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Survey

A household carbon footprint calculator for islands: Case study of the United States Virgin Islands

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ABSTRACT

Island regions are at a heightened level of vulnerability to climate change impacts and recently a great degree of political attention has been given to planning low-carbon economic strategies for Small Island Developing States (SIDS). To develop useful mitigation strategies, an understanding of greenhouse gas emissions currently attributable to various social sectors is necessary. We use consumption-based life cycle accounting techniques to assess the carbon footprint of typical households within the US Virgin Islands. We find the average carbon footprint in the territory to be 13 tCO_2e per year per capita, roughly 35% less than the average US per capita footprint. Also, electricity and food are much larger contributors to total footprint than in the US. Results highlight scope for behavioral and technological changes that could significantly reduce the footprint. The model has been developed into an open access online tool for educational purposes.

1. Introduction

Energy access is widely acknowledged as a major economic driver for social development and economic growth (Goldemberg and Johansson, 1995). Given the constraints of distance and scale that islands face, energy has an intensified impact on islands and their macroeconomic management (United Nations Economic and Social Council, 1996). Its availability thus plays a vital role in the cost and quality of electricity and transportation, and also impacts the provision of basic goods and social services (Kristoferson et al., 1985). The IPCC also highlights the vulnerabilities of island resources to a warming climate (Mimura, 2007). Recent cost assessments project that increased hurricane damages, loss of tourism revenue and infrastructure damages alone will cost the Caribbean $22 billion annually by 2050, representing 10% of the current Caribbean economy (Bueno et al., 2008). Concerns for these broad consequences of climate change vulnerability and energy security have led to action on various islands, through government policy and commercial enterprise, to promote efficiency and introduce indigenous energy resources into local fuel mixes (Weisser, 2004a,b).

The United States Virgin Islands (USVI) is one such territory where action is already being taken to develop new energy strategies. In total, the islands consist of just over 1900 km^2 of rugged terrain with very limited amounts of flat land for agriculture or other primary and secondary sector activities. Tourism accounts for roughly 80% of economic activity, and 30% of the land area has elevation less than 5 m (Trading Economics, 2010), placing significant importance on the territory's 190 km of coastline (CIA, 2011). Furthermore, the USVI consumes about 85,000 bbl oil/day to meet electricity, desalination and transportation needs (CIA, 2011). This is largely because the islands' generation systems are 100% dependent on fuel oils. Thus, not only are the islands' coastlines vulnerable to climate impacts but the territory's economy is also vulnerable to the volatility and availability of foreign energy resources.

The local government has attempted to address this situation through the USVI Legislature's recent passing of Act 7075 (Bill No 28-0009). This Act amends previous VI Code by expanding the capacity of various energy efficiency and renewable energy incentive programs available within the territory and highlights the immediate need for strategic energy policy (VI Legislature, 2009). Soon after in 2010 the governor of the USVI signed a memorandum of understanding with the US Department of Energy to create a clean energy development strategy for the territory. The goal of this strategy is to achieve a 60% reduction in fossil fuel reliance by the year 2025 (Lantz et al., 2011). To catalog where opportunities to implement meaningful energy conservation and efficiency measures or renewable energy integration truly exist, it is important for decision makers to develop an understanding of the territory's energy landscape beyond utility boundaries. However, to date few local agencies collect data related to metrics on household and commercial resource use. Exploring how energy is being used both directly and indirectly by households for transportation, food, goods and services and household utility is thus a useful exercise.

The data collected for energy allocation is also useful for understanding how emissions are being generated across the island as a result of household consumption. Such carbon footprint analysis is useful as island territories take deliberate strides toward low carbon

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economies. A carbon footprint calculator would also serve as an educational tool for encouraging awareness and promoting behavior change among island residents. A recent study by the CoolClimate Network at the University of California, Berkeley compared the carbon footprints of average US households in 28 metropolitan regions, which range from 38 to 52 metric tons CO_2e per year (Jones and Kammen, 2010). However, as a US island territory, the USVI finds itself in a particular context of isolation from the mainland, limited land for local arable produce and a 100% fuel oil electricity generation mix. Here we attempt to account for such peculiarity and identify the size and composition of typical USVI household carbon footprints.

There are two predominant methods for calculating carbon footprints: Process Analysis and Economic Input Output (EIO) Analysis (Wiedmann and Minx, 2008). Using an EIO methodology similar to that developed by the CoolClimate Network, this paper presents a top-down consumption-based accounting model for USVI households. The model uses life cycle assessment (LCA) to approximate greenhouse gas (GHG) emissions during the extraction, processing, transport, use and disposal phases of various commodities and maps this to their respective consumption by households. Consumption-based LCA attempts to provide a complete picture of greenhouse gas emissions related to individual consumer spending choices and is therefore well suited for development of consumer-oriented carbon management tools (Wier and M, 2001). Benchmark carbon footprints are calculated for the three major inhabited islands of the USVI, five household sizes and five income brackets for a total of over 75 different household groups. The results of the model have been incorporated into an open access online tool for educational purposes.[1]

2. Material and Methods

2.1. General Household Characteristics

The US Virgin Islands (USVI) has an estimated population of 115,800 persons. St. Croix and St. Thomas comprise 47% and 49% total population respectively. St. John is considerably smaller, with less than 4% of the total population. According to the 2007 Community Survey conducted and published by the Eastern Caribbean Center (ECC) (Eastern Caribbean Center, 2007) mean household size and income are 2.2 persons and $41,884 per annum, respectively. Similarly, the annual per capita income as reported by the Bureau of Economic Research (BER) is roughly $21,600 (Bureau of Economic Research, 2010a), about half of the US average. With an unemployment rate of more than 9% at the end of 2011 (Bureau of Economic Research, 2011), 11% of all households live on less than $10,000 per year, compared to 7% for the US, and about half of USVI households live on less than $35,000 a year in comparison to a third of all households in the US (Bureau of Economic Research, 2010b). Only 25% of households have air conditioning, roughly half the households have computers and two thirds use bottled or tanked gas rather than electricity for cooking purposes.

2.2. Estimating Household Consumption

While the impacts of household consumption extend to land use issues, water management, waste management and pollution (Mimura, 2007), we focus on estimating the carbon footprint of household consumption. The total household carbon footprint (HCF) can be expressed as the product of consumption, which we approximate by spending, and the emissions per unit of consumption summed over each commodity or activity included in the model. We use data collected to estimate default values for the various household size and income bracket groups (discussed below) and the online footprint calculator assumes these values where user input is not provided.

$$\mathrm{HCF}(\mathrm{tCO_2e}) = \sum\nolimits_{\text{commodities}} \text{Average Annual Spending} \times \text{Emission Factor} \tag{1}$$

We consider only the three predominantly inhabited islands: St. Thomas, St. Croix and St. John. Annual household consumption values for each commodity were calculated for each household group based on data from the most recent Household Income and Expenditure Survey, conducted by the ECC in 2005 (Eastern Caribbean Center, 2005). Given the small population sizes on each island and concerns over confidentiality, the results of the survey are cited as territorial household averages and no distinction between household income brackets or sizes is made. Data on household characteristics was also taken from the Community Survey (Eastern Caribbean Center, 2007). We determine the average household income and size and map average monthly and annual spending to this group.

As a proxy for resolution on differences in consumption across household types, we assume that the relative differences in spending between major income brackets and the average household income bracket are proportional to the differences observed in the continental US. This assumption is also made for spending differences across household sizes. US consumption trends were taken from the 2008 US Consumer Expenditure Surveys (US Bureau of Labor Statistics, 2008). The spending values for each household type are then a combination of these two influences. A third data set, the 1997 Consumer Expenditure Survey (Eastern Caribbean Center, 1997), is older but reports on average household spending by island. The ratios of spending for each island compared to the territorial average were used to create multipliers for each commodity. The product of these multipliers and the expenditure values for each household type are the default values for spending used in the model.

The ECC Household Income and Expenditure Survey provides data on household utility expenditures including electricity, gas, water and sewage disposal. It also provides household expenditures on gasoline for private transportation as well as spending for public transportation fares. We chose goods and services categories based on the commodities reported in the ECC survey and therefore model spending related to furniture and household appliances, clothing, entertainment, personal care, auto care and medical goods. The services we model include vehicular services, household maintenance and repair, education, health care, communication, personal business, entertainment and recreation.

We model food consumption based on dietary intake rather than spending. The food production and supply sector is highly complex. Because of variations in methods of production, processing, transportation, distribution, waste management and compounding factors such as locality and seasonality, many popular carbon calculators opt to base emissions on quantities of food consumed by users or by categorizing users through dietary lifestyles (Kim and Neff, 2009). Furthermore, one of the major limitations of EIO-LCA is the assumption of linear correlation between spending on a commodity and environmental impacts (Kim et al., 2008). As Jones and Kammen show in an analysis of 2009 US Consumer Expenditure Surveys, there is little correlation between spending on food and dietary intake across income brackets. Increased spending is likely related to consumption of higher quality or branded food products (Jones and Kammen, 2010). Following this argument and in the absence of consumption estimates specific to the Virgin Islands, data for dietary trends in the Caribbean Region and international Caribbean communities were used to approximate caloric intake (Ramdath et al., 2010; Sharma et al., 2002, 2009).

[1] http://coolclimate.berkeley.edu/usvi_calc

2.3. Selection of Emission Factors

2.3.1. Utilities: Electricity, Water, Gas, Waste and Construction

The data for direct electricity emission factors was obtained from the USVI Water and Power Authority (WAPA). WAPA provided a 2009 data set on fuel use, generator performance, total production and load profiles for each island. All generators are diesel-fired with total fuel mix being 93% No.2 Fuel and 7% No.6 Fuel, so that based on estimates of fuel carbon content, direct emission factors (gCO_2e/kWh) were calculated. The indirect emissions attributed to the construction, operation and maintenance of the islands' generators were also estimated but the impacts related to extraction and transportation of fuel used remain to be properly explored (discussed in Section 3.2 below).

Similarly, 2009 data directly from WAPA was used to calculate the direct emissions from water production. All water supplied to residential, commercial and industrial customers by WAPA is produced by desalination. Based on fuel use for water production and the total output of these units, an effective fuel rate was calculated. More than 70% of households supplement or substitute WAPA water service by using cisterns (Eastern Caribbean Center, 2007). Given that there are maintenance costs associated with cistern ownership, it is unclear what fraction of a household's reported spending on water is related to desalination and distribution. Currently, we assume that all water-related spending goes toward WAPA water provision unless otherwise stated by user. Indirect emissions from the construction, operation and maintenance of desalination plants have been obtained from literature review (Raluy et al., 2005).

The sewage and waste emission factor currently being used is based on data provided by the Virgin Islands Waste Management Authority (VIWMA) on electricity, water and direct fuel use for its various functions. It appears that roughly half of the households in the territory are serviced by the VIWMA public sewer system. Many households instead rely on owning septic tanks or cesspools (Eastern Caribbean Center, 2007). Again, we assume spending is related to VIWMA utility bills unless otherwise stated by the user. Cylinders of butane and propane gas are commonly used for cooking gas in the USVI. The carbon content of these gases was determined based on chemical formula and density and is used as a direct emission factor. We source indirect emission factor estimates (Jaramillo et al., 2007) and use the household construction emission factor cited in Carnegie Mellon's EIO-LCA (Green Design Institute, 2009). These estimates will be validated in the future.

2.3.2. Transportation

Life cycle GHG emission factors from diesel and gasoline are taken from the GREET Model (Argonne National Laboratory, 2009). We combine this with our own estimates of fuel efficiency on the islands to create direct and indirect gCO_2e/gal emission factors. Air travel and public transport emission factors are from the Greenhouse Gas Protocol (World Resource Institute and World Business Council for Sustainable Development, 2011). EIO-LCA is used for estimates of emissions from motor vehicle manufacturing (Tukker et al., 2010). Better data is needed on USVI specific fuel economy for both private and public transportation. Furthermore, there are many non-conventional modes of transportation used between islands that require further investigation (discussed in Section 3.2 below).

2.3.3. Food, Goods and Services

EIO-LCA models cradle-to-gate environmental impacts for a given unit of economic activity. The methodology employed by the CoolClimate Network creates weighted emission factors by further attributing some fraction of consumer spending to transportation, distribution and retail activity, and then estimating these additional emissions (Jones and Kammen, 2010). GHG emission factors for food groups are expressed per calorie consumed for each food category rather than per dollar spent. These emission factors were calculated using a top-down approach. Cradle-to-consumer GHG emissions per household are estimated using EIO-LCA for each food category. These are divided by the total calories of that category consumed per household according to USDA to give emissions per calorie. EIO-LCA emission factors do not cater for the difference between imports and locally produced food, goods or services, representing a limitation of the methodology. The USVI imports most food and manufactured goods (CIA, 2011). We attempted to account for the specific transportation-to-island and distribution impacts of each commodity but were unable to obtain data from the territory's main shipping and distribution company (discussed in Section 3.2 below). We hope to elaborate on this limitation in the future.

3. Results and Discussion

3.1. Benchmark Carbon Footprint Results

The model produces carbon footprint results for any combination of the three islands, five household sizes and five income brackets. Fig. 1 shows carbon footprint estimates for US territories. The CoolClimate Network averages the US household carbon footprint to be roughly 20 tCO_2e per capita (Jones and Kammen, 2010; EIA 2011). The average for Hawaii is estimated to be 17 tCO_2e per capita (Jones and Kammen, 2010). Based on our model the USVI has a footprint of 13 tCO_2e per year per capita. St. Croix and St. Thomas both have lower household carbon footprints than St. John. Hawaii has a population of 1.3 million, a per capita income of $42,000 and just over a quarter of the state's households live on less than $35,000 a year (State of Hawaii, 2010). Though economically more well off than the USVI, Hawaii makes for interesting comparison. Being located approximately 2500 miles from the continental US, it is one of the most geographically isolated areas of the world. Given that the state imports most of its food and manufactured goods, its shipping related GHG emissions are significant and yet its household carbon footprint remains less than the US footprint.

Fig. 2 shows household emissions by commodity and activity for the average St. Thomas household. Fig. 3 shows a comparison between islands based on commodity groups. Major contributors to the average household's annual footprint are electricity use (7 tCO_2e per year), fuel use for private transportation (4 tCO_2e per year), water use (2 tCO_2e per year) and consumption of meats (1.5 tCO_2e per year). The relative importance of these activities to US household emissions varies greatly across calculators but Jones and Kammen find that direct motor fuel is the largest contributor to the US household footprint followed by electricity, meat, health care, other foods, natural gas and air travel. The impact of private transportation is roughly

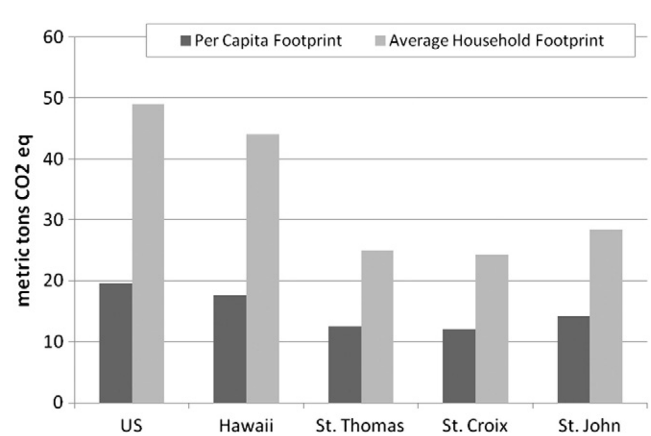

Fig. 1. Average household and per capita carbon footprints for the US, Hawaii and the USVI.

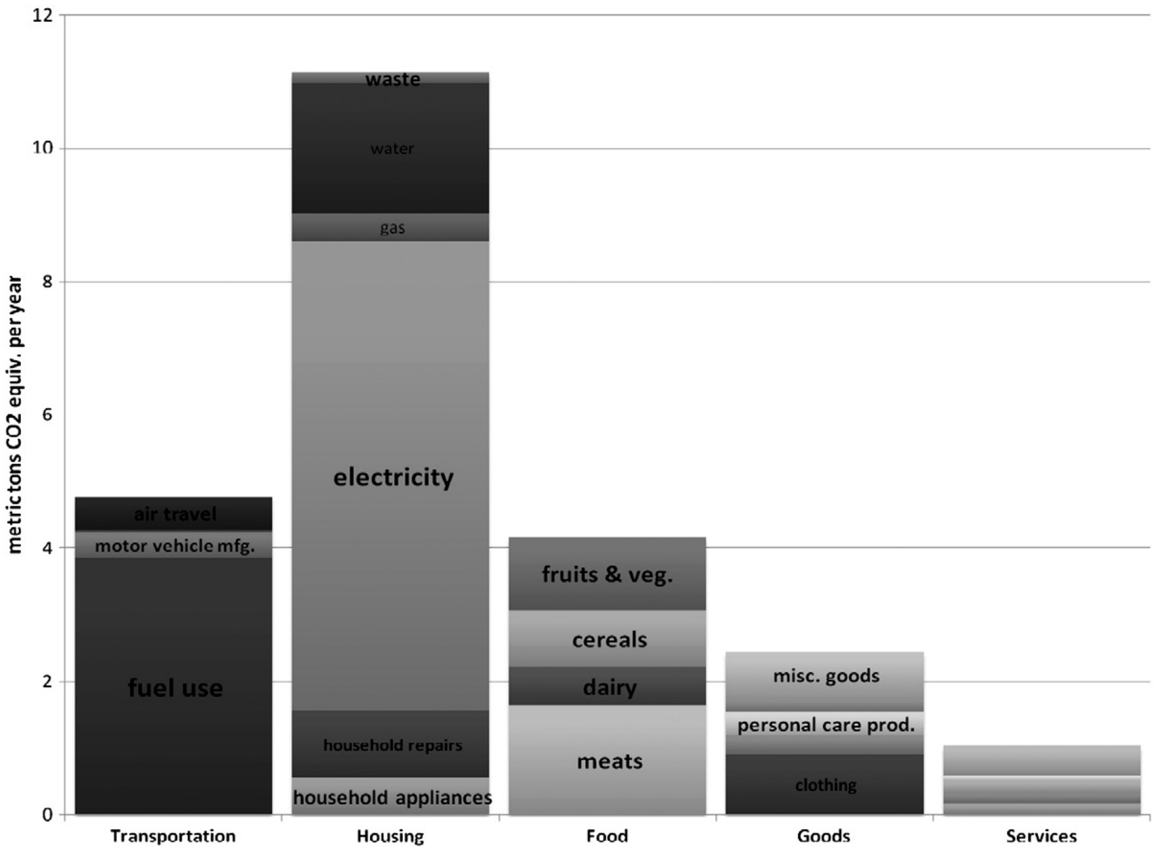

Fig. 2. Total carbon footprint for average St. Thomas household (2 persons, $40–60,000 annual income).

30% larger than that of electricity (Jones and Kammen, 2010). Padgett et al. present a comparison across a number of popular US household carbon calculators that also shows fuel use for private transportation to be a dominant contributor (4–5 tCO_2e per year) (Padgett et al., 2008). Interestingly, the absolute value of direct fuel use is roughly the same in the USVI – likely due to lower fuel efficiencies – though electricity use still dominates emissions.

Electricity is generally a major contributor in US households although the impact ranges from 3 to 11 tCO_2e per year (Padgett et al., 2008). This is in part because of the range in living environments that households are exposed to across the US and the varying emission intensities of different generation fuel mixes. Yet few homes in the USVI own air conditioning units or other electricity heavy appliances. In fact, the average home in the USVI consumes roughly 4000 kWh/year (Southern States Energy Board, USVI Energy Office, 2009) compared to 11,000 kWh/year in Florida (similar values cited in Padgett et al.). This highlights the carbon intensity of electricity

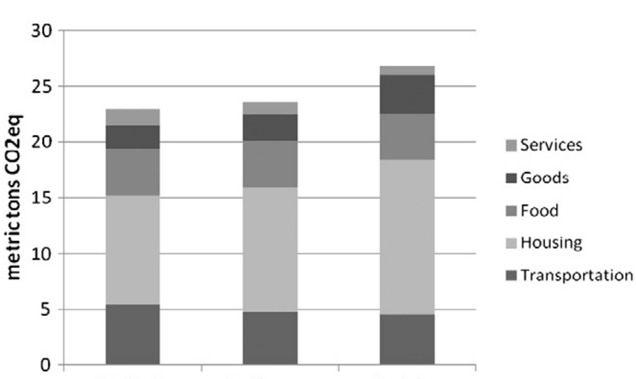

Fig. 3. Carbon footprints for average households in St. Croix, St. Thomas and St. John.

production in the USVI, given the age and efficiency of WAPA facilities, despite an incomplete analysis of indirect emissions. The energy input needs of the water desalination process are also compounded by the high electricity generation emission factor. This clear domination of electricity and fuel for transportation is consistent with the analysis given in reports issued by the USVI Energy Office (VIEO) (Southern States Energy Board, USVI Energy Office, 2009). According to VIEO, the median household spends 10% of income on electricity. Fuel for transportation is fast becoming more important to households and according to VIEO since the year 2000, gasoline usage has increased by 20% while diesel usage tripled.

Thus in general, a greater fraction of total emissions is attributable to transportation than housing (or utility) needs for the US as compared to the USVI. These results are consistent with other studies, which show that mobility and manufactured goods are typically a larger share of household footprint in higher income countries, while food and utility services are more important in developing countries (Bin and Dowlatabadi, 2005; Hertwich and Peters, 2009). In fact, the contribution of household utility services in the USVI is almost double the global average cited in Hertwich and Peters, again highlighting the carbon intensity of utility services. Differences in spending are likely to further explain the lesser importance of goods and services in the USVI. Spending on food, goods and services (not including transportation and household utilities) represents 40% of income before taxes in the US (US Bureau of Labour Statistics, 2010) compared to less than 30% in the USVI (Eastern Caribbean Center, 2005).

Fig. 4 shows the trend in footprint across income group and household size. We find that doubling income increases the footprint by 15% while doubling household size increases the footprint by 25%. We also run a multiple regression on the average USVI results, which show household size to have a more significant coefficient than income. In contrast, doubling income increases the US footprint by

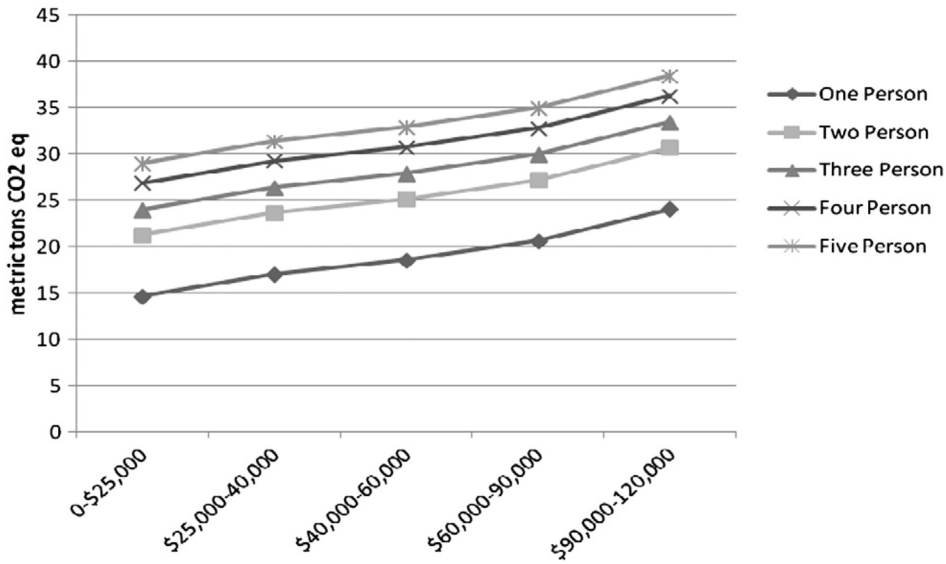

Fig. 4. USVI household carbon footprint across income quintiles and household sizes.

26% while doubling household size increases the footprint by 30% (Jones and Kammen, 2010). This elasticity is roughly the same in St. Croix and St. Thomas but the effect of household size over income is smaller on St. John, where the ratio of spending to income is more similar to the US. Given that we model food based on number of persons rather than spending, the greater impact of household size implies that food is an important driver for carbon emissions in the islands. This in turn emphasizes the sensitivity of territorial emissions to population. This ties well into the findings of other studies on the importance of food as a contributor to developing countries emissions as discussed above.

It is interesting to note that we can identify the importance of household size and food despite assuming that relative expenditure across household groups follows continental US trends. The average household in the US saved 4% of income in 2011 (US Bureau of Economic Analysis, 2012). Despite being an increase from less than 2% in 2009, this is still one of the lowest saving rates among developed countries. Because the rate of saving is so low, income has a higher effect on US household emissions. Thus our assumption of similar spending trends is in fact conservative and still the model highlights the impact of household size. It should be noted however that our model assumes a linear relationship between emissions and spending on goods and services. An assumption of the higher emission intensity of more expensive luxury goods may not hold and it will serve well to explore these trends further.

The differences in footprint between St. John, St. Thomas and St. Croix are largely dependant on consumption trends, given that most emission factors are assumed to be constant across islands. Largest total expenditures are reported in St. John. However households in St. John seem to spend relatively more on electricity and less on fuel for transportation than households on the other islands. This may be a function of affluence and the smaller size of the island respectively. Combining the number of households in various income groups with respective footprints gives a footprint of roughly 1.2 million tCO_2e per year for the 50,000 households of the territory. St. John accounts for 6% while St. Croix and St. Thomas account for roughly 47% each. Fig. 5 provides more data on the territory's cumulative footprint, showing home energy to be responsible for 31% of total emissions. This correlates well with VIEO data, which shows WAPA residential sales to be on the order of 287,000 MWh per year (Southern States Energy Board, USVI Energy Office, 2009). Using our emission factors, this would account for 310,000 tCO_2e per year. This is very similar to our territorial estimate of 350,000 tCO_2e per year, lending to our confidence in the assumptions made for spending trends.

3.2. Limitations

There are a number of limitations that we have come across in the development of this model which will be addressed during its future modification. One of the most difficult issues faced was the lack of information available on spending and consumption patterns in the USVI. This was addressed by using US household consumption trends for corresponding household groups relative to average. However, given differences in the cost of living between the continental US and the USVI, these trends are likely not perfectly aligned. This difference in cost of living might influence patterns such as average household income threshold for car ownership, which may be higher in the USVI. The use of US trend lines should thus be supplemented or replaced by better household survey data.

Another major assumption in the model is the linear relationship between income, spending and quantities of consumption. As income increases, consumption expenditures are often directed toward more

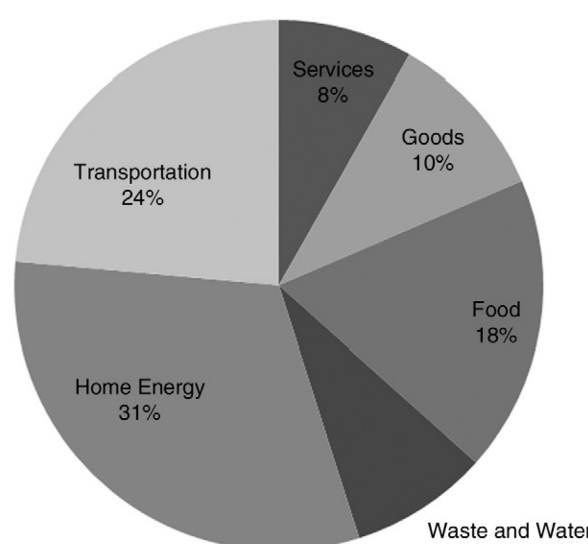

Fig. 5. Total emissions from households in the USVI by commodity.

luxurious products that do not necessarily require proportionately greater resource per unit than goods designed to meet basic needs. This relationship between income and emissions should be explored. In a similar vein, the assumptions used in public transportation spending trends may be overly simplified given that lower income groups often spend a disproportionately larger fraction of income on public transportation. This could explain the relatively small contribution of public transportation to emissions and could also serve to overemphasize the contribution of utilities. Through public transportation surveying work currently being done with the University of the Virgin Islands (UVI) we hope to better approximate public transportation spending.

Another major limitation was in modeling emissions related to the shipping of fuel, food and goods to the island. Most food and goods are imported into the territory (CIA, 2011) so this affects all commodities modeled, even utilities as crude oil is shipped to St. Croix for refining. We were unsuccessful in attempts to obtain information on shipping routes, frequency or cargo loads from the major shipping and distribution companies in the territory. We are currently exploring different avenues of contact for obtaining relevant data. A number of other emission factors also require further investigation. For instance, little data is available on the indirect emissions related to utility activity such as the fuel requirements of garbage disposal transportation services or the construction of cisterns for water collection. We are also working with WAPA to understand indirect emissions related to construction, operation and maintenance of generators.

The fuel economies of motor vehicles and public transportation vehicles in the USVI given shorter road networks, hilly terrain and local driving habits may be significantly different from average US fuel economies. There are also a number of transportation options for inter-island transport, including seaplanes, ferries and other marine vessels. Given the commonplace nature of travel between islands, both for leisure and commuting to work, a better understanding of these modes would be useful. Taxis and small buses known locally as Safaris are common modes of public transportation on island. Ferries and seaplanes are popular methods for traveling between islands. We attempted to obtain information on ridership and passengers for taxi companies, ferry companies and inter-island air travel companies but were unsuccessful. The ECC survey reports household spending on fares for taxis and ferries but we cannot correlate gross spending on fares to passenger miles traveled. The UVI public transportation survey along with future work with the Port Authority, Air Port Authority and the Bureau of Motor Vehicles, should address this gap.

3.3. Conclusions and Future Work

The calculator as presented here is still in formative stages but has already spurred significant local interest given its various applications. In keeping with the USVI ambition of achieving 60% reduction in fossil fuel use by 2025, the VI Energy Office has established 'VI Energize' a public awareness campaign aimed at informing citizens about the progress continually being made by the Energy Office (National Renewable Energy Laboratory, 2011). Another aim of the campaign is to encourage sustainable lifestyle choices throughout communities so that inhabitants of the islands develop a sense of interest, responsibility and stakeholder-ship in moving the territory to a more self-sufficient energy future. Our analysis provides a useful tool for this public sensitization program. We also provide useful insights into scope for energy use improvements that can come from the residential sector in the USVI. This is important in determining the most effective low carbon community strategies and how to stimulate residential behavioral change (Heiskanen et al., 2010; Junhua and Ying, 2011).

The results of our study demonstrate the importance of electricity, transportation and food as categories of consumption that contribute to GHG emissions and, by extension, draw heavily on energy resources imported into the territory. This analysis might provide support for the Energy Office and related agencies to propose transportation policies that target fuel efficiency. There is also a rational for further research into the potential benefits of alternative transportation and the accessibility of the public transportation system. The tool can also be helpful in policy discussions surrounding the societal costs and benefits that might come from greater focus on either demand side or supply side efficiency in electricity production. Our interactive tool can be used directly for educational purposes in schools, community demonstrations and other campaign events to explain the concepts of carbon and energy conscientiousness. Results can serve as a powerful statement in such forums, encouraging community discussion about driving habits, local agriculture, conservation and household energy use.

To best serve in such capacities, there are many ways the footprint tool can be built upon and a number of research initiatives have been established to obtain territory-specific data sets as outlined in sections above. Current and future work involves: (i) implementing of Transportation Survey to explore local estimates of vehicle fuel efficiency and ridership for intra- and inter-island transportation, (ii) obtaining estimates of fuel needs for imports and shipping food, goods and services from shipping companies, (iii) developing better estimates of inter-island air travel spending and emissions, (iv) developing more accurate consumer expenditure assumptions across income and household size groupings, (v) developing a climate action planner and pledge page for the calculator with suggestions for emissions reduction behaviors, to enhance its capacity as a learning tool. By increasing the resolution of the footprint tool we will contribute to an understanding of behavior and consumption patterns in US communities. The uniqueness of US island territories is often overlooked in collecting information for national databases. In conducting this research we contribute, in small part, to a national scientific sensitization to the character of marginal communities.

In designing this carbon footprint calculator we have developed a framework for further analysis of spending trends and energy use within the USVI residential sector. This is the first calculator to be developed for the Caribbean region or for a US island territory and one of the first for SIDS in general. The model shows electricity use and private road transportation to be major contributors to spending and energy use, providing support for energy efficiency strategies that relate to domestic energy use and travel. We have also highlighted areas of data deficiency and have initiated a number of offshoot research initiatives that will hopefully enhance the tool's ability to guide audiences toward responsible consumption choices. As more reliable data becomes available, we intend to expand the calculator to the local tourism and business sectors, having demonstrated that this is a useful exercise given the nature of island territories.

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