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Article

Ecological Footprints and Lifestyle Archetypes: Exploring Dimensions of Consumption and the Transformation Needed to Achieve Urban Sustainability

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Abstract: The global urban transition increasingly positions cities as important influencers in determining sustainability outcomes. Urban sustainability literature tends to focus on the built environment as a solution space for reducing energy and materials demand; however, equally important is the consumption characteristics of the people who occupy the city. While size of dwelling and motor vehicle ownership are partially influenced by urban form, they are also influenced by cultural and socio-economic characteristics. Dietary choices and purchases of consumable goods are almost entirely driven by the latter. Using international field data that document urban ways of living, I develop lifestyle archetypes coupled with ecological footprint analysis to develop consumption benchmarks in the domains of: food, buildings, consumables, transportation, and water that correspond to various levels of demand on nature's services. I also explore the dimensions of transformation that would be needed in each of these domains for the per capita consumption patterns of urban dwellers to achieve ecological sustainability. The dimensions of transformation needed commensurate with ecological carrying capacity include: a 73% reduction in household energy use, a 96% reduction in motor vehicle ownership, a 78% reduction in per capita vehicle kilometres travelled, and a 79% reduction in air kilometres travelled.

Keywords: urban; sustainability; ecological; footprint; cities; consumption; benchmark; household; lifestyle; archetype

1. Introduction

Scientists have coined this the age of the Anthropocene, an era defined by the extraordinary impact humanity has in shaping earth's topography and influencing global ecosystems [1,2]. This is also the era of the global urban transition, marked by the majority of humanity now living in cities [3]. The global urban transition increasingly positions cities as important in determining sustainability outcomes because they serve as a nexus of consumption activity and related source of pollution [4–8].

Cities are dissipative structures that rely on vast imports of energy and materials to retain internal coherence of form and function [5,9–11]. Despite technological advancements in energy and materials efficiency across the global economy of 30% and 50% respectively [12], urban metabolism studies reveal that resource consumption in cities is growing [13–18]. This observation is important in light of two important facts: first, cities already account for 75% of global resource consumption and greenhouse gas emissions [4]. Second, humanity's ecological footprint, a measure of demand on nature's services [19], already exceeds global biocapacity supply by 50% [20].

Cities can offer highly efficient forms of living in terms of providing compact urban spaces where people can meet their daily needs with limited reliance on fossil fuels and efficient distribution of infrastructure services [4,18,21,22]. However, global urbanization establishes infrastructures of provisioning that lock more than half the world's population in unsustainable patterns of production and consumption [23–25]. This seeming paradox between the internal efficient distribution of resources within cities and the unsustainable inter-regional exchange of resources between cities and the hinterlands that support them points to the importance of considering cities within their bioregional and global ecological context. The city and the dispersed hinterlands from where it draws resources comprise an inseparable urban ecosystem [5,9,19,26,27]. The future of cities depends on urban development trajectories that take this whole urban ecosystem into account.

To achieve ecological sustainability, significant and absolute reductions are needed in demand on nature's services to yield resources and assimilate wastes. Estimates range from a factor of five [12] to ten [28]. This translates to an 80% to 90% reduction in energy and materials flows through the global economy [12]. An important question, therefore, is what dimensions of transformation are needed for cities to become sustainable, defined as existing within global ecological carrying capacity?

Much of the urban sustainability literature addresses the built environment, describing land use and design characteristics of buildings, streets and related infrastructure. However, equally important is the consumption characteristics of the people who occupy the city, including their dietary choices, purchases of consumable goods, patterns of motor vehicle ownership, *etc.* Some of these attributes are influenced by the physical characteristics of the city, but they are also influenced by income levels, cultural characteristics, and personal values [16,29,30].

My objective is to explore the dimensions of transformation that are needed in consumption patterns that define urban ways of living such that they do not exceed per capita, global, ecological carrying capacity. Specifically, I address the following questions:

(1) What patterns of per capita household consumption in food, buildings, consumables, transportation, and water align with global ecological carrying capacity?
(2) How big is the gap between world average per capita household consumption and what would be needed to stay within global ecological carrying capacity?

(3) What dimensions of transformation are needed in per capita household consumption to achieve urban sustainability?

Answers to these questions provide new insights regarding: (a) qualitative descriptions of consumption patterns conducive to urban sustainability, and unsustainability; at the household level; (b) quantitative assessment of the reductions in global average household consumption needed to achieve urban sustainability as measured through ecological footprint analysis; (c) identification of the predominant aspects of household consumption that would need to be transformed in order to achieve urban sustainability, defined as living within global ecological carrying capacity.

2. Research Approach and Methods

Building on Moore [23], I use ecological footprint analysis (EFA) in combination with lifestyle archetypes of urban dwellers from around the world to probe how consumption characteristics in the domains of food, buildings, consumables, transportation, and water play a role in determining urban sustainability outcomes. I chose these five areas because they capture the majority of directly measured household and personal consumption data for energy and materials. Each lifestyle archetype represents the average consumption and household characteristics of urban dwellers according to their cities' (and/or countries') average ecological footprint.

EFA estimates the area of biologically productive land and water required to continuously support the material and energy consumption and waste assimilation demands of a given population at prevailing levels of technology, money income, and socio-cultural values [19]. Specifically, it orients the city within its global context by accounting for its ecological load, meaning the productive land required to support its biological and industrial metabolism "wherever on Earth that land is located" [19] (p.11). It can address not only the life processes of urban residents but also the technological, physical and mechanical demands of modern lifestyles [19]. This enables the ecological footprint to be applied to anything that consumes energy and materials—including cities, their buildings and infrastructure, and/or the urban populations that reside within them [6]. Thus, EFA can inform an integrated approach to urban policy development that addresses both urban form and social behaviour.

Differing consumption patterns and their corresponding ecological loads can be compared across cities, or countries, or used to inform equity issues when the footprint is assessed against the "fair Earthshare" estimated as the average amount of bio-productive capacity available on a global per capita basis [19] (p. 54). With 7.3 billion people on Earth and only 12 billion hectares of ecologically productive land and sea area, the Earthshare is estimated at approximately 1.7 hectares of land per person [31], assuming average global ecological productivity across all hectares, also known as a "global hectare" (gha) [32].

If everyone lived within the global ecological productivity of a fair and/or average Earthshare (1.7 gha/ca), humanity could live sustainability within the carrying capacity of Earth. This concept is also known as one-Earth or one-planet living [19,23,33]. Following the same logic, people who demand more than this amount of nature's services to support their lifestyles (*i.e.*, demanding between 1.7 gha/ca and 3.4 gha/ca) are living a two planet lifestyle. This is because if everyone lived this way it would take more resources than our single Earth could supply. The assumption is that another Earthlike planet would be needed in order to supply the excess demand. People living at more than twice the average Earthshare (*i.e.*, at more than 3.4 gha/ca) are said to be living a three-planet lifestyle and so on.

I used the WWF [20] living-planet ecological footprint index to identify and group countries according to their average per capita ecological footprint at the one-planet, two-planet, and three-planet (or more) levels of consumption. I chose to use the study year 2007 because this was the most recent year for which equivalence factors (used in ecological footprint analysis) were available at the time the research was undertaken (see WWF [34]). I also reviewed ecological footprint analyses of cities within the countries indexed, making an effort to locate EFA studies within countries at the various levels corresponding to: one-planet, two-planet, three-planet or more levels of per capita demand on nature's services. These studies included the following countries: Italy [35], Canada [36], Norway [16], China [17], Chile [37], United Kingdom [38], and United States of America [39].

I then undertook a literature search of field study data that qualitatively and quantitatively described patterns of average household consumption in various countries. I paid particular attention to any studies in cities for which an ecological footprint analysis had also been undertaken. The data from the field study literature included: caloric intake, food consumption by type and weight [40–48], number of household members, size of dwelling space, dwelling type, motor vehicle ownership, vehicle kilometres travelled, ownership of personal appliances by type [16,49–51], and per capita municipal solid waste by type and weight [52]. I further complemented the field study research with an analysis of urban metabolism studies, where available, for cities in the countries identified in the step above. These studies documented average per capita consumption of energy by type and associated carbon dioxide emissions, consumption of water, production of municipal solid waste by type and weight [8,15,17,35].

I also pursued analysis of country-wide statistical data for average household and per capita consumption to complement the city-specific data. The analysis comprised: caloric intake, meat consumption, water consumption, household size, energy use within households by energy type and associated carbon dioxide emissions, motor vehicle ownership, average vehicle kilometres travelled, carbon dioxide emissions associated with total average per capita consumption [53–55], public transit use [53], and air travel [53,56]. I also documented average income and human development indicators (e.g., years of education, literacy, and longevity) [54,55,57–59].

I then used triangulation to match those countries for which I had collected household and per capita urban consumption data to the countries in the WWF [20] living-planet ecological footprint index at the one-planet, two-planet, three-planet, or more levels of demand on nature's services in order to short list a sample selection of case studies. Eleven countries were included in the one-planet category, eight in the two-planet category, and fifteen in the three-plus-planet category, for a total of thirty-four countries (see Table 1, originally presented in Moore [23]). By correlating average household and per capita consumption and waste data with the city's and/or countries corresponding average, per capita ecological footprint data, I was able to establish a range of consumption benchmarks in the domains of food, buildings, consumables, transportation, and water that map to one-planet, two-planet, three-planet (or more) living. I used the findings to build profiles that include a qualitative description of personal and household consumption patterns coupled with quantitative data pertaining to both consumption and ecological footprint. I then used these profiles, with their respective consumption benchmarks, to develop lifestyle archetypes for one-planet, two-planet, three-planet living, *etc.*

The word "lifestyle" means an approach to living that includes habitual behaviours and moral attitudes [60]. A lifestyle can also be affected by the political, geo-physical, and socio-economic conditions in which a person finds themselves. The word "archetype" means an original pattern, model, or prototype [60]. In this research, the two words combined describe patterns of living that can be used as prototypes.

Table 1. Countries in the research sample grouped by average per capita ecological footprint.

Country Name	Ecological Footprint (gha/ca)
THREE-PLUS-PLANETS (>6 gha/ca)	
United States of America	7.99
Canada	7.00
Australia	6.83
Kuwait	6.33
THREE-PLANETS (6<>4 gha/ca)	
Sweden	5.88
Norway	5.55
Mongolia	5.53
Spain	5.42
Germany	5.09
Italy	4.98
United Kingdom	4.90
New Zealand	4.89
Israel	4.82
Japan	4.71
Russia	4.44
TWO-PLANETS (4<>2 gha/ca)	
Chile	3.23
Mexico	2.99
Brazil	2.90
Bosnia and Herzegovina	2.76
Argentina	2.60
Thailand	2.36
South Africa	2.30
China	2.21
One-Planet (<2 gha/ca)	
Mali	1.93
Ecuador	1.88
Cuba	1.84
Guatemala	1.78
Uzbekistan	1.74
Viet Nam	1.40
Iraq	1.35
Philippines	1.30
Ethiopia	1.11
India	0.91
Haiti	0.67

3. Results and Discussion

Table 2 (modified from Moore [23]) reveals that the three-plus-planet countries have the highest levels of consumption across virtually all domains of consumption. They also have the highest human development index rating, a metric comprising socio-economic indicators including education, health and income [61]. In general, the progression from high to low consumption correlates with the archetype groupings, where the lowest levels of consumption and human development are associated with the one-planet archetype. Nevertheless, there are some exceptions within and between the archetypes that reveal important opportunities for further investigation. For example, many of the countries in the three-planet archetype, e.g., Germany and Japan, achieve commensurate levels of education and longevity with countries in the three-plus archetype. This implies that past a certain point, consumption is not directly correlated with human development outcomes. This finding is corroborated in the literature [62]. Also, some countries in the one-planet archetype, e.g., Ecuador and Cuba, achieve a high human development index commensurate with that of the three-planet archetype [54,59].

Table 2. Summary of consumption data by lifestyle archetype.

Component	Three-Plus-Planets (>6 gha/ca)	Three-Planets (6–4 gha/ca)	Two-Planets (4–2 gha/ca)	One-Planet (<2 gha/ca)	World Average
Ecological Footprint (gha/ca)	7.04	5.11	2.76	1.45	2.21
Carbon Footprint (tCO_2/ca)	19	9	4	1.5	4.1
Food					
(t/ca)	0.693	0.857	0.693	0.548	n/a
Daily caloric supply	3525	3240	2893	2424	2809
Buildings (kWh/ca)	14,381	8850	2545	692	2596
Built Area (m^2/ca)	51	29	13	8	10
Consumables					
(Paper t/ca)	0.2	0.2	0.1	0.01	0.1
and Wastes					
(solid waste t/ca)	0.55	n/a	0.41	0.25	n/a
Transportation					
Vehicle/ca	0.5	0.5	0.28	0.004	0.1
Vehicle kmT/ca	9482	5550	1265	582	2600
Air kmT/ca	3622	2264	484	125	564
Transit Ridership	10%	20%	24%	19%	n/a
Water					
(m^3/ca)	1159	498	702	822	632
% domestic	23%	24%	13%	9%	10%
Human Development					
Life Expectancy (years)	79	79	71	66	67
Education (years)	16	16	14	11	12
Literacy Rate (%)	98	99	94	72	n/a
Affluence Gross National Income (PPP $/ca)	38,953	29,996	10,023	5207	n/a

There is general correlation across the archetypes such that the higher the ecological footprint, the higher is the carbon footprint, caloric intake, building energy use, dwelling space, vehicle ownership, vehicle and air kilometers travelled, residential water consumption, longevity, literacy and income. While not a surprising finding in and of itself, there are also some intriguing nuances. For example, total amount of food consumed is not strongly correlated with the ecological footprint, implying that the type of food eaten in the diet plays a greater role in influencing the footprint than the amount of food consumed. For example, the per capita tonnage of food consumed in the three-plus archetype is equivalent to that of the two-planet archetype and both are lower than that of the three-planet archetype. This observation is corroborated in the literature, with specific attention given to the role that consumption of meat plays in influencing high ecological footprint outcomes for affluent societies [16]. By contrast, although the tonnage of food consumed in the two-planet archetype is similar to that of the three-plus archetype, the two-planet archetype is characterized by a greater reliance on carbohydrates in the diet (see Tables 3 and 4 below). Similarly, the total amount of water consumed is not strongly correlated with the ecological footprint, but percentage of water allocated to residential consumption is. Finally, there is weak correlation between transit ridership and the ecological footprint. This is probably due to the fact that for very poor societies, walking supersedes transit as a dominant form of transportation [63].

Table 3 (originally presented in Moore [23]) comprises a summary of statistical data and a description of average lifestyles within the one-planet countries studied. Data is from: CIA [58], FAO [40–47], World Bank [55,64,65], UN Habitat [52], WRI [54], Worldmapper [53], ICAO [56], Menzel and D'Aluisio [48], Menzel and Mann [51].

Table 4 comprises a summary of statistical data and a description of average lifestyles within the two-planet countries studied. The same statistical data sources are used as for Table 3.

Table 5 comprises a summary of statistical data and a description of average lifestyles within the three-planet countries studied. The same statistical data sources are used as for Table 3 above. Note that because of the small sample of cases comprising lifestyles at more than three-planet living, an individual profile is not presented. The reader can reasonably assume that qualitative descriptions for the more than three-planet lifestyle would generally follow those of the three-planet, albeit at higher levels of quantitatively measured consumption.

Reflecting on the data captured in Tables 2–5, it is clear that low consumption is correlated with low ecological footprints. Through the lifestyle archetypes analysis, and the data presented in Table 3 specifically, it is now possible to identify specific values for consumption in food, buildings, consumables, transportation, and water that align with the global, per capita, ecological carrying capacity goal of one-planet living. These data can be used as consumption benchmarks to help identify whether per capita household consumption across the city, or within specific parts of a city, align with or exceed global per capita ecological carrying capacity. As such, these data can provide a useful template to help governments and citizens identify what actions might be appropriate to take in an effort to reduce their own ecological footprint. The data could also be used to complement urban metabolism studies that capture the average energy and materials flows of a city for multiple sectors, including residential, commercial, institutional and industrial. The data can also help identify those aspects of household consumption that are driven by socio-economic factors, such as diet or air travel, for which urban policy directed at land use and built environment are ineffectual. Finally, in comparing the average consumption patterns of households within a given city to those developed in this research for the one-planet, two-planet and three-planet lifestyle archetypes, city officials and citizens have a means by which to identify how their local consumption patterns map to those in the various archetypes. They can also identify the general magnitude of reductions that would be needed across the domains of food, buildings, consumables, transportation, and water in order to move towards the ecologically sustainable one-planet living archetype.

Table 3. International profile of one-planet living (under 2.0 gha/ca).

Component	Consumption (units/ca/year)	Comments
Ecological Footprint	1.45 gha	Ecological footprint values range from 0.67 to 1.93 gha/ca.
Carbon Dioxide Emissions	1.5 tCO_2	Includes total country emissions amortized over the entire population. Emissions range from 0.1 to 5 tCO_2/ca. Approximately 0.2 tCO_2/ca can be attributed to emissions from home heating and electrification.
Food	548 kg Includes: meat 21 kg	The diet is predominantly vegetarian with 40%–60% of daily energy supplied from cereal crops and 4%–7% from meat. Average daily consumption is 2424 calories. Approximately 66% of total income is spent on food, supplemented by subsistence agriculture. With the exceptions of Ecuador and Cuba, malnutrition and food insecurity remain a challenge.
Buildings and Built Area	8 m^2 692 kWh 0.2 toe (Measures the amount of primary energy from all sources consumed by the residential sector (excluding transportation) in unit of tonnes of oil equivalent (toe)) 0.2 tCO_2	Less than half the population (45%) is urban, with approximately 5 people per household. Approximately 70% of the urban population has access to sanitation services and infrastructure.
Consumables and Wastes	0.3 radio 0.2 telephone 0.2 TV 0.02 computer 10 kg paper 247 kg waste	There is no disposable income. Most consumable items are shared both within and among households. Many items are re-purposed and reused.
Transportation	0.02 vehicles 582 VkmT 125 AkmT	There is low to no ownership of motorized passenger vehicles. Approximately 19% of the population uses public transit for commuting purposes. Personal motorized vehicle travel averages 582 km/ca and air travel 125 km/ca.
Water	74 m^3	Only 9% of total water consumption (822 m^3/ca/year) is utilized for domestic purposes.
Human Development	0.544 HDI	With the exceptions of Cuba and Ecuador, the Human Development Index ranges from low (0.430) to medium (0.595).

Table 4. International profile of two-planet living (between 2.0 gha/ca and 3.4 gha/ca).

Component	Consumption (units/ca/year)	Comments
Ecological Footprint	2.76 gha	Ecological footprint values range from 2.21 to 3.23 gha/ca.
Carbon Dioxide Emissions	4 tCO_2	Includes total country emissions amortized over the entire population. Emissions range from 2 to 8 tCO_2/ca. Approximately 0.2 tCO_2/ca can be attributed to emissions from home heating and electrification.
Food	693 kg Includes: meat 29 kg	The diet is predominantly vegetarian with 30%–46% of daily energy supplied from cereal crops and 8%–16% from meat. Average daily consumption is 2893 calories. Approximately 30% of total income is spent on food.
Buildings and Built Area	13 m^2 2545 kWh 0.2 toe (Measures the amount of primary energy from all sources consumed by the residential sector (excluding transportation) in unit of tonnes of oil equivalent (toe)) 0.2 tCO_2	Almost two thirds of the population (64%) is urban, with approximately 4 people per household living in relatively high density urban form. Approximately 76% of the urban population has access to sanitation services and infrastructure.
Consumables and Wastes	0.42 radio 0.6 telephone 1.3 TV 0.07 computer 100 kg paper 374 kg waste	Approximately 60% of income is disposable. Most consumable items are shared both within and among households. Many items are re-purposed and reused.
Transportation	0.28 vehicles 1265 VkmT 484 AkmT	There is approximately one motor vehicle per household. Approximately 24% of the population uses public transit for commuting purposes. Personal motorized vehicle travel averages 1265 km/ca and air travel 484 km/ca.
Water	91 m^3	Approximately 13% of total water consumption (702 m^3/ca/year) is utilized for domestic purposes.
Human Development	0.703 HDI	The Human Development Index ranges from (0.601) to (0.780).

Reflecting on the data captured in Tables 2–5, it is clear that low consumption is correlated with low ecological footprints. Through the lifestyle archetypes analysis, and the data presented in Table 3 specifically, it is now possible to identify specific values for consumption in food, buildings, consumables, transportation, and water that align with the global, per capita, ecological carrying capacity goal of one-planet living. These data can be used as consumption benchmarks to help identify whether per capita household consumption across the city, or within specific parts of a city, align with or exceed global per capita ecological carrying capacity. As such, these data can provide a useful template to help governments and citizens identify what actions might be appropriate to take in an effort to reduce their own ecological footprint. The data could also be used to complement urban metabolism studies that capture the average energy and materials flows of a city for multiple sectors, including residential, commercial, institutional and industrial. The data can also help identify those aspects of household consumption that are driven by socio-economic factors, such as diet or air travel, for which urban policy directed at land use and built environment are ineffectual. Finally, in comparing the average consumption patterns of households within a given city to those developed in this research for the one-planet, two-planet and three-planet lifestyle archetypes, city officials and citizens have a means by which to identify how their local consumption patterns map to those in the various archetypes. They can also identify the general magnitude of reductions that would be needed across the domains of food, buildings, consumables, transportation, and water in order to move towards the ecologically sustainable one-planet living archetype.

Table 5. International profile of three-planet living (between 3.4 gha/ca and 6.0 gha/ca).

$IsI_i(p)$ Component	Consumption (units/ca/year)	Comments
Ecological Footprint	5.11 gha	Ecological footprint values range from 4.82 to 5.88 gha/ca.
Carbon Dioxide Emissions	9 tCO_2	Includes total country emissions amortized over the entire population. Emissions range from 5 to 11 tCO_2/ca. Approximately 0.7 tCO_2/ca can be attributed to emissions from home heating and electrification.
Food	857 kg Includes: meat 25 kg	Increasing amounts of processed food, including bottled beverages, comprise the diet. Average daily consumption is 3240 calories. Approximately 20% of total income is spent on food.
Buildings and Built Area	29 m^2 8850 kWh 0.6 toe (Measures the amount of primary energy from all sources consumed by the residential sector (excluding transportation) in unit of tonnes of oil equivalent (toe)) 0.7 tCO_2	Approximately 75% of the population is urban, with approximately 3 people per household. Over 95% of the urban population has access to sanitation services and infrastructure.
Consumables and Wastes	0.68 radio 0.8 telephone 0.6 TV 0.32 computer 200 kg paper 450 kg waste	Approximately 60% of income is disposable. Most consumable items are shared both within and among households. Many items are re-purposed and reused.
Transportation	0.5 vehicles 5550 VkmT 2264 AkmT	There is more than one motor vehicle per household. Approximately 20% of the population uses public transit for commuting purposes. Personal motorized vehicle travel averages 5550 km/ca and air travel 2264 km/ca.
Water	120 m^3	Approximately 24% of total water consumption (498 m^3/ca/year) is utilized for domestic purposes.
Human Development	0.849 HDI	The Human Development Index ranges from (0.733) to (0.940).

I can also now answer the question: how big is the gap between world average per capita household consumption and what would be needed to stay within global ecological carrying capacity. Table 2 presents the consumption benchmarks associated with global average consumption as well as that associated with one-planet living. Recall that one-planet living requires an average demand on nature's services no greater than 1.7 gha/ca. According to Table 2, the world average ecological footprint is 2.21 gha/ca. This means that the global average ecological footprint would need to be reduced 23% (down 0.51 gha/c from 2.21 gha/ca). If I were to use the one-planet archetype presented in Table 2 as the benchmark value then the reduction would be 34% (down 0.76 gha/ca from 2.21). This difference can be attributed to the characteristics of the limited sample size used to compile the consumption benchmarks in the one-planet lifestyle archetype. Future research encompassing a broader sample size is needed to narrow the discrepancy. Nevertheless, the findings point towards a reduction somewhere between one-third and one-quarter of current average ecological footprint that would be needed to bring the global population in alignment with global per capita ecological carrying capacity.

Following this same procedure, I can also estimate the dimensions of transformation needed in per capita household consumption to achieve urban sustainability in each consumption domain, including the overall carbon footprint. The following reductions would be needed to close the gap between world average per capita household consumption and ecological carrying capacity: 63% reduction in the average per capita carbon footprint, a 14% reduction in average per capita caloric intake, a 73% reduction in household energy consumption, a 20% reduction in per capita dwelling space, a 96% reduction in per capita motor vehicle ownership, a 78% reduction in per capita vehicle kilometres travelled, and a 79% reduction in per capita air kilometres travelled.

Although these only represent rough estimates, the magnitude of reduction begins to demonstrate a pattern somewhat reminiscent of the 80% to 90% reductions in energy and materials throughput identified by von Weizsäcker *et al.* [12] and Rees [28]. Of course, the magnitude of reduction would be greater for that portion of the global population consuming at levels commensurate with the two-planet, three-planet and three-plus planet lifestyle archetypes respectively (see Table 6).

While food often represents one of the most significant components in ecological footprint assessments of cities [16,23,35]; the research points to more traditional foci on buildings and transportation as areas where the greatest transformations would be needed, including in air travel which falls outside the influence of the built environment. Consumables and to a lesser extent the wastes associated with their use also represent important opportunities for transformation. However, with only one category for consumable products represented in this analysis, *i.e.*, paper, it would be premature to speculate on whether it represents a significant opportunity for transformation. Further research to characterize a broader range of consumable products across the archetypes could benefit this line of inquiry. Qualitative descriptions of the lifestyle archetypes (see Tables 2–5) characterize several appliances commonly found in households, all of which use energy to operate. Because the research already captures energy use in buildings as a distinct category, I have not included appliances in Table 6 to avoid double-counting or overstating their importance. Water, although scarce in many parts of the world, does not seem to have a significant impact on ecological footprint assessments because of the assumption that the water molecule itself is not taken out of the global hydrological cycle as it passes through households in cities [66]. What is counted in EFA is the disturbed land area associated with water provisioning (e.g., a man-made reservoir) and the energy associated with the treatment and conveyance of water [66]. This could explain the stronger correlation between urban sustainability and water use as a percentage of domestic consumption, based on the assumption that all urban water supplies rely to some degree on energy for treatment and conveyance. Further investigation into the domains of consumption and the dimensions of transformation that would be needed to achieve urban sustainability are clearly warranted.

Table 6. Dimensions of transformation needed to achieve urban sustainability.

Component	Three-Plus-Planets (>6 gha/ca)	Three-Planets (6–4 gha/ca)	Two-Planets (4–2 gha/ca)	One-Planet (<2 gha/ca)	World Average
Ecological Footprint (gha/ca)	−79%	−72%	−47%	1.45	−34%
Carbon Footprint (tCO_2/ca)	−92%	−83%	−63%	1.5	−63%
Food					
(t/ca)	−21%	−36%	−21%	0.548	n/a
Daily caloric supply	−31%	−25%	−16%	2424	−14%
Buildings					
(kWh/ca) and	−95%	−92%	−73%	692	−73%
Built Area (m^2/ca)	−90%	−72%	−63%	8	−20%
Consumables					
(Paper t/ca)	−95%	−95%	−90%	0.01	−90%
and Wastes					
(solid waste t/ca)	−55%	n/a	−39%	0.25	n/a
Transportation					
Vehicle/ca	−99%	−99%	−99%	0.004	−96%
Vehicle kmT/ca	−94%	−90%	−54%	582	−78%
Air kmT/ca	−97%	−94%	−74%	125	−79%
Transit Ridership	+9%	−1%	−5%	19%	n/a
Water					
(m^3/ca)	−29%	+65%	+16%	822	+30%
% domestic	−20%	−15%	−4%	9%	−1%

4. Conclusions

The research demonstrates a preliminary attempt to profile different levels of average per capita household consumption using lifestyle archetypes and correlating demand on nature's services using ecological footprint analysis. The research contributes new insights regarding what patterns of per capita household consumption in the domains of food, buildings, consumables, transportation, and water align with global per capita ecological carrying capacity, defined as one-planet living. Features of the one-planet living archetype include low per capita carbon dioxide emissions of 1.5 tCO_2, a predominantly vegetarian diet of 2424 calories per capita per day, large households (e.g., five people on average) sharing a relatively small dwelling space (8 m^2/ca), in which most appliance and consumable items, such as radios, telephones, televisions and computers are shared. There is low vehicle ownership (0.02 vehicles/ca), low vehicle kilometres travelled (582 km/ca), and very little travel by airplane (125 km/ca). To achieve per capita ecological carrying capacity, the global community would, on average, need to reduce its ecological footprint between 34% and 24%. Those societies at higher levels of consumption would face much larger reductions than those already living close to the one-planet archetype. On average, the dimensions of transformation needed commensurate with ecological carrying capacity include: a 73% reduction in household energy use, a 96% reduction in motor vehicle ownership, a 78% reduction in per capita vehicle kilometres travelled, and a 79% reduction in air kilometres travelled.

Material flow analysis (MFA) is a useful tool for understanding the energy and material metabolism of a city and its per capita distribution across its resident population. However, these studies are costly and seldom performed. Fewer still are the studies that link that metabolism to the associated demands on nature's services using ecological footprint analysis. The use of lifestyle archetypes can provide a quick reference guide to help urban planners and policy makers understand whether, based on household or individual consumption data, their city is likely to fall within the one-planet, two-planet, three-planet (or above) demand on nature's services. The use of lifestyle archetypes can also help illuminate those aspects of per capita household consumption that fall outside the influence of policy changes affecting the built environment, e.g., dietary choices, air travel, and consumable purchases.

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Conflicts of Interest

The author declares no conflict of interest.

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