cropland is larger than that of a biologically diverse, intercropped piece of land with lower yields. Thus, it is important to take a more in-depth look at the Ecological Footprint, or combine this measure with other biodiversity measures, when attempting to compare different resource management schemes.

Though the Ecological Footprint does not account for all human impacts on the environment, the measure does provide a tangible indicator of "unsustainability," when overall resource use is not matched by resource supply each year. The Footprint does not prescribe how a region can be sustainable in terms of resource use. However, when consumption outstrips the rate that resources can be supplied, then it has to be assumed that standing stocks of resources are being depleted or that waste is accumulating in the atmosphere. This translates into increasing risks for biodiversity.

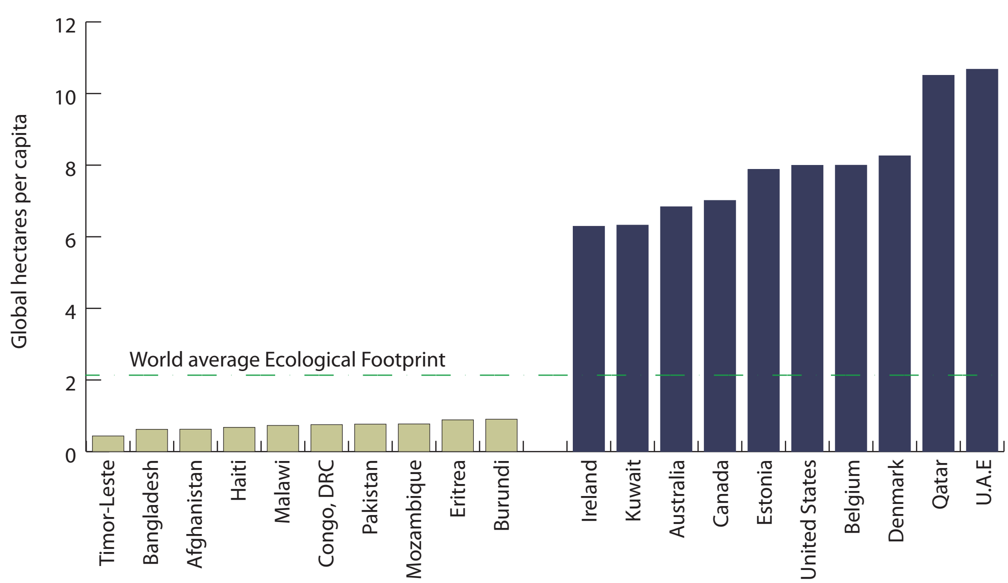

Figure 1. Countries with the top 10 largest and smallest Ecological Footprints per capita in the world.

Summary of the San Francisco Footprint

On average, Americans consume more than most global populations in terms of demand on the planet's resources (see Figure 1 on previous page). In 2007, the average Ecological Footprint of consumption in the U.S. was 6.7 global hectares (gha) per person. San Francisco's Ecological Footprint (see Appendix A for method) was about 6% higher, at 7.1 gha per person. While this result is much higher than the average available biocapacity in the U.S. (3.9 gha per capita) or the world as a whole (1.8 gha per capita), Footprint analyses of cities usually show a greater divergence from the country average (see figure 2).

This suggests that San Francisco may have developed in a more sustainable manner than other cities around the world, given the cultural context of the country it is based in. However, since the United States has such a high average Ecological Footprint, this result may be surprising to some San Francisco residents who may have expected our compact, transit-supplied city to have a much lower Ecological Footprint than the U.S. average.

Some of this discrepancy between expectations and the preliminary results arises due to methodological constraints, in particular that the expenditure data is not San Francisco specific: covering the San Francisco-Oakland-Fremont Metropolitan Statistical Area (San Francisco MSA). There is significant diversity within this MSA, among household incomes, urban form, transit utilization, and more, so the region's average Footprint may be less accurate for a subset of it (such as a city or neighborhood).

An additional limitation is the assumption that commodities from the 400+ categories examined have the same Ecological Footprint per unit in San Francisco and the U.S. on average. For example, a choice to consume a product that has been produced with high efficiency (low losses of raw materials during processing) would not show up in the result. Finally, the relatively low resolution of the expenditure data used constrains the resolution of the final result, and the expenditure data is not San Francisco specific.

However, the San Francisco MSA has an exceptionally high average income. Even if purchases made are generally low intensity, consumption is likely to be higher due to higher disposable income. Additionally, transportation infrastructure is not as highly developed as it is in cities such as New York, despite San Francisco's compact nature (and especially true when looking at the entire MSA; Fremont in particular has a very under-developed public transit system). This is likely a contributor to the higher vehicle ownership ratio seen in the expenditure data.

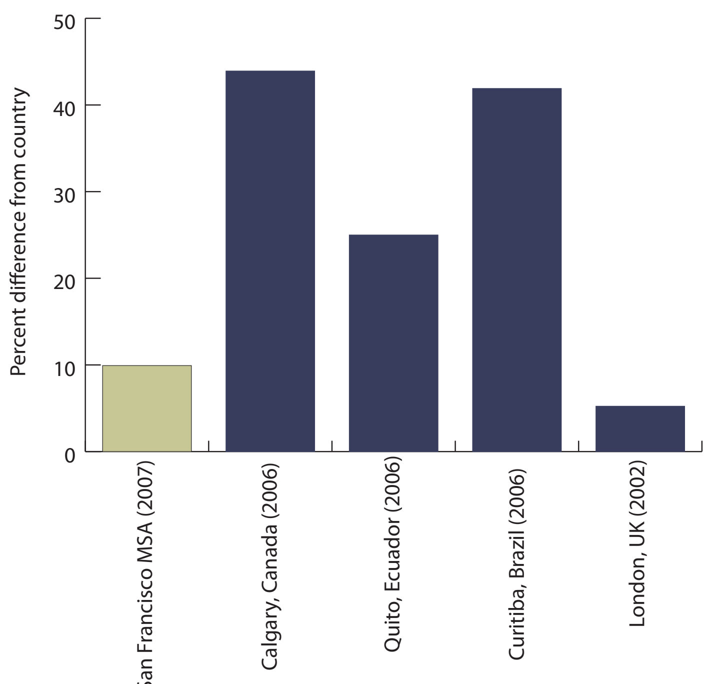

Figure 2. The Ecological Footprint of various cities in relation to the country they are located in. Analyses may be performed using different methods.

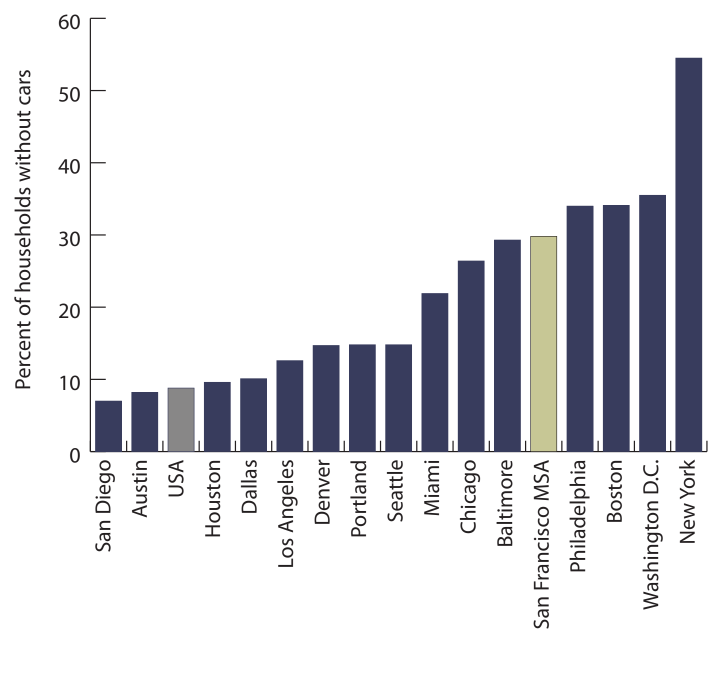

Figure 3. The percent of households without private cars in various U.S. cities. Data from plaNYC Inventory of New York City Greenhouse Gas Emissions, September 2010.

San Francisco MSA in Context

The San Francisco MSA compares unfavorably with other major U.S. cities, ranking 4th largest per capita Ecological Footprint out of the 18 examined. The cities were quite evenly distributed above and below the U.S. average Footprint, and when combined account for nearly a third of the U.S. population. Residents of New York were found to have the lowest Ecological Footprint, at 6.1 global hectares per capita; residents of Seattle had the highest, at 7.4 global hectares per capita. New York ranked lowest in only one of the 12 categories, communication, which was the smallest contributor to the overall Footprint. Seattle ranked highest in the food and non-alcoholic beverages category, as well as the restaurant and hotels category. San Francisco does not rank either highest or lowest in any category.

Since the Ecological Footprint, as a consumption measure, is highly influenced by disposable income, it is useful to look at how different cities' Ecological Footprints change in relation to changes in income and expenditures.

Figure 5 shows that there is only a weak correlation between average income (before taxes) and the Ecological Footprint of the city, suggesting that consumption patterns are influential in determining the Ecological Footprint. The relationship between the Ecological Footprint and expenditures (Figure 6) is slightly stronger, but there is still a great deal of variation from the predicted linear dependency.

A major argument for urbanization is the increased efficiencies it affords, especially in the realm of transportation. The data reflect this, with Figure 7 showing a decreasing Ecological Footprint per capita with increasing population density. The San Francisco MSA lies significantly above the trend, with a surprisingly high Footprint given its relatively high density.

Running a multiple regression of the Ecological Footprint against population density and per capita expenditure, about 60 percent of the result is explained, with both variables indicated as significant in explaining the variation. A $1000 increase in expenditure is expected, on average, to correlate with a 0.09 gha per capita increase in Ecological Footprint. A 100 people per square mile increase in population density is associated with a 0.06 gha per capita decrease in the Ecological Footprint.

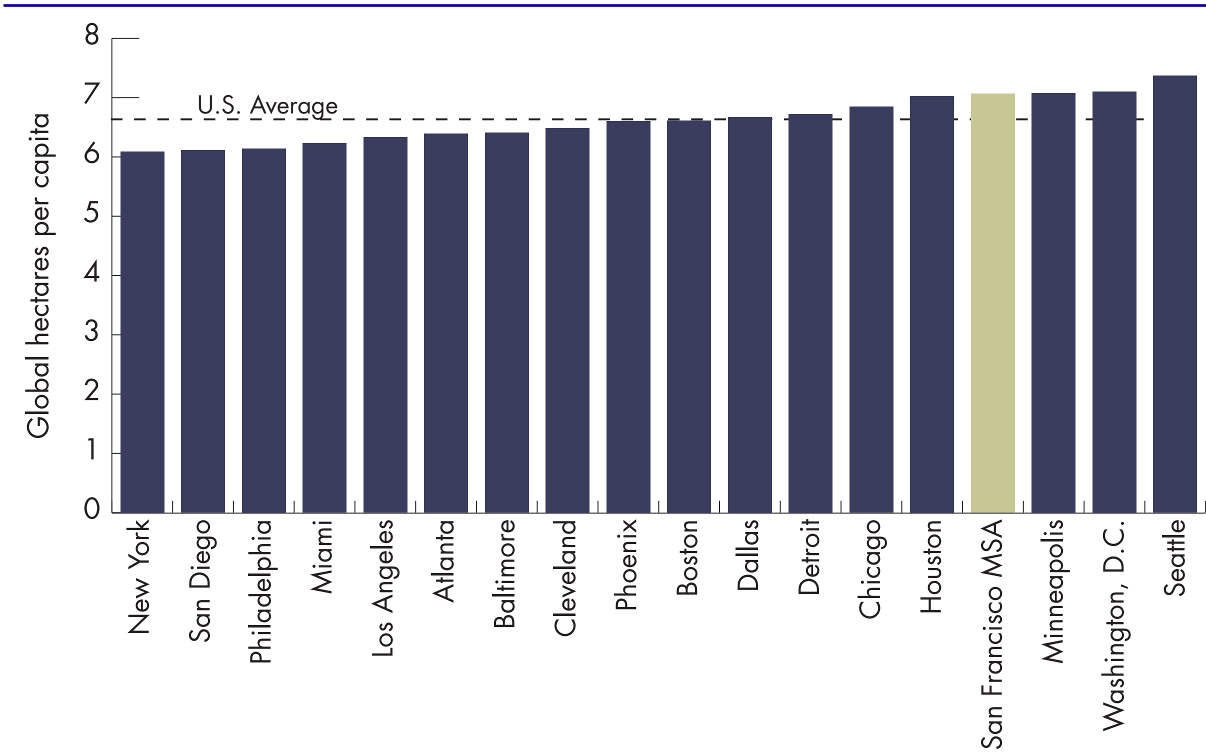

Figure 4. The average Ecological Footprint of residents of various cities in the United States.

These results suggest that, unsurprisingly, encouragement away from consumption and towards saving is one way to reduce a city's Ecological Footprint. The data also reinforce the argument that increasing density, with the associated increased viability of public transport, is a productive avenue for reducing the Footprint.

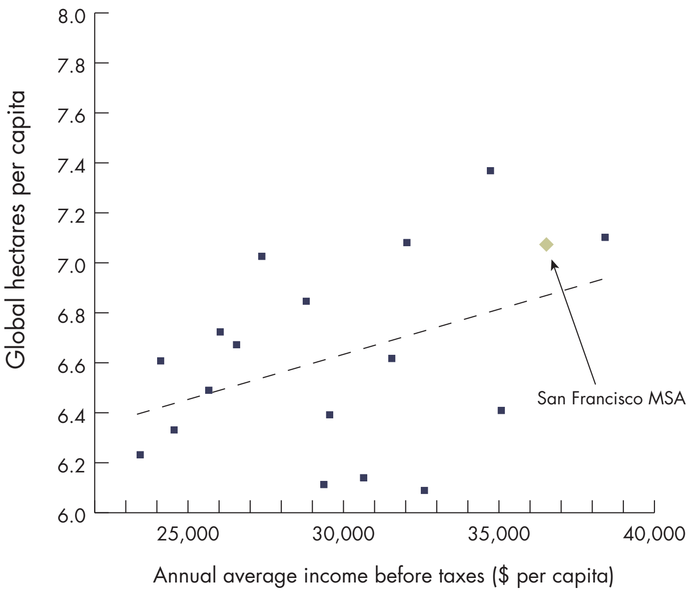

Figure 5. The average Ecological Footprint per capita of various cities in the U.S. in relation to the average income before taxes per capita.

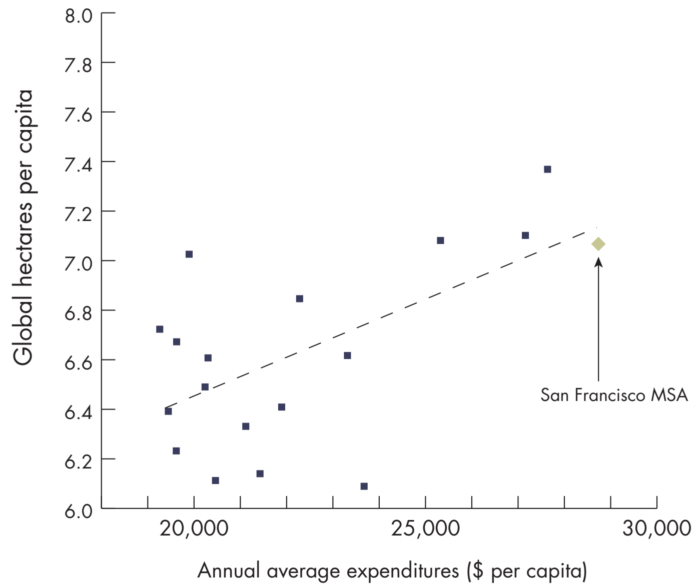

Figure 6. The average Ecological Footprint per capita of various cities in the U.S. in relation to the average expenditure per capita.

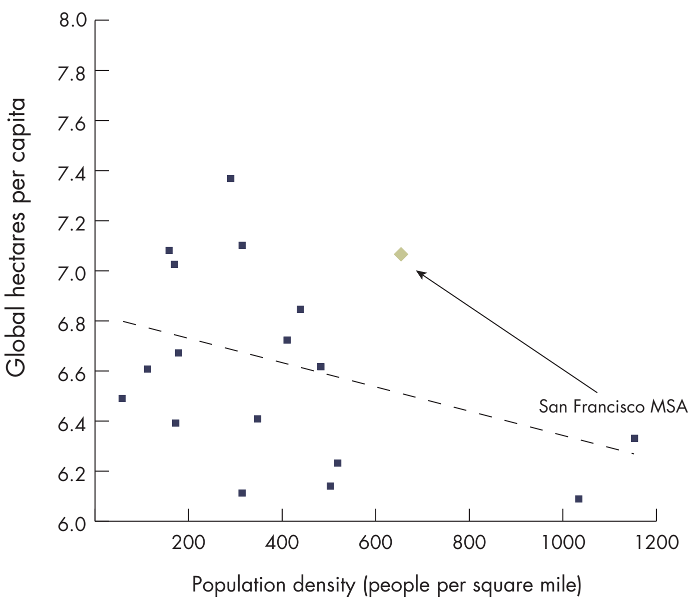

Figure 7. The average Ecological Footprint per capita of various cities in the U.S. in relation to the city's population density.

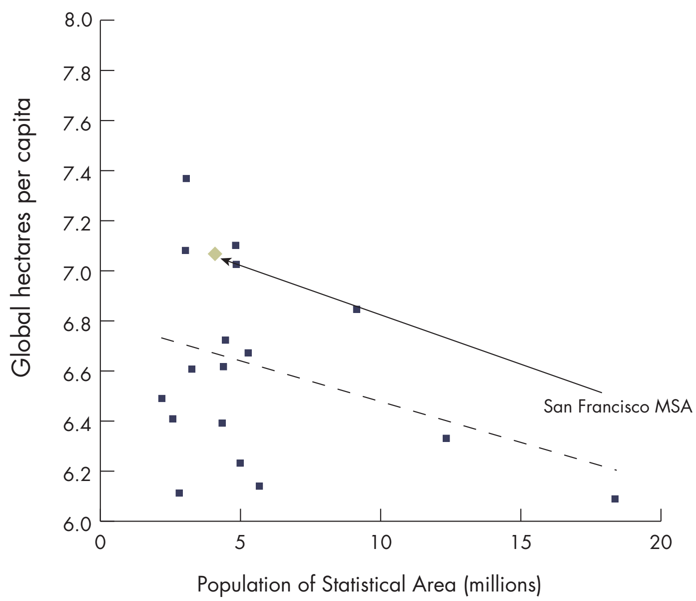

Figure 8. The average Ecological Footprint per capita of various cities in the U.S. in relation to the city's total population.

San Francisco MSA Detailed Results

A resident of the San Francisco MSA had an average Footprint greater than the average American in nearly all areas of consumption, with the exception of 'health', 'communication', 'education' , and 'miscellaneous goods and services' (see Figure 9a). The relative difference between the Footprints was greatest in 'Alcoholic beverages and tobacco' and 'restaurants and hotels'.

That the transportation sector in the San Francisco MSA had a higher Ecological Footprint than the U.S. average is one of the most surprising results. A breakdown of the contributors to this sector is shown in Figure 9b.

'Moving, storage, and freight services' contributes the largest portion for both the U.S. and San Francisco. The excess Ecological Footprint for San Francisco may relate to greater movement between accomodations and the additional moving services required, as

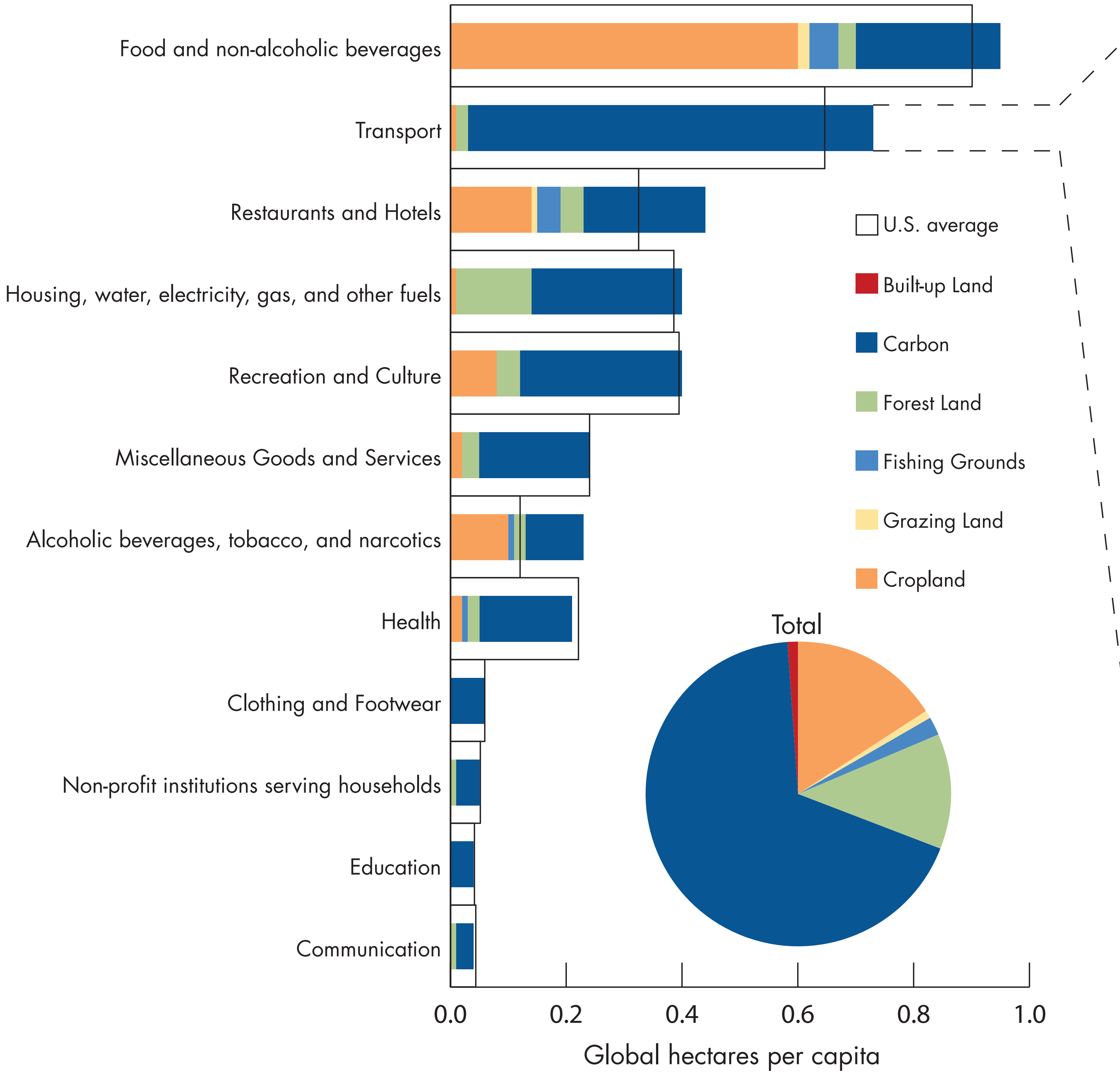

Figure 9a. The average Ecological Footprint of San Francisco MSA residents, by category. Black outlines represent U.S. average values.

well as higher demand for freight services. The use of 'gasoline and other motor fuel' is slightly higher in San Francisco. The expenditure is likely to be biased by the inclusion of more commuter-based locations such as Fremont and Oakland, but also may reflect a high use of private vehicles for recreational purposes.

The purchase of new automobiles and light trucks is lower in San Francisco than in the U.S. as a whole, which is also reflected in the slightly lower vehicle ownership rate shown in the BLS survey (1.8 vs. 1.9 per household).

As can be seen in figure 9a, with the exception of 'food and beverages', the carbon Footprint is the major component of all sectors. This highlights the importance of mitigating carbon dioxide emissions from the activities of city residents, especially emissions which are not directly emitted but are embodied within the goods and services purchased.

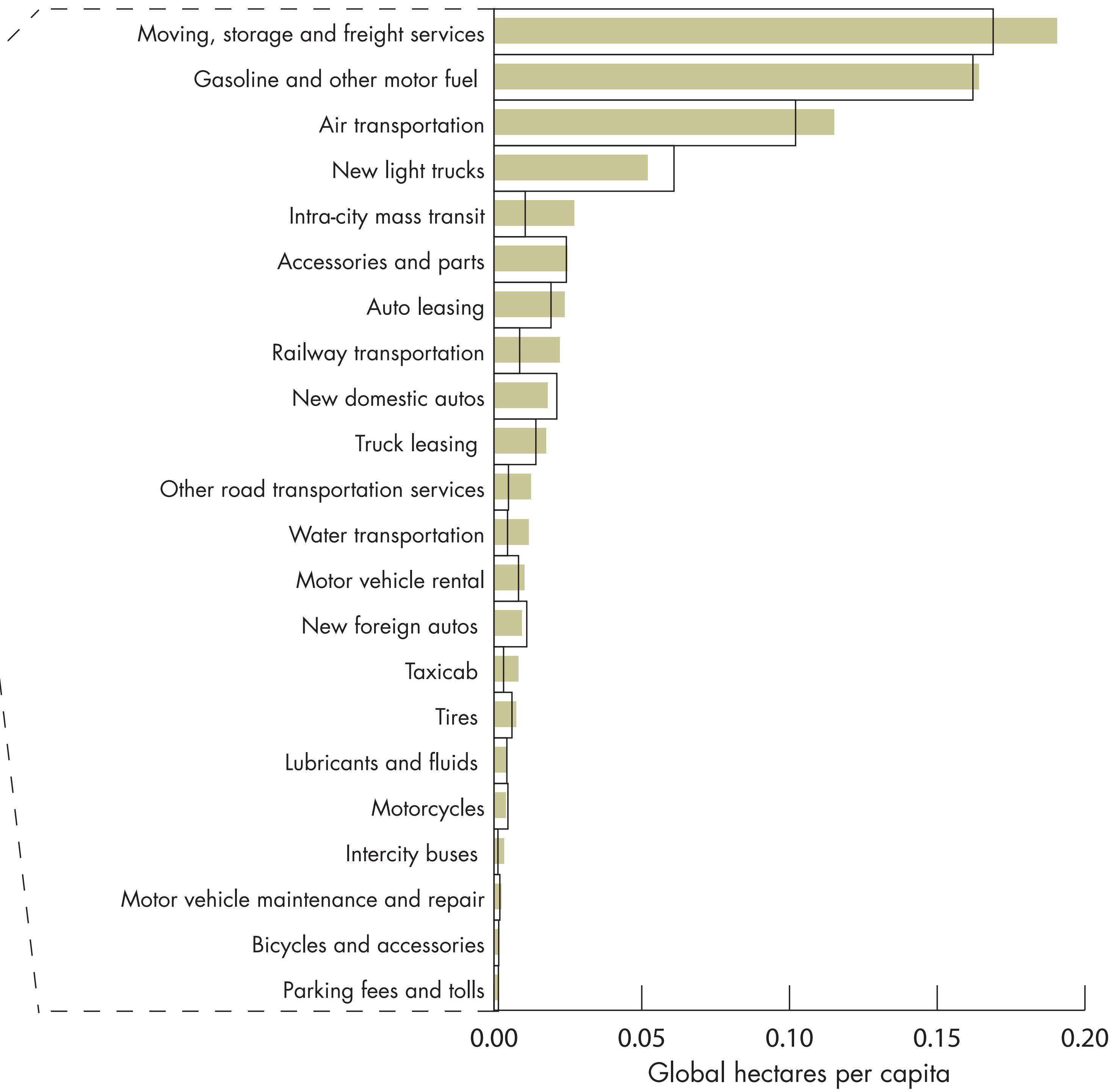

Figure 9b. The average Ecological Footprint of San Francisco MSA residents, by transportation category. Black outlines represent U.S. average values.

Data Improvements

The expenditure data obtained from the Census Bureau was for the entire San Francisco Metropolitan Statistical Area (MSA), which includes cities as dissimilar as San Francisco, Oakland, and Fremont. For example, per capita average incomes are $42,400; $29,500; and $36,800 respectively, and the percentage of commuters using public transportation is 33%, 17%, and 7% respectively.

The aggregation of these diverse locations (see Figure 9) reduces the resolution of the results and makes it difficult to propose solutions for limiting the Ecological Footprint of residents. Though there is no separated expenditure data for the various locations, it may be possible to tease out the individual Ecological Footprints based on a combination of data extracted from the American Community Survey, such as vehicle ownership, house size, commute method, and income.

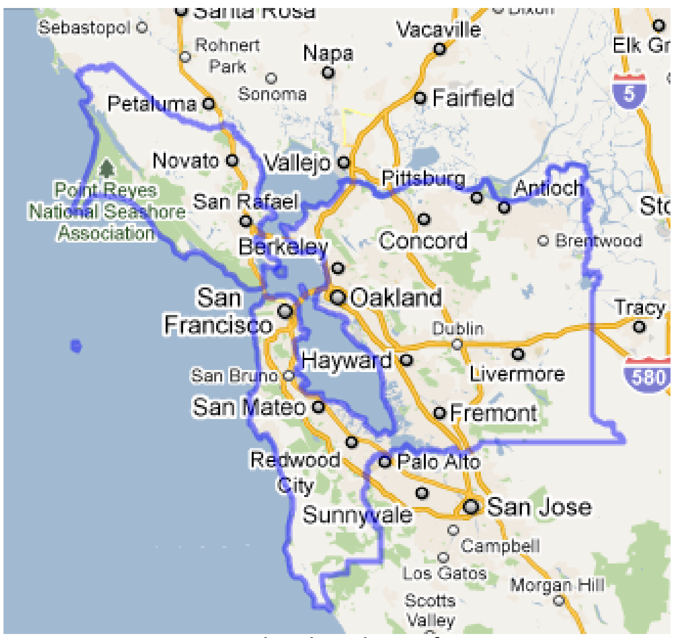

Figure 10. Geographic borders of San Francisco MSA

Methods that include either the use of San Francisco specific expenditure data or attempt to extract the expenditure of the other two cities will likely yield results that are much closer to reality.

There are two additional major areas where improvement in the data and methodology would be desired when examining the Ecological Footprint of the San Francisco MSA: food consumption and transportation.

San Francisco's culture is heavily towards one of organic, high quality food. With the associated price premium that such food attracts, the average expenditure on food in San Francisco is apparently higher. Although the methodology includes adjustments for price, the resolution of the expenditure and price data is not sufficient to capture high granularity items like organic food. In addition, such food is likely to have a different Ecological Footprint than conventionally farmed food.

In order to fully resolve this, the following data are required (partial data could also be used):

- Average expenditure per calorie of food by San Francisco residents and the U.S. average
- Average contribution of organic and artisanal foods to the San Franciscan and U.S. average food basket
- Estimates of the Ecological Footprint per calorie produced for organic, artisanal, and conventionally produced foods

San Francisco has made significant investments in its public transportation infrastructure, yet many inefficiencies and inconveniencies are still present. The city is heavily dependent on the use of relatively fuel-inefficient buses (albeit mostly electrified) rather than light-rail or subway (such as BART). However, a significant portion of the residents live without personal automotive transportation, and verification of the apparent high Ecological Footprint associated with transportation throughout the MSA is needed.

In order to explore the transportation issue more thoroughly, the following data are required:

- Average carbon dioxide emissions from personal transportation by San Francisco residents and the U.S. average
- Average fuel efficiency of cars in San Francisco
- Average Vehicle Miles Traveled (VMT) by private automotive transportation in San Francisco
- Average car ownership by San Francisco residents
- Average age of privately owned cars in San Francisco

Average annual expenditures	San Francisco MSA	US Average
Total	$68,966	$49,633
Food	$8,393	$6,131
Food at home	$4,323	$3,464
Cereals and bakery products	$562	$459
Meats, poultry, fish, and eggs	$919	$777
Dairy products	$478	$387
Fruits and vegetables	$916	$600
Other food at home	$1,448	$1,241
Food away from home	$4,070	$2,667
Alcoholic beverages	$774	$456
Housing	$26,111	$16,919
Shelter	$18,800	$10,023
Owned dwellings	$11,238	$6,730
Rented dwellings	$6,208	$2,602
Other lodging	$1,355	$691
Utilities, fuels, and public services	$3,204	$3,477
Household operations	$1,567	$984
Housekeeping supplies	$600	$639
Household furnishings and equipment	$1,939	$1,797
Apparel and services	$2,456	$1,880
Transportation	$10,591	$8,757
Vehicle purchases (net outlay)	$2,973	$3,244
Gasoline and motor oil	$2,589	$2,384
Other vehicle expenses	$3,550	$2,592
Public transportation	$1,479	$538
Healthcare	$3,321	$2,853
Entertainment	$3,409	$2,698
Personal care products and services	$932	$588
Reading	$174	$118
Education	$1,450	$945
Tobacco products and smoking supplies	$176	$323
Miscellaneous	$1,101	$808
Cash contributions	$1,822	$1,821
Personal insurance and pensions	$8,256	$5,336
Life and other personal insurance	$270	$309
Pensions and Social Security	$7,986	$5,027

Table 2. Comparison between the average household expenditure on items in the San Francisco-Oakland-Fremont Metropolitan Statistical Area and the US average. These data are adjusted for different prices within the calculation methodology.

Appendix A: Ecological Footprint Calculations

The Ecological Footprint converts the amount of raw materials used or carbon dioxide emitted into the amount of bioproductive land and water required to supply these resources or store the wastes created. This translation requires knowledge of world average yields in various raw material products (e.g. average yield of roundwood in tonnes per hectare for forest products) and knowledge of the specific land-use type equivalence factor (see Annex A for more information), which takes world average bioproductive land of multiple different land-use types and translates it into global hectares (gha).

The basic calculation for the Ecological Footprint is illustrated in Equation 1. For example, two tonnes of roundwood (a cut of timber) may be harvested from a forest. This product weight is divided by the average yield per hectare for that forest, and then scaled by the yield factor. The yield factor is the ratio between national (or sub-national) average yield and world average yield for the product in question, and weights land according to its relative productivity. The final step is to multiply by the equivalence factor, a scaling value that converts the actual area in hectares of different land types (forest, cropland, grazing land, etc) into a global hectare equivalent.

$$EF = \frac{P}{Y_N} \cdot YF \cdot EQF \quad \text{Equation 1.}$$

where P is the weight of product harvested, Y_N is the average yield for P, and YF and EQF are the yield factor and equivalence factor.

For biocapacity, the calculation utilizes the area (A) of land in that land-use type (cropland, forest land, grazing land, etc.), multiplied again by the yield factor and equivalence factor as shown in equation 2.

$$BC = A \cdot YF \cdot EQF \quad \text{Equation 2.}$$

Yield factors vary by product, land-use type, and location while equivalence factors only vary by land-use type, and are identical for every location in a given year. The equivalence factors used for this analysis, from the 2010 Edition of the National Footprint Accounts, are listed in Table 1. The equivalence factor for cropland shows that in 2007, cropland was 2.51 times more productive than world average bioproductive land. Inland water, on the other hand, was less than half as productive.

Area Type	Equivalence Factor [global hectares per hectare]
Cropland	2.51
Forest	1.26
Grazing Land	0.46
Marine & Inland Water	0.37
Built-up Land	2.51

Table 1. Equivalence factors, 2007. National Footprint Accounts 2010. Global Footprint Network.

Construction of US Input-Output table

The U.S. Bureau of Economic Analysis (BEA) provides Make and Use tables (also known as Supply and Use tables) at three levels of detail: sector, summary, and detailed. The detailed level is comprised of approximately 426 commodity sectors, and is most appropriate for the analysis we perform in that, for most steps, these sectors will not need to be disaggregated at all.

A standard Input-Output table can be constructed from these tables following a standardized methodology:

1. Take the Make table (M) and calculate a matrix S, where S = mij/Xj (where mij denotes individual cells in M and Xj represents a vector of total output from each sector)

2. Replace any undefined cells in S (where Xj = 0) with zeroes

3. Take the Use table (U) and replace blanks with zeroes

4. The intermediate IO table is given by SU – a 426x426 matrix

a. Compensation of employees; taxes; gross operating surplus – fraction of total value added from use table, multiplied by difference between total industry output and intermediate output

b. Total industry output is sum of intermediate demand and final demand

i. Final demand given by MD, where D is the final demand from the use table [428x13]

Forming the Leontief Inverse

The Leontief Inverse matrix is a common construct in Input-Output analysis and forms the backbone of the Consumption Impact Matrix procedure.

We wish to know: what is the total output associated with the final demand for certain sectors of the economy? This total output includes both direct (the output from the sector itself) and indirect (the inputs required from other sectors by the sector that is supplying the final demand).

Total output, X, equals intermediate (indirect) demand plus final demand (F), and intermediate demand is given by the indirect requirements per unit of output (A) multiplied by the output.

$$X = AX + F$$
$$X - AX = F$$
$$IX - AX = F$$
$$(I - A)X = F$$
$$X = F(I-A)-1$$

The Leontief Inverse is represented by (I-A)-1, where I is the identity matrix (a matrix with ones on the main diagonal and zeroes elsewhere) and A is formed by dividing the intermediate requirements a_{ij} by the output X_j in the IO table.

Initial Allocation of Environmental Impacts

In order to determine the environmental impact caused by a certain quantity of final demand, it is necessary to allocate the measured environmental impact to the sectors that are directly pressuring the environment (e.g. the direct pressure on forests is caused by the logging industry, not by the paper industry). Historically, at Global Footprint Network, the initial allocation of the Ecological Footprint was in terms of the calculated Ecological Footprint of consumption. However, since allocation of output to consumption sectors and exports is performed within the I-O framework, this step was not consistent with standard I-O analysis (though it did have the benefit that consistency with NFA reported totals are forced). Consequently, for the analysis here, the initial allocation is based upon the vector representing the sum of the Ecological Footprint of production and the Ecological Footprint of imports.

Though the analysis is not affected by whether a conversion to per capita values is made before the initial allocation or on the final result, here the adjustment was made at the final step since this gives greater meaning to the intermediate results.

When working with the Ecological Footprint, each land-use type must be allocated separately. In addition, if the aggregated results for each allocation do not match the NFA total (for example, due to the exclusion of the scrap sector from the IO table) then a proportional adjustment was made to each sector.

1. Cropland

a. Crop EFP and EFI: use first 4 digits of HS+ code in NFA (crop_efp and crop_efi) and concordance between IO commodities and harmonized foreign trade codes.

b. Crop in Livestock EFI: use first 4 digits of HS+ code in NFA (livestock_efi) and concordance between IO commodities and harmonized foreign trade codes.

c. Crop in Fish EFI: use match between Commodity name in NFA (fish_commodity_efi), HS_code from MySQL (fish_10.commodity) and concordance between IO commodities and harmonized foreign trade codes.

2. Grazing land

a. Grazing EFP: Take total feed demand in NFA and multiply by % grass (feed_demand_n). Use first 4 digits of HS+ code in and concordance between IO commodities and harmonized foreign trade codes. Sum across categories. Use FAF livestock 2010 04 25 worksheet prepared by Jean-Yves to split Footprint between dairy cattle and cattle ranching (55% and 45% respectively)

b. Grazing EFI: use first 4 digits of HS+ code in NFA (livestock_efi) and concordance between IO commodities and harmonized foreign trade codes.

3. Fishing grounds

a. Fishing EFP: All allocated to fishing sector

b. Fishing EFI: use match between Commodity name in NFA (fish_commodity_efi), HS_code from MySQL (fish_10.commodity) and concordance between IO commodities and harmonized foreign trade codes.

c. Fish in Livestock EFI: use first 4 digits of HS+ code in NFA (livestock_efi) and concordance between IO commodities and harmonized foreign trade codes.

4. Forest land

a. Forest EFP: All allocated to logging sector

b. Forest EFI: Manual mapping of FAO codes in NFA (forest_efi) to harmonized codes. Then used concordance between IO commodities and harmonized foreign trade codes.

5. Built-up land

a. Allocated based on fraction of total output that sector contributes

6. Carbon uptake land

a. Carbon EFP: Carbon inventory from ESA

i. Matching based on sector names (with manual check and cleanup). Total direct carbon emissions from each sector allocated to IO commodity sector.

ii. If ESA sector maps to multiple IO sectors, split based upon fractional output

b. Carbon EFI: Used HS2007 – SITC correspondence table to match up SITC codes in NFA (carbon_efi) and concordance between IO commodities and harmonized foreign trade codes.

Determining Impacts from Final Demand

The summed EF production and EF imports initial allocation vectors were divided by sector monetary outputs to give an intensity vector – N – for each land-use type (Ecological Footprint requirements per unit of output for primary use industries).

Multiplying N by the Leontief Inverse (I-A)-1 gives the direct and indirect EF requirements per unit of output. These requirements can then simply scaled up by the final demand to give a matrix showing the EF by land-use type by final demand from each sector.

Conversion to CLUM and Scaling

By Global Footprint Network definition, a Consumption Land Use Matrix (CLUM) represents the environmental impacts of a given population disaggregated by consumption categories. This CLUM can then be scaled using household expenditure (HHE) data to approximate the impacts from sub-populations.

The final demand category "Personal consumption expenditures" in the I-O table was assumed to be the only category that varies amongst regions and these expenditures are the only ones reflected in the consumer expenditure surveys.

1. I-O sectors mapped to PCE categories using BEA bridge table

a. Missing sectors either allocated manually or based on similar sectors

2. PCE totals divided by US population in 2007 (308,674,000) to give household EFC per capita (CIM)

3. ACCRA price differentials constructed (SF prices/347 city average) [purchased dataset]

4. Consumer Expenditure Survey ()

5. Manual mapping of ACCRA to CES to construct per person price-adjusted consumption ratios

6. Manual mapping of CES to PCE categories to construct San Francisco CIM

a. Electricity line also adjusted by difference in carbon intensity of electricity production