SOCIO-STRUCTURAL FORCES PREDICTING GLOBAL INEQUALITY OF WATER CONSUMPTION: AN EMPIRICAL STUDY AND PATH MODEL

by

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I dedicate this thesis to my mother.

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ABSTRACT

Water quantity and use are important in the modern world system, as natural resources are exploited extensively by capitalist interests in industrially advanced, core nations while the lower strata of the world system in the economically peripheral countries are left with limited access to natural resources, particularly water resources. Despite the sociological importance of water resources, there is little research on global water usage from a world systems perspective. This study uses data from 174 countries to examine how socio-structural forces—world system position, per capita beef consumption, per capita energy consumption, and urbanization—affect water resource consumption as measured by per capita water footprint. Findings show that 50% of the variance in per capita water footprint is explained by these structural forces. Per capita beef consumption and per capita energy consumption have significant positive direct effects, and world system position has a significant indirect effect, on per capita water footprint, after controlling for other variables.

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INTRODUCTION

Modern civilization puts unprecedented pressure on the carrying capacity of nature in many different ways. Consumption practices, in particular, have a determining effect on resource depletion. Variation in global consumption practices can be extensively explained by global inequality patterns. The current study examines underlying social forces at the global scale that affect water consumption practices. Given the social implications of water resources, I contend that it is sociologically important to understand hydro-social dynamics, or the interdependent relationship between society and water resources. Despite its sociological importance, very little sociological research has been done on this topic. Most empirical investigations into water resources have been done in the earth sciences. Therefore, the academic and policy realms of water resources have been replete with hydro-scientific analyses of water resources and technological solutions for water resource management.

Lack of sociological attention to water resources stems from at least three related factors. First, the broader area of society-environmental study has long been ignored by classical sociologists (Dunlap and Catton 1994). Second, the common social perception of water resources as “limitless natural resources” may have led sociologists to ignore the seriousness of this issue (Ciampi 2013). Third, the domination of water research by hydro-sciences may also have led sociologists to conclude that this is not a sociological domain. Despite limited sociological attention, there have been a few sociological studies (e.g., Baer 1996; Longo and York 2009; Ciampi 2013) that deal with global water resources. However, most of these are more theoretical than empirical. This study aims to help rectify the imbalance in academic attention to water resources by empirically examining variation in global water consumption using a sociological perspective.

A key theoretical perspective used by sociologists in analyzing global environmental issues is world systems theory. However, global water resources have garnered little attention from world systems analysts. World systems analysts have looked at several other environmental issues, such as the connection between world system position and issues such as greenhouse gas emissions (e.g., Jorgenson 1995) and ecological footprint (e.g., Jorgenson 2003; Jorgenson and Burns 2006; Kick and McKinney 2014). Analysis of global water resources would also benefit from world systems theory. In accordance with world systems theory and prior research, I argue that global water resources are disproportionately consumed by core/advanced countries of the world. These core countries control larger shares of world water resources and engage in unsustainable agricultural and industrial production, negatively affecting global environmental sustainability and socio-economic integrity. The current study empirically examines how the social structure of the modern world system affects water resource consumption. I hypothesize that world system position determines the level of per capita water use. The higher the position (core countries) in the world system, the higher the levels of per capita water use.

SOCIETY AND WATER RESOURCES

Water plays a significant role in shaping human social and economic life. On the one hand, human activity involves substantial amounts of water for production processes in agricultural and industrial sectors, as well as in household use. On the other hand, ecological processes are inherently dependent on water in order to maintain the integrity of ecosystems. Ecosystems are well functioning as long as the water cycle is not disrupted. The extent of current human activities, however, threatens to substantially disrupt the global water cycle (Vörösmarty et al. 2010; UNEP 2008). Disruption of the water cycle would be devastating to aquatic and other ecosystems. Similarly, there are a wide range of social consequences of such a water crisis, such as increasing social conflict over the use of water resources and worsening daily hardships already faced by people in developing nations.

Problems of water availability are attributable to increased rates of water consumption and population growth (Baer 1996; Ciampi 2013). There has been a threefold increase in global water use in the past 50 years (Ciampi 2013). Aquifers are being exploited faster than the aquatic system can refill them (Longo and York 2009; Hanjra and Qureshi 2010). The fact that 50% of the rivers and lakes in the world have been polluted with toxic chemicals (Hanjra and Qureshi 2010), along with other evidence of increasing water pollution, exacerbates water shortages, as water becomes increasingly unusable for human consumption. Increasing global water scarcity could cause a global societal-ecological collapse in the 21st century. According to the United Nations:

> As competition for freshwater resources grows and climate change affects resource availability, it will become more difficult to meet socio-economic-based

demands while maintaining ecosystem integrity and environmental sustainability (UNESCO 2016:27).

Water shortages are likely to have far-reaching effects on social organization. According to UNEP (2008), 450 million people are experiencing water scarcity in 29 countries (Hanjra and Qureshi 2010); it is projected that there will be 25 countries facing water stress in Africa alone by 2025 (UNEP 2008). Indeed, two out of every three people in the world are expected to reside in water stressed areas by 2025 (UNEP 2008; Hanjra and Qureshi 2010). Already, water shortages are significantly impacting the poor in several countries (Ciampi 2013); water shortages worsen the situation poor people already face struggling to meet their basic needs. For instance, the World Health Organization reports that women are those predominantly responsible for collecting water in sub-Saharan African countries. The average trip to collect water takes 30 minutes and they often need to make several trips a day to collect water (Ciampi 2013). Children are also often engaging in water collection, which takes away from time available for education. Many school-aged children have dropped out of school in order to collect water for their families (Ciampi 2013).

With increasing globalization and development, competition will likely increase for water between sectors (agriculture, industry, electricity generation, household). This competition will likely result in greater amounts of water being transferred out of the agricultural sector, leaving less water for food production (Hanjra and Qureshi 2010). Large industrial firms from the core countries will keep producing industrial products, accumulating capital, and dominating the global economy. To do so, they will need to take more and more water from the agricultural sector. The resulting food insecurity will hit poor people in poor countries the hardest (UNEP 2008). Political tension will likely also rise over control and use of water between local, national, and international actors (Hanjra and Qureshi 2010).

WORLD SYSTEMS THEORY

The fundamental proposition of world systems theory is that the entire modern world is one social system in which nation states are social actors; powerful states with strong economies, military power and technological innovations create global structural constraints through which they economically exploit poor countries. For instance, through the creation of international financial institutions, advanced economies adopt trade policies favoring themselves while taking advantage of raw materials and large, cheap labor pools from poor countries. The modern capitalist world system has created three hierarchically structured positions of nations in the world system: core, periphery, and semi-periphery countries. Core countries are wealthy and industrially advanced while periphery countries are poor. Between core and periphery countries, there are semi-periphery countries that are exploited by core countries and that exploit periphery countries (Wallerstein 2004). Semi-periphery countries are more developed than periphery countries and are less developed than core countries.

World systems theory became very popular among environmental sociologists during the early 1990s. The argument presented by world systems researchers who have focused on global environmental degradation is that global natural resources are overexploited by a few wealthy capitalists in industrially advanced core nations. Consequently, the lower strata of the world system in the world’s economic periphery countries are left with little access to natural resources. World systems theory has been widely used as a theoretical framework for explaining environmental degradation or resource exploitation at the global scale (e.g., Jorgenson 1995; Burns et al. 1997; Jorgenson 2003; Jorgenson 2004; Jorgenson and Rice 2005; Rice 2008; Stretesky and Lynch 2009). Previous studies (e.g., Burns et al. 1994; Kick et al. 1996; Bartley and Bergesen 1997) have consistently found a positive association between world system position and various types of environmental degradation (e.g., deforestation, carbon emissions).

Criticizing traditional sociological approaches that focus on individual nation-states, Immanuel Wallerstein developed world systems theory to explain the historical roots of increasing global interconnectedness. The modern world system is a capitalist world economy that came into being during the 16th century. As feudalism was collapsing in Europe, the early stages of industrialization and urbanization were being set. The newly created capitalist system led to the growth of a bourgeoisie class in European cities who needed more natural resources and laborers in order to maximize capital accumulation. This process of capital accumulation expanded to the entire world through European exploration and colonization of new regions. The entire world became interconnected and hierarchically stratified based on one social system -- the capitalist world economy. On the top of the hierarchy in the global stratification system are industrially advanced core countries while the lower strata are economically stagnant poor countries, referred to as periphery nations. The core-periphery relationship is based on a division of labor and a relationship of exploitation. Using market mechanisms and, sometimes, military coercive power, core countries maintain an economic system that helps transfer endless accumulation of capital from periphery to core, leaving periphery countries proletarianized (Wallerstein 2004).

In accordance with world systems theory's propositions, I argue that we must connect environmental problems to global structure. Global structural forces influence resource depletion. Capital accumulation and production processes in the modern world system, as argued by Jorgenson (2003), can be readily associated with environmental outcomes. Substantial empirical evidence over the last several decades has consistently shown that stratification in the world system is an important predictor of various types of environmental degradation. The earliest studies linking environmental problems to world systems theory dealt with deforestation (e.g., Burns et al. 1994; Kick et al. 1996). These studies found that semi-periphery countries had the most catastrophic deforestation (Bartley and Bergesen 1997). Through colonization, core countries in Europe and the USA overexploited forests in Asia and other parts of the periphery and semi-periphery regions of the world.

A second wave of environmental research informed by the world systems perspective focused on greenhouse gas emissions (Bartley and Bergesen 1997). Burns, Davis, and Kick (1997), for instance, found a positive connection between world system position and national emissions of greenhouse gases, such as carbon dioxide and methane. They found that "CO2 production is most closely associated with the core position in the world system, and that methane production is most closely associated with the semi core position" (1997: 452). In departing slightly from Wallerstein, they classified semi periphery countries into two divisions: semi-core and semi-periphery.

Semi-core refers to those countries that are more developed than semi-periphery and very close to core countries in terms of economic advancement.

The third wave of research connecting environmental problems to world systems theory examined the effects of natural resource consumption, international trade, and commodity export on various environmental and social outcomes (e. g., Jorgenson 2004; Jorgenson and Rice 2005; Rice 2008; Stretesky and Lynch 2009). The current study expands on prior world systems research by examining how world system position influences per capita water consumption measured by per capita water footprint.

HYPOTHESES

World system position is highly correlated with other factors that influence natural resource use generally and water use specifically. These additional factors, or socio-structural forces, must be considered when analyzing the impact of world system position on water use. The additional factors considered in this research are: per capita beef consumption, per capita energy consumption, and urbanization. These four variables, world system position, per capita beef consumption, per capita energy consumption, and urbanization, are both theoretically and empirically tied to water consumption, or per capita water footprint.

World system position relates to water consumption specifically because high per capita GDP and less global dependence in terms of trade encourage higher levels of resource consumption in rich countries. Higher consumption requires a higher level of water use. Not only does the volume of total consumption influence water use but consumption patterns also influence water usage. People in advanced economies are extensive consumers of water-intensive products such as meat and energy. Furthermore, higher levels of industrialization and urbanization increase people's income levels which in turn leads to higher consumption in advanced economies. Therefore, I hypothesize that world system position has a significant direct, as well as total effect (direct + indirect [i.e., through the effect of other variables]) on per capita water footprint.

Agricultural consumption patterns (e.g., high vs low meat consumption) are one of the driving forces behind water consumption (Hoekstra and Chapagain 2007). In particular, livestock products require substantially higher amounts of water (directly and indirectly) than crop products because live animals consume drinking water as well as crop products, and they require greater amounts of water in their production processes. Beef production is especially high in water usage. In order to produce 200 kg of boneless beef in a farming system, 7200 kg of roughages, 1300 kg of grains, 24 cubic meters of water for drinking and 7 cubic meters of water for servicing are required. This results in a total of 533401 cubic meters of water needed (Hoekstra and Chapagain 2007).

Although culture and belief systems (e.g., Hinduism, Buddhism, environmentalism) determine beef consumption patterns in some parts of the world and in some philosophies of people, overall beef consumption is largely determined by economic development, industrial farming systems, and articulated markets. People in rich countries with higher levels of income have easy access to industrial farming systems for livestock production and thus, to an industrially produced beef market which in effect increases beef consumption. In accordance with Hoekstra and Chapagain's (2007) argument, I hypothesize that per capita beef consumption is a significant predictor of per capita water footprint.

Energy production is also highly water-intensive. The United Nations reports that 15% of total global water withdrawal is used in energy production, with 90% of this used for power generation (UNESCO 2014). Energy is considered an important prerequisite for the economic development of a country. The industrialization process is hobbled in many developing countries largely due to a lack of energy supply. Thus, levels of energy consumption influence industrialization, urbanization and overall economic development of a country. Energy is an essential element when it comes to industrial production processes. Moreover, people in the richer countries consume a higher level of industrial products. This consumption pattern is also determined by the level of economic development. Since the development of a country is largely dependent on the level of energy consumption, it is logical to argue that countries with higher levels of energy consumption have higher levels of water consumption. I therefore hypothesize that per capita energy consumption is a significant predictor of per capita water footprint.

Previous research has also used urbanization as a predictor for level of natural resource consumption (e.g., Jorgenson 2003; Jorgenson and Burns 2006), hypothesizing that higher levels of urbanization are positively related to per capita ecological footprint. However, inconsistent findings were reported. The argument on which their hypothesis was based is that urban areas shelter higher levels of industrial and economic activities as well as provide an improved market for material commodities which require natural resources for production processes (Jorgenson 2003; Jorgenson and Burns 2006). Furthermore, natural resources are consumed at higher levels by people with higher levels of income and literacy (Jorgenson and Burns 2006). Since levels of income and literacy are higher in urban inhabitants, they tend to consume a higher level of natural resources.

Unlike many other natural resources, water is used mostly for agriculture (70%) while industrial and household use account for 20% and 10% respectively (UNESCO 2016). This might suggest that higher levels of urbanization may not predict higher water consumption since the majority of water is used in the agricultural sector which is based in rural areas. However, overall water withdrawal statistics do not represent the true level of water consumption since water moves “virtually” from rural to urban areas. Virtual water is water used in production of products that are consumed elsewhere. The virtual water required for producing agricultural commodities is imported and consumed by people in urban areas. In addition, many agricultural raw materials are transferred to urban regions for industrial production processes which in turn are consumed largely by people within urban areas. Building on the arguments of previous research, I contend that water resources are mostly consumed by industrial production processes through the use of agricultural raw materials and industrial commodity production in urban areas as well as by those who have higher access to natural resources (the inhabitants of urban regions). I hypothesize that countries with higher levels of urbanization have higher levels of per capita water footprint.

Based on world systems theory and related research, the individual hypotheses tested in this thesis are:

H1: World system position has a positive direct effect on per capita water footprint.

H2: Per capita beef consumption has a positive effect on per capita water footprint.

H3: Per capita energy consumption has a positive effect on per capita water footprint.

H4: Urbanization has a positive effect on per capita water footprint.

H5: World system position has a positive effect on per capita beef consumption.

H6: World system position has a positive effect on per capita energy consumption.

H7: World system position has a positive effect on urbanization.

H8: World system position has a positive total effect on per capita water footprint.

METHODS

Data were collected from several academic and government sources, including the Organisation for Economic Co-operation and Development (OECD) and the World Bank. Specific data sources for each variable are listed below. Data for each variable were collected for all available countries. Units of analysis were individual countries. The final sample size (*n* = 174) for analysis was determined by the number of countries with available information on the dependent variable (per capita water footprint). Missing values on the remaining variables were imputed by the statistical program (AMOS in SPSS) using maximum likelihood estimation. Since missing data is a widespread problem in cross-national study, maximum likelihood estimation is a better technique to handle missing cases than other methods such as listwise or pairwise deletion (Jorgenson 2003). The complete list of countries used in this analysis is given in Appendix A; countries are listed by world system position.

Dependent Variable: Per Capita Water Footprint

Per capita water footprint measures water consumption at the national level. The data for per capita water footprint come from Hoekstra and Mekonnen (2012). Water footprint is defined as the total volume of freshwater used to produce goods and services that are consumed (evaporated and incorporated into products) by the inhabitants of a nation plus water pollution per unit of time (Hoekstra and Mekonnen 2012). While water consumption has traditionally been measured by only taking into account water withdrawals within a national boundary (FAO 2010 cited in Hoekstra and Mekonnen 2012), water footprint considers the total volume of water consumption of a nation by calculating the virtual movement of water from one country to another through trade of commodities and services. The concept of virtual water is central to water footprint measurement. Virtual water refers to the volume of freshwater required to produce goods and services (Hoekstra and Chapagain 2007). When goods and services are imported or exported, the water contents that were required to produce those also virtually move from one country to another. In this era of globalization in which trading of goods and services is unprecedented, substantial amounts of water are virtually traded along with commodities and services all around the world. Water footprint is calculated as internal water footprint of a nation + virtual water import - virtual water export. Unlike conventional water use measurement, gray water (the degree of freshwater pollution) is combined with green (rainwater) and blue water (surface and ground water) to account for internal national water footprint. Three sectors of water use—agriculture, industry and household water supply—are included in the water footprint measure. Since traditional water consumption measures only count water withdrawals internal to a nation, they do not measure actual water consumption levels of a nation since virtual water is not included. In many countries, water consumption through trade may be higher than domestic water withdrawals or vice versa. Thus, per capita water footprint is a better measure of water consumption at the national level. Per capita water footprint is measured in cubic meters. The data for this measure is for the period of 1996-2005. The total number of countries for which data are available is 174. The level of measurement for this variable is the ratio.

Independent Variable: World System Position

World system position is operationalized using Kentor's measure of world system position (Kentor 2000). I have taken the data for this measure from Jorgenson (2003); he converted three categories of countries in the world system into four for the purpose of analysis. Although the level of measurement for this variable is ordinal with four categories (low periphery countries [coded as 1 for analysis], high periphery [2], semi-periphery [3], and core [4]), these four categories are treated as if they are a continuous variable (interval or ratio) for analysis in this thesis. Despite the fact that many world system scholars use only economic aspects to determine a world system position, the modern world capitalist system is largely a function of the interplay of a political/military power of nations and competitive advantage in production (Jorgenson 2004). Kentor's (2000) measure of world system position includes economic, military and political dimensions (Jorgenson 2004) and it resonates with the basic theoretical propositions of Immanuel Wallerstein's world system perspective. The number of countries for which data are available and congruent with my dependent variable is 89. Values for the remaining countries were imputed, as noted earlier.

Intervening Variables

Per capita beef consumption. The data for per capita beef consumption come from OECD for the 1990-95 period (OECD-FAO 2016). The level of measurement for this variable is ratio. The unit of measurement of this variable is kilograms per capita. Although the available sample size for per capita beef consumption is small (n = 41), the distribution of cases by world system position is relatively even. The number of original cases of this variable for low periphery countries is 8, for high periphery is 14, for semi-periphery is 8, and for the core is 6 (5 countries with available data on per capita beef consumption were missing values on world system position). Values of per capital beef consumption for the remaining countries were imputed.

Per capita energy consumption. The data for per capita energy consumption are taken from the World Bank (2014) for the 1990-95 period. The unit of measurement is kilograms of oil equivalent per capita. Per capita energy consumption is defined as primary energy consumption before transformation to other end-use fuels. It is calculated as indigenous production + imports and stock changes - exports and fuels supplied to international ships and aircraft. The level of measurement for this variable is ratio. The sample size for per capita energy consumption is 150. Values of per capita energy consumption for the remaining countries were imputed.

Urbanization. The data for this variable come from the World Bank for the 1990-1995 period (World Bank 2014). These data were originally collected from national statistical offices by the United Nations Population Division. Levels of urbanization are measured by the percentage of total population living in urban areas. The level of measurement for this variable is ratio. The total available cases for urbanization are 168. Values of urbanization for the remaining countries were imputed.

Statistical Approach

All data were entered into SPSS for analysis. Descriptive statistics and a comparison of means (one-way ANOVA) by world system position were run in SPSS for each variable with available data. The AMOS program within SPSS was used to run correlations between all variables and a path analysis or structural equation model. All missing data were imputed by AMOS using maximum likelihood estimation. Figure 1 depicts the model that was analyzed. Each hypothesis (from above) is included in this model. The plus (+) signs indicate a hypothesized positive direction of each path in the model. The independent variable (world system position) is hypothesized to have a positive direct effect on the dependent variable (per capita water footprint; H1). The independent variable is likewise hypothesized to have a positive effect on each of the intervening variables (per capita beef consumption, per capita energy consumption, and urbanization; H5-H7). The intervening variables are hypothesized to have a positive effect on the dependent variable (H2-H4). The independent variable is also hypothesized to have a positive total effect (direct and indirect, through the intervening variables) on the dependent variable (H8).

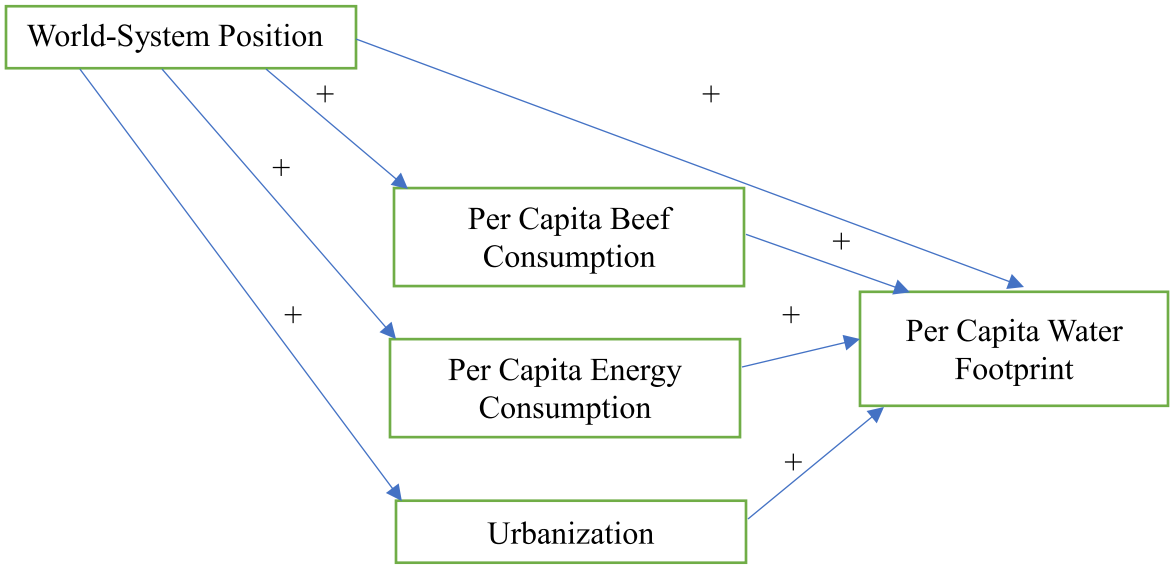

Figure 1. Hypothesized Path Model

RESULTS

Table 1 provides descriptive statistics for each of the variables used in the analysis. Additionally, Table 1 provides the mean values for each variable by world system position. Listwise deletion was used for missing cases (i.e., imputed values were not utilized in Table 1).

Table 1

Descriptive Statistics and Comparison of Means by World System Position

			Mean by World System Position (*n*)			
Variables	*n*	Mean	Low Periphery	High Periphery	Semi Periphery	Core
World system position	89	2.3	--	--	--	--
Per capita water footprint	174	1653.0	1279.3 (29)	1608.4 (27)	1814.0 (14)	1758.1[a] (19)
Per capita beef consumption	41	10.9	2.8 (8)	10.7 (14)	15.9 (8)	17.6[b] (6)
Per capita energy consumption	150	1796.0	445.1 (23)	1258.4 (27)	2616.3 (14)	4483.1[c] (18)
Urbanization	168	51.2	33.8 (29)	56.9 (27)	68.1 (14)	75.0[d] (19)

[a] $F = 6.186$, $df = 3$, $p = .001$
[b] $F = 2.419$, $df = 3$, $p = .084$
[c] $F = 32.804$, $df = 3$, $p < .001$
[d] $F = 26.258$, $df = 3$, $p < .001$

Table 2 presents bivariate correlations among variables in the model. The correlation between position in the world system and per capita energy consumption is the strongest ($r = .752$) and the correlation between per capita energy consumption and per capita beef consumption is the weakest (*r* = .371). .However, all of the correlations are moderate to strong correlations.

Table 2

Correlation Matrix of Model Variables

Variables	Per Capita Water Footprint	World System Position	Per Capita Beef Consumption	Per Capita Energy Consumption	Urb.
Per Capita Water Footprint	--				
World System Position	.390	--			
Per Capita Beef Consumption	.593	.373	--		
Per Capita Energy Consumption	.425	.752	.371	--	
Urbanization	.410	.664	.581	.634	--

Note: Correlations were run in AMOS after imputation of missing values. AMOS does not produce *p* values for these correlations.

Figure 2 visually presents the results for the path model. The effects of predictor (independent and intervening) variables on the outcome (intervening and dependent, respectively) variables as well as the explained variance of outcome variables (R^2) are presented in Table 3. The decomposition of effects (direct and indirect) through intervening variables is presented in Table 4.

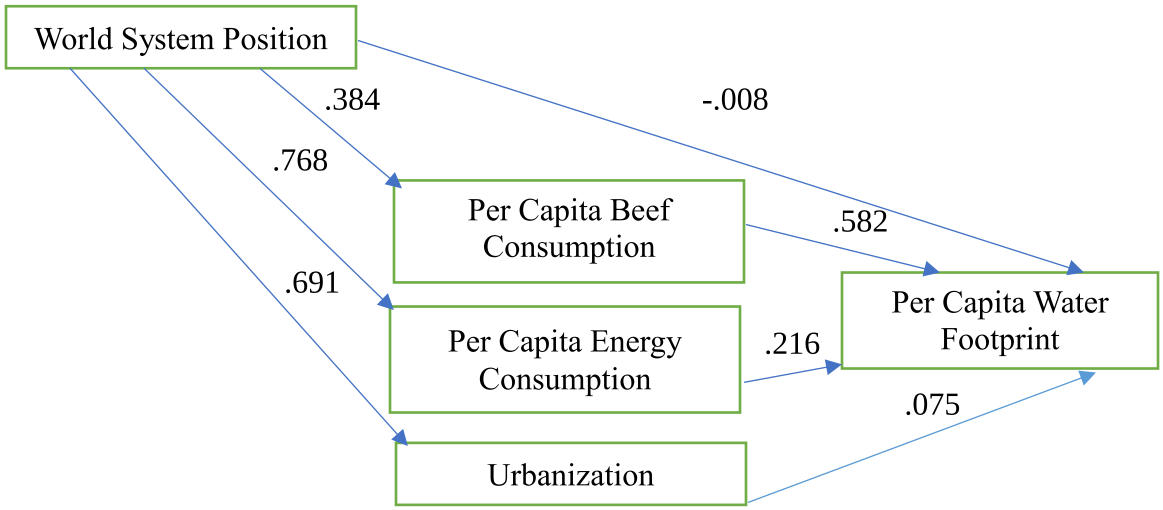

Figure 2. Path Model Results

All independent and intervening variables in the model are hypothesized to have a positive effect on each outcome variable while controlling for other variables. Findings show that 6 out of the 8 hypotheses are supported. Although there is a moderate bivariate correlation between world system position and per capita water footprint, the direct effect of world system position on per capita water footprint in the path model is not significant ($\beta = -.008$, $p > .10$). Hypothesis 1 is therefore not supported.

Table 3

Direct Effects of Model Variables (Beta Weights or β) and Explained Variance (R^2)

Independent variables	Intervening variables			Dependent variable
	Per Capita Beef Consumption	Per Capita Energy Consumption	Urbanization	Per Capita Water Footprint
World System Position	.384**	.768***	.691***	-.008
Per Capita Beef Consumption	--	--	--	.582***
Per Capita Energy Consumption	--	--	--	.216*
Urbanization	--	--	--	.075
R^2	.147	.590	.478	.499

Note: ***$p < .001$, **$p < .01$, *$p < .10$

The relationships of per capita beef consumption ($\beta = .582$, $p < .001$) and per capita energy consumption ($\beta = .216$, $p < .10$) on per capita water footprint are both positive and significant, indicating that hypotheses 2 and 3 are supported. However, the relationship between urbanization ($\beta = .075$, $p > .10$) and per capita water footprint is not significant, showing that despite a moderate bivariate correlation between the two variables, hypothesis 4 is not supported in the path model. World system position has a significant positive effect on each of the intervening variables, indicating that hypotheses 5 through 7 are supported.

The variables in the model explain roughly 50% of the variance in per capita water footprint. The other 50% of the variance is due to unexplained causes that might include measurement error, random chance, and variables not included in the model.

Nearly 48% of the variation in urbanization is explained by world system position. World system position explains 59% of variation in per capita energy consumption and nearly 15% of variation in per capita beef consumption.

Table 4

Decomposition of Effects on Per Capita Water Footprint

Variables	Direct	Indirect	Total
World System Position	-.008	.441**	.433**
Per Capita Beef Consumption	.582**		
Per Capita Energy Consumption	.216*		
Urbanization	.075		

Note: ***$p < .001$, **$p < .01$, *$p < .10$

Although world system position has no significant direct effect on per capita water footprint, its total effect, which occurs through its impact on per capita beef consumption, per capita energy consumption and urbanization, is statistically significant. The indirect effect of world system position on per capita water footprint is fairly strong (.441), which makes the total effect similarly strong (direct plus indirect effect). Despite the fact that world system position does not appear to be a significant predictor by itself while controlling for other variables in the model, its inclusion in the path model is very important since it has a strong indirect effect through intervening variables on per capita water footprint. This finding supports my final hypothesis that the world system position has a significant positive total effect on per capita water footprint.

DISCUSSION AND CONCLUSION

The findings of the current study reveal that consumption patterns of other materials are an important determinant of water resource consumption. There are two different kinds of consumption patterns: agricultural and industrial. Since bovine meat is a part of agricultural production processes, the variable, per capita beef consumption, measures consumption pattern of an agricultural product. The result showing a positive relationship between beef and water consumption supports Hoekstra and Chapagain's (2007) argument that beef consumption is one of the key factors in water resource consumption. In a different study, Burns et al (1997) show a positive association between cattle production and methane emissions—one of the serious environmental outcomes threatening the sustainability of the planet Earth. Like methane emissions, water consumption is a function of bovine meat consumption that similarly poses a serious threat to natural resources. This finding suggests a recommendation for policy makers that livestock production, especially bovine meat production, must be curtailed or made more sustainable.

Per capita energy consumption measures industrial consumption patterns. As argued earlier, considering the transfer of agricultural products to industrial processes, the majority of energy consumption occurs in industrial production processes. Citizens in developed countries consume more industrial products, so they consume more energy. Results of this study support this argument. Consumption practices and capitalist interests in the core countries have been found to be associated with global environmental outcomes (Stretesky and Lynch 2009) such as carbon dioxide and methane emissions.

This study fails to find support for the effect of urbanization on water consumption after controlling for per capita beef consumption, per capita energy consumption and world system position. Each of these variables are, however, highly intertwined theoretically and empirically. It is likely that the effects of urbanization have already been accounted for through these variables or that issues of multi-collinearity may have dampened the observed effects of urbanization.

World system position is a measure of global stratification of the countries. World system scholars argue that the global core-periphery hierarchy generates systematic constraints that people in the periphery are not able to overcome. These constraints make them consume less while their counterparts in the core nations consistently enjoy economic advantages and consume more. Although this study does not find support for this argument if we look only at the direct effect of world system position on per capita water footprint while controlling for per capita beef consumption, per capita energy consumption, and urbanization, world system position influences per capita water footprint indirectly through its impact on per capita beef consumption, per capita energy consumption, and urbanization. Using world system position and theory to explain environmental outcomes remains justified.

One of the limitations of this research is the treatment of the independent variable (world system position) as a continuous variable while it is an ordinal level measure with only four categories. Given that the two major categories of countries, core versus periphery, have extensive differences in water consumption, comparing countries by category may provide different results, such as a significant direct effect of world system position on per capita water footprint. Thus, I recommend that future research use categorical comparisons between the groups by creating dummy variables in order to see if there is a significant statistical difference between the categories (e.g., core vs other).

Several variables were considered prior to the final analysis but were left out for various reasons. Future research should consider additional intervening variables. The variables that I considered but did not include in the model were: domestic inequality, literacy rate, globalization index, and per capita dam construction. Domestic inequality and literacy rate are socio-economic and socio-demographic characteristics that are highly correlated with the variables included in the model. Thus, they do not improve explanation of per capita water footprint. The globalization index measures a country's openness to the world in terms of economy, military cooperation and cultural homogeneity. However, underlying this variable is level of economic development, which is also incorporated in world system position. In fact, this is a common problem with this kind of research—several key variables are theoretically and empirically linked to economic development. However, it would be interesting to see the effect of globalization on water resource consumption in a separate model since I would argue that the concept of globalization is theoretically independent of world system position. Finally, ecological modernization theorists often argue that technological efficiency eventually reduces the level of environmental degradation. I attempted to test this argument by including per capita dam construction as a measure of technological efficiency of water management. Even before controlling for other variables in the model, I put this variable in a scatter plot with per capita water footprint and found no linearity of relationship between the two. Perhaps this variable measures just a small part of technological efficiency of water management. In addition, there are many parts of the world that do not have waterways for dam construction but use a huge volume of virtual water. Thus, geographical distribution of water sources over the globe also determines whether or not a country needs to be technologically efficient for water management. However, this distribution does not prevent a country from using virtual water. Therefore, it does not really matter how hard it is to get water directly from water sources in a country when it comes to true level of water consumption measured by water footprint. An additional variable that could be considered is population or population growth rate. Again, population growth rate is also highly linked to economic development and ultimately to world system position.

Another potential limitation of this research is the reliance upon available data. Although this issue occurs whenever data collected by governments or agencies is used, we need to keep in mind that these data are only as good as the collection and reporting procedures used. Most of these data were originally provided by the individual country and the data collection procedures may not be similar. It is challenging to use data from various global sources, especially when each source provides information for a different set of countries.

In sum, material resource consumption has been increasing at an accelerating rate. This is largely a function of socio-structural forces, including consumption patterns and the core-periphery global hierarchy. In line with world systems theoretical propositions, I posit that the benefits provided to citizens of richer parts of the world are received at the expense of the natural world and the people of impoverished parts of the world. Failure to consider the whole world as a single system makes it difficult to address environmental degradation and social disorganization. I contend that the current study usefully reflects on the global nature of inequality with respect to consumption of water resources.

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APPENDIX

APPENDIX A: LIST OF COUNTRIES INCLUDED IN THE ANALYSIS

Core Countries (n = 19)

Australia	Denmark	Japan	Sweden
Austria	Finland	Netherlands	Switzerland
Belgium	France	Norway	United Kingdom
Canada	Germany	Russia	United States
China	Italy	Spain	

Semi-Periphery Countries (n = 14)

Argentina	India	New Zealand	Saudi Arabia
Brazil	Israel	Poland	Trinidad and Tobago
Czech Republic	Korea, Republic	Portugal	Venezuela
Greece	Mexico		

High Periphery Countries (n = 27)

Algeria	Gabon	Pakistan	Sri Lanka
Botswana	Hungary	Panama	Syrian Arab Republic
Chile	Indonesia	Paraguay	Thailand
Colombia	Jordan	Peru	Tunisia
Congo Dem Rep	Kuwait	Philippines	Turkey
Ecuador	Malaysia	Romania	Uruguay
Egypt	Morocco	South Africa	

Low Periphery Countries (n = 29)

Angola	Dominican Rep	Lesotho	Senegal
Bangladesh	El Salvador	Liberia	Sudan
Bolivia	Ethiopia	Mali	Tanzania
Burkina Faso	Guatemala	Mozambique	Togo
Cameroon	Haiti	Myanmar	Uganda
Chad	Honduras	Nicaragua	Zambia
Congo Republic	Kenya	Nigeria	Zimbabwe
Cote D'Ivoire			

Other Countries (World System Position imputed; n = 85)

Albania	Georgia	Mongolia
Antigua and Barbuda	Ghana	Namibia
Armenia	Grenada	Nepal
Azerbaijan	Guinea	New Caledonia
Bahamas	Guinea-Bissau	Niger
Barbados	Guyana	Occ. Palestinian Terr.
Belarus	Iceland	Rwanda

Belize
Benin
Bermuda
Bosnia and Herzegovina
Brunei Darussalam
Bulgaria
Burundi
Cambodia
Cape Verde
Central African Republic
Comoros
Costa Rica
Croatia
Cuba
Cyprus
Dominica
East Timor
Eritrea
Estonia
Fiji Islands
French Polynesia
Gambia
Iran
Ireland
Jamaica
Kazakhstan
Kiribati
Korea Dem People's Rep
Kyrgyzstan
Laos
Latvia
Lebanon
Libya
Lithuania
Luxembourg
Macedonia
Madagascar
Malawi
Maldives
Malta
Mauritania
Mauritius
Moldova
Saint Kitts and Nevis
Saint Lucia
Saint Vincent Grenadines
Samoa
Sao Tome and Principe
Serbia and Montenegro
Seychelles
Sierra Leone
Slovakia
Slovenia
Solomon Islands
Suriname
Swaziland
Tajikistan
Turkmenistan
Ukraine
United Arab Emirates
Uzbekistan
Vanuatu
Viet Nam
Yemen