ENVIRONMENTAL JUSTICE
Volume 5, Number 1, 2012

DOI: 10.1089/env.2011.0009

Climate Injustice: CO_2 from Domestic Electricity Consumption and Private Car Use by Income Decile

Dan Rabinowitz

ABSTRACT

Environmental justice is primarily concerned with uneven distribution of environmental harms and with the consequences such inequality often has for individual and community well-being, development, and growth. Recent expansion in quantity and improvement in quality of data on current and historic greenhouse gas (GHG) emission levels by country has drawn attention to differentiated national responsibilities for the intensification of the atmosphere's greenhouse effect and, concomitantly, for global warming. This shift is pertinent for environmental justice, a field that tended in the past to focus more on the uneven distribution of environmental harms than on responsibility for initially causing them.

Building on the new sensitivity to differentiated responsibility for climate change, this article focuses on a hitherto understudied field: differences in GHG emissions between populations within countries. Using Israel as a case study, and focusing on GHG from domestic electricity consumption (DEC) and private vehicle use (PVU), it looks at emissions by income decile. Results suggest that individuals belonging to the top income decile are responsible for per-capita emissions that are approximately 25 times higher than those of individuals belonging to the bottom decile, and that carbon inequality between the top and bottom deciles can sometimes amount to over four times the monetized consumer inequality between them. Recognition of GHG emission as multiplier of socio-economic inequalities is essential for the design and implementation of ambitious, workable, and fair corrective climate policies.

INTRODUCTION

Works informed by the logic of environmental justice (see for example Bullard 1994; Bryant 1995; Cole and Foster 2001; Rhodes 2003; Shrader-Frechette 2005) tend to focus on unequal collective exposure to environmental hazards. Indigenous groups, ethnicized and racialized minorities, geographically peripheral populations, low-income groups, and communities embodying combinations of some or all of these disparities often find themselves at the receiving end of terrestrial toxic waste, poor air-quality, polluted water, environmental noise pollution, overcrowded residential spaces, insufficient recreational space, and more.

Schlosberg (2007), in his account of the variety of interpretations of environmental justice amongst activists and organizations in the U.S. and beyond, collapses definitions of the term into four main trajectories: equitable distribution of environmental risks and benefits; meaningful participation in environmental decision making; recognition of local knowledge and cultural difference as legitimate elements of environmental decision making; and a general ability of individuals and communities to operate and flourish in society at large.

The growing body of social scientific research into climate change and its consequences suggests that local, national, regional, and global inequalities often act simultaneously as both causes and effects of global warming (see Timmons-Roberts and Parks 2006; Jamieson 2007). Some writers recognize global warming as a multiplier of economic, technological, and infrastructural vulnerabilities (see Roncoli et al. 2001; Hoffman and Smith 2002; Vásquez-León et al. 2003; Adger, Arnell, and Thompkins 2005; Nickels et al. 2006; Crate and Nutall 2008; Orlove et al. 2008; Singer 2009). Others highlight the relationship between its potentially catastrophic consequences and hyper-consumption patterns so prevalent in

Dr. Rabinowitz teaches at the Department of Sociology and Anthropology at Tel-Aviv University and Central European University.

late capitalism (Wilk 2008; Baer and Singer 2009; Singer 2010).

The burgeoning debate on the socio-political aspects of climate change focuses attention on an aspect of environmental justice that is yet to receive the full attention it deserves:differentiated responsibility for the emergence of environmental hazards. Data on current and historic greenhouse gas (GHG) emissions by country, published regularly by the World Resources Institute (WRI 2008) and the United Nations Framework Convention on Climate Change (UNFCCC 2010), illustrates how northern nations, which benefited from comprehensive industrial modernization earlier, are accountable for the lion's share of global historic CO_2 emissions and the concomitant intensification of the greenhouse effect. In fact the current effort by the international community to curb emissions and gradually reduce atmospheric GHG is premised on a universal understanding of this differentiated responsibility, and seeks workable ways to rectify it.

But while awareness of the unequal responsibility for global warming on a global scale abounds, and data on current and historic inequalities between nations is readily available,[1] empirical data on inequalities between sub-groups *within* countries in terms of GHG emissions remains scant.[2] This lacunae is particularly pressing at a time when governments all over are seeking technological solutions and legislative, fiscal, and administrative means to curb GHG emissions. Clearly, more insight into the social, economic, and political consequences that technical innovations, policy tools, and administrative measures might have for different populations is urgently required.

This article, which uses Israel as a case study, focuses on GHG emissions from domestic electricity consumption (DEC) and private vehicle use (PVU). Based on data produced by Israel's Central Bureau of Statistics (CBS) and the Israel Electric Corporation (IEC), it follows three analytical objectives. One, as indicated, is to go beyond the erstwhile and important focus on uneven distribution of environmental harms, and to enhance an environmental justice perspective that is sensitive to differentiated responsibility for causing the harm in the first place. Second, methodological in nature, is to go beyond between-country comparisons and develop indicators for in-country analysis—comparingCO2 emissions by population sub-group. Third is to use the results from the particular case analyzed as an illustration of the value of environmental justice concepts for design and implementation of corrective climate policies.

[1]See World Resource Institute Web site (WRI 2008) for data on current and historic GHG emissions by state.

[2]Hohner and Robinson's (2008) position paper argues that non-Hispanic whites in the U.S. emit on average 20% more GHG per capita compared to blacks. A suggestive document, it is premised primarily on composite figures, leaving the empirical basis for its main assertions less explicit. Data provided by Sweden's Bureau of Statistics, available at <http://www.scb.se/Pages/TableAndChart____104319.aspx>, likewise provide aggregate figures.

METHODOLOGY AND RESULTS

CO_2 emissions from DEC

In 2009 electricity consumption in Israel amounted to 48,947 million kilowatt hours (kWh), of which 15,117 million kWh (30.1%) were consumed in domestic residences (IEC 2010b: 21, Table 31a). Figures pertaining to GHG emissions indicate that in 2008, the most recent year for which such data was calculated by CBS, electricity generation was responsible for 42.4 million tons CO_2—54.3% of the country's total GHG emissions (CBS 2010a: 934).[3] IEC figures for 2009 (IEC 2010a :7), the most recent year for which data on CO_2 emission from power generation and is available, indicate that average CO_2 emission per kWh electricity produced at IEC power stations was 707 grams CO_2 per kWh, which at annual production of 53.1 billion kWh yielded an overall emission from IEC installations of 37.54 million tons.[4]

Table 1 is based on IEC's 2009 figures of average annual electricity consumption per household by income decile (IEC 2010b: 30). These figures, divided by the average number of persons per household in each decile,[5] yield annual electricity consumption per capita by decile. This is the basis of my Carbon Inequality Index, (CaII: emissions from DEC), featured in the right hand column of Table 1. The "CaII: emissions from DEC" takes average CO_2 annual emissions (DEC) of individuals in the bottom income decile as standard (value = 1), then calculates the respective ratios between this figure and average annual per capita emissions in every other income decile. The most striking figure is of course the "CaII: emissions from DEC" figure calculated for the top income decile. It indicates that an individual living in a household belonging to this decile is responsible on average for annual CO_2 emission (from DEC) approximately 24 times higher than the emission attributable to individuals residing in a household belonging to the bottom income decile.

Carbon inequality index (emissions from DEC) as a multiplier of inequality in consumer spending

The Carbon Inequality Index (CAII: emissions from DEC), as previously calculated, was used as the basis for the calculation of carbon inequality as a multiplier of inequality in consumption. To achieve this, the Carbon

[3]Adapted from CBS 2010a, Table 27.6. The figure is the sum of the emissions in the table accounted to "Energy Industries."

[4]Upwards of 95% of electricity in Israel is generated by IEC power plants, which burn coal (more than 60% of total fuel input and declining), natural gas (just under 30% of total fuel input, and growing) and a small amount of fuel oil. IEC's report for 2009 suggests a total of 53.1 billion kWh at CO_2 coefficient of 707 grams per kWh, yielding a total of 37.54 million tons. The figures for the previous year (2008) were 54.4 billion kWh generated, at 741 CO_2 per kWh (IEC 2009: 11), yielding an overall emission from IEC installations of 40.31 million tons.

[5]As this study looks at consumption rather than income generation or other types of domestic production, and since in consumption terms children and the elderly are equivalent to adults, my calculations use number of persons per household rather than standardized number of persons per household.

Table 1. Carbon Inequality Index—Per Capita Emissions of CO_2 from Domestic Electricity Consumption (CAII: emissions from DEC), by Income Decile, Israel 2009

Decile	*Annual Kw/h consumed per household*[1]	*Number of persons per household*[2]	*Kw/h per capita*	*CO_2 emissions from DEC (Kg. CO_2 per Kw/h)*[3]	*Annual per capita CO_2 emissions (Kg)*	*Carbon Inequality Index (DEC)*[4]
Top (1)	19,687	2.7	7,291	0.707	5,154	24.20
2	12,003	3.1	3,872	0.707	2737	12.85
3	9,567	3.2	2,990	0.707	2114	9.92
4	7,962	3.3	2,413	0.707	1706	8.00
5	6,728	3.4	1,979	0.707	1399	6.57
6	5,697	3.6	1,582	0.707	1118	5.25
7	4,776	3.7	1,291	0.707	913	4.29
8	3,897	3.9	999	0.707	706	3.31
9	2,974	4.3	692	0.707	489	2.30
Bottom(10)	1,564	5.2	301	0.707	213	1.00

Notes and sources
[1]IEC 2010b: 30, Table 44.
[2]CBS 2010a: 297, Table 5.32.
[3]IEC 2010a: 7.
[4]The ratio of CO_2 emissions per capita (DEC) in the decile to CO_2 emissions per capita in the bottom decile.

Inequality Index (emissions from DEC) was divided by the Inequality Index in Consumer Spending—per capita spend (in shekels) in each income decile divided by per capita spend in the bottom income decile. The ratio between the indices expresses Carbon Inequality (emissions from DEC) as a multiplier of consumer inequality. The multiplication ration for all income deciles can be seen in Table 2.

CO2 emissions from PVU, Israel 2008[6]

In 2010 the number of private cars registered in Israel, which grew by nearly 40% since 2000[7] and by 15.9% since 2006,[8] went for the first time above the two million mark.[9] Israel currently has 326 vehicles per 1,000 people, of which 258 are private cars.[10]

In 2008 Israeli vehicles emitted a total of 15,884 tons CO_2 equivalent (CBS 2010a: 934)[11]—20.4% of all GHG emissions.[12] This makes the transport sector second only to the energy sector (electricity generation) in terms of GHG emissions. In 2008, approximately 50% of CO_2 emissions emanating from the transport sector (7,408,000 tons) were emitted by petrol engines.[13] The share of petrol engines of overall emissions in the transport sector is consistently rising (Ibid.).

In 2008 private vehicles in Israel travelled a total of 30,448,000,000 km (about 30.5 billion km) (CBS 2010c: 13, 23).[14] If we divide the figure for 2008 of total CO_2 emissions from petrol engines (7,408,000 tons) by the total distance travelled, the average emission per private vehicle that year comes to 243 grams CO_2 per km(g/km). Dividing the total CO_2 emissions from private cars (2008) by the number of private vehicles that year (1,890,537) yields an average annual emission level of 3.92 tons CO_2 per private vehicle in Israel.

These of course are aggregate figures for the country as a whole. But bearing in mind the extent to which ownership and use of private vehicles reflects consumer inequality, let us now turn to a more nuanced analysis of GHG emission by income decile.

Comparing average per capita CO_2 emissions from PVU across population groups requires data on (a) the average distance (kilometers per annum) that an individual belonging to the relevant group travels in their private car; and (b) average CO_2 emission perkm (g/km) travelled in a car typical to the relevant group. These two figures multiplied yield an average annual emission from PUV per capita, a figure that can be used for operational comparison across groups.

Obtaining the two figures requires statistical data not all of which is readily available. Statistics on vehicle

[6]At the time of preparing this article for publication, the most recent year for which data from Israel on vehicle use and the CO_2 emission attributable to it was available was 2008.

[7]CBS 2010a: 893.

[8]The number of private cars in 2006 amounted to 1,685,000 and in 2009 to 1,947,000 vehicles. (Adapted from CBS 2010b: 13).

[9]In 2009 the fleet of private cars consisted of around 1,947,000 vehicles (CBS 2010b: 13). The Hebrew financial newspaper *Globes* reported on August 3, 2010 that in the period until July 2010 an additional 103,224 private cars were sold. <http://www.globes.co.il/news/article.aspx?did=1000579257>.

[10]The term *motor vehicles* includes private cars, taxis, and mini buses. Israeli vehicle ownership is low compared to Western Europe, USA, and Japan. Average (general) vehicle ownership in Western Europe is over 500 per 1,000 people and in the USA, 840 vehicles per 1,000 people (CBS 2010b: 15). Vehicle ownership (private cars only) in Western Europe is around 460 (in Italy around 600), in Japan 325, and in the USA, 450 (CBS 2010b: 39).

[11]The figure is adapted from CBS 2010a, Table 27.6, and uses the total emissions figure as being derived entirely from "transport."

[12]Adapted from CBS 2010a, Table 27.6.

[13]CO_2 emissions from petrol engines, which in 2005 represented 48.2% of all transport emissions, rose to 51.2% in 2009 (CBS 2010b: 107).

[14]In 2009 the figure rose by 5.1% to 31,989,000,000 km (nearly 32 billion km) (CBS 2010a: 894).

Table 2. Carbon Inequality (emissions from DEC) as Multiplier of Consumption Inequality by Income Decile, Israel 2009

Decile	*Carbon Inequality Index (DEC)*[1]	*Total spend per household (NIS)*[2]	*Persons per household*[3]	*Spend per capita (NIS)*	*Consumer Inequality Index*[4]	*Carbon Inequality (DEC) as multiplier of consumer inequality*
Top (1)	24.20	21,130	2.7	7825	6.20	**3.90**
2	12.85	17245	3.1	5563	4.41	**2.91**
3	9.92	14690	3.2	4590	3.64	**2.73**
4	8.00	13160	3.3	3988	3.15	**2.54**
5	6.57	12333	3.4	3627	2.87	**2.29**
6	5.25	10970	3.6	3047	2.41	**2.18**
7	4.29	9996	3.7	2702	2.14	**2.00**
8	3.31	9448	3.9	2423	1.92	**1.72**
9	2.30	7902	4.3	1838	1.45	**1.59**
Bottom (10)	**1**	6560	5.2	1262	1	**1**

Notes and sources
[1]Source: Table 1 above.
[2]CBS 2010a: 288, Table 5.27 (in Hebrew).
[3]CBS 2010a: 297, Table 5.32.
[4]Ratio between per capita spend (NIS) in the decile and per capita spend in the bottom deciles.

ownership and usage in Israel are presented by vehicle segment (privately owned cars, other cars, buses, freight vehicles, two wheelers); year of manufacture; country of origin; manufacturer; engine volume; and distance traveled. Data also exists for privately owned vehicles by owner's address. But integrated data on vehicles by income deciles (e.g., ownership percentages, age of fleet, engine volume, distance traveled, type of use, emissions levels, etc.) is lacking. To bridge these gaps I used available aggregate data and integrated it with the help of the operational assumptions detailed below.

First, the number of private vehicles available to households in the various income deciles.[15] To calculate this, I used the interactive table generator available at the social survey page on Israel's CBS Web site,[16] which enables cross-tabbing by filters selected by the user.[17] The social survey is an in depth annual survey the CBS runs by a few thousand representative households, focusing each time on a number of pre-selected topics. The 2008 social survey collected, amongst other things, data on ownership and use of private cars. The raw data provided by the survey was manipulated through the table generator, with income decile as the primary filter and the number of private cars per household as the second.

My point of departure for calculating the average number of private cars available to households in the upper income decile was that in 2008 92.7% of households in that decile owned at least one vehicle, and 48.4% owned two or more (CBS 2010b: 298).Further calculations revealed that of the 194,982 households in the decile which own vehicles (92.7% of the overall number of households), 18.1% owned a single car, 66% owned two cars, 12.2% owned three cars, 3.1% owned four cars, and 0.5% owned five cars or more. In sum, the 210,300 households in the upper decile in 2008 owned 386,970 cars—a weighted average of 1.84 cars per household. A similar procedure was applied to the bottom decile (21.4% of households in it owned one car in 2008, and 0.8% owned two cars), producing a weighted average of 0.23 cars per household, and to all deciles in between. The results (average cars per household) are presented in Table 3, second column from the left.

Next we want to calculate the average distance traveled by a private car by decile. One reference point is the average distance travelled by private cars in Israel at large, which in 2008 was 16,700 kilometers (CBS 2010c: 24). Moreover, CBS's survey of kilometers travelled (CBS 2010c: 24, Table 2) indicates that in 2008, as in every other year on record, the newer the car the longer the distance travelled. In 2008, cars four years or younger travelled on average 17,900 km per annum (p.a.) (7.2% above the aggregate average of 16,700 km), those 5–9 years old travelled 16,900 km p.a. (0.6% above average), those 10 to 21 years old 15,200 km p.a. (7.8% below the average) and cars over 22 years old travelled 14,100 km p.a., 15.6% below average.[18] The 7.2% above average figure (cars 0–4 years old) was assumed to including an escalating inner progression whereby brand new cars (one year old or less, i.e., model year 2008) travelled considerably more than 7.2% above average—my assumption is 15%, which translates to 19,205 km p.a.—while cars three and four years old travelled less.

[15]Each income decile in Israel has approximately 210,226 households.

[16]<http://surveys.cbs.gov.il/Survey/survey.htm>.

[17]I am grateful to Anat Oren for introducing me to this facility and for her help with calculations emanating from tables generated.

[18]Calculations based on CBS 2010c: 24, Table 2 suggest that earlier years saw an even more dramatic difference between younger and older cars in terms of distance travelled. In 2003, cars older than 22 years covered 32.1% less distance than the average figure for all cars. In 2004 they covered 41.2% less than all cars, in 2005 39.8% less, in 2006 22.7% less, and in 2007 21.2% less than the average distance covered by all cars. Cars four years old or younger maintain a figure of ca. 10% above average kilometer travelled for the entire decade.

Table 3. Carbon Inequality Index—Per Capita Emissions of CO_2 from Private Vehicle Use (CAII: emissions from PVU) by Income Decile, Israel 2008

Decile	Cars per household[1]	Persons per household[4]	Cars per capita	Km traveled per year[2]	Emission (kg CO_2 per km)[3]	Kg CO_2 per car p.a.	Kg CO_2 per capita p.a.	Carbon Inequality Index[4]
Top (1)	1.84	2.7	0.68	20,875	0.192	3989	2718	**27.2**
2	1.63	3.1	0.53	19,900	0.220	4378	2320	**23.2**
3	1.28	3.2	0.40	18,800	0.250	4700	1880	**18.8**
4	1.00	3.2	0.31	17,775	0.280	4977	1555	**15.5**
5	0.71	3.4	0.21	16,700	0.235	3925	824	**8.24**
6	0.71	3.6	0.20	16,700	0.235	3925	785	**7.85**
7	0.52	3.6	0.14	15,650	0.235	3678	515	**5.15**
8	0.45	3.9	0.12	14,600	0.290	4234	508	**5.08**
9	0.35	4.3	0.08	13,575	0.230	3122	250	**2.50**
Bottom (10)	0.22	5.2	0.04	12,525	0.200	2505	100	**1**

Notes and sources
[1]Adapted from CBS 2010a: Table 5.32.
[2]Ibid.
[3]Methodology for calculation explained in text.
[4]Ratio of CO_2 emissions (PVU) per capita in an income decile to the CO_2 emissions (PVU) per capita in the bottom income decile.

To estimate the average age of the 386,970 cars available to households in the upper decile we must first note that the average age of cars in Israel in 2008 was 6.9 years (CBS 2009 Table B); that 41% of all vehicles (769,160 private cars) operating in Israel that year were under four years of age, and that 2008 alone saw 177,000 new private cars purchased. One indication of the weight of the upper income decile in these purchase is found in an article based on data provided by the Israeli branches of the eight most popular car brands in Israel (Haselkorn 2009). The article reveals that in 2008, out of 103,791 cars listed in the government's Price Band 2 (mid size family saloons), 86,270—some 83%—were sold to leasing companies. Since leasing companies do much of their business with high-tech companies and financial organizations that make saloon cars available to executives and highly skilled research and development personnel, most of whom earn wages that place them in the upper income decile, it is safe to assume that a considerable proportion of new cars of all price bands are held by households that belong to that decile. My assumption, for the want of more accurate data, is that households belonging to the upper income decile are responsible for 70% of the incoming cohort of new cars every year—approximately 124,000 in 2008. I further assume that the balance of purchases is distributed between the second income decile (20% of new car purchases) and the third income decile (10%). This figure represents one third of the 386,970 cars available to upper decile households, implying that households in that decile tend to replace a third of their cars every year—something I will return to shortly.

For now, I factor in the fact that upper income deciles own newer cars by adding an additional 4.8% to the average distance travelled, yielding 12% above average (18,704 km p.a.).

Regarding the bottom income decile, a recent figure indicates that 169,000 of the cars registered in Israel were manufactured in 1993 or earlier (CBS 2010b: 40). Since in 2008 households belonging to the bottom income decile owned between them only 45,000 vehicles,[19] it is safe to assume that the vast majority of cars owned by households in this decile were 22 years old or older. This implies that average distance travelled by them was 14,100 km p.a.—15.6% less than average (CBS 2009c: 24, Table 2).

Another factor that impacts distance travelled annually by private cars in Israel is engine size. CBS's survey of kilometers travelled indicates that in 2008, as in every other year since 2000 (the year these figures were first recorded), the larger the engine the longer the distance travelled (CBS 2010c: 25, Table 3). In 2008, cars with engine size smaller than 1,000 cubic centimeters (cc) travelled on average 14,600 km p.a. (12.6% below the aggregate average of 16,700 km p.a.). Those with engines sized 1001–1600 cc travelled 16,000 km p.a. (4.2% below average), those with engines sized 1601–2000 cc travelled 18.6 km p.a. (11.4% above aggregate average) and cars with engines bigger than 2001 cc travelled 19,000 km p.a., 13.8% above average.[20] Assuming that cars with larger engines, which tend to be considerably more expensive to buy and to operate[21] are concentrated mainly in the top income decile, and assuming further that most cars in

[19]0.22 cars per household, 201,800 households.

[20]Calculations based on CBS 2010c: 24, Table 2 suggest that some earlier years saw an even more dramatic difference between larger and smaller engine cars in terms of distance travelled. In 2000, cars with engines bigger than 2,001 cc covered 20.8% more distance than the average figure for all cars; In 2001 they covered 18.5% more than all cars, in 2002 15.5% more, in 2005 21% more, and in 2006 19.6% more than the average distance covered by all cars. Cars with engines smaller than 1,000 cc traveled 16.6% less than the average for all cars in 2001, and around 14% less for most years thereafter.

[21]Israeli taxation on cars, which is considerable, uses engine size as a primary criterion: the larger the engine, the higher the taxes. This often pushes retail prices for larger cars up by tens of percentage points above the manufacturer's recommended price.

lower deciles are relatively small, I added 10% to the figure of 18,704 km p.a. calculated above as the age-related average distance travelled by cars available to households in the upper decile, and subtracted an additional 10% from the 14,100 km p.a. figure calculated above as the age-related average distance travelled by cars available to cars belonging to the bottom decile. The addition at the top and subtraction at the bottom yielded a new figure of 20,574 km p.a. as the average distance for cars available to households in the top decile (23.2% above the national average) and 12,690 km p.a. as the average distance travelled by cars available to household in the bottom decile (24% below the national average). The two figures were then rounded to 25% above average and 25% below average respectively, to somehow reflect the differentiated sensitivity of wealthier and poorer households to the cost of driving.[22] The respective final figures are 20,875 km p.a. for cars held by top income decile households; and 12,525 for cars held by bottom income decile households. I further assumed that p.a. distances travelled by cars available to households in the middle deciles are distributed on the continuum between the top and bottom deciles in a linear and even fashion.

Next is average CO_2 emissions per kilometer traveled. This figure is influenced primarily by the efficiency and size of engines. Here again the age of cars is crucial: technological advancement in the early twenty-first century considerably enhances engine efficiency with every passing year, constantly forcing a decrease in CO_2 emission levels.

Calculation of the average age of cars owned by households belonging to the top income decile was premised on the assumption, substantiated above, that such households typically replace a car once every three years. One third of all cars owned by these households in 2008, in other words, will have been of model year 2008; one third were of model year 2007, and one third of model year 2006.

Clean Green Cars,[23] who provide data for average emissions by manufacturer for the years 2009 and 2010[24] suggests that the range of emissions per kilometer travelled for cars produced in 2009 was between 133 g/km and 248 g/km, with an average for all manufacturers of 152 g/km. According to this source Mazda, which happened to be the best selling brand in Israel in 2009, averages at 156 g/km for all models. I use this figure as the average emission of cars of model year 2009 operating in Israel.

Clean Green Cars also reports an average 4.76% decline in CO_2 emissions from 2009 to 2010 for all manufacturers combined. Assuming a similar improvement in the previous two years, an average was calculated of 163 g/km for vehicles manufactured in 2008, 171 g/km for cars manufactured in 2007 and 179 g/km for cars manufactured in 2006. The weighted average emission for private cars owned by top income decile households in 2008 was thus 171 g/km.

Another variable to consider in this decile are sport utility vehicles (SUV) and luxury vehicles. Ten thousand SUVs were delivered to customers in the first half of 2010,[25] suggesting an annual figure of 20,000. To this I add an assumed 14,000 luxury vehicles other than SUV, yielding a total of 34,000 SUV and other luxury cars delivered per annum. This was then multiplied by three production years (minus 2.9% difference p.a.), yielding approximately 99,000 vehicles, representing 25.5% of all vehicles in the top income decile. Average emission for this segment (cars produced in 2009) was calculated at 235 g/km.[26] Factoring in the 4.9% annual efficiency improvement, the average for 2008 and the two preceding model years is calculated as 259 g/km. The weighted average emission for the 73.7% of cars in this decile that are not in the luxury and SUV segment (171 g/km) combined with that of the 25.5% of luxury and SUV cars (259 g/km) yields 192 g/km for all cars in the top income decile.

My calculation of the typical emission levels of vehicles owned by households in the bottom income decile was premised on the figure that in 2009 169,000 of the cars registered in Israel were manufactured in 1993 or earlier (CBS 2010b: 40). As already indicated, since households in the bottom income decile that year owned between them only 45,000 vehicles,[27] it is safe to assume that the vast majority of cars owned by households in this decile were at least 17 years old or older.

Most sources offering data on private cars' emission levels restrict themselves to models manufactured after 2000. Carbonfootprint.com however enables calculation of emissions from older vehicles too, but does it not by manufacturer and year but by fuel type and engine volume.[28] Using this carbon calculator for a hypothetical representative pre-2000 vehicle with an engine smaller than 1,400 cc that travels 12,525 kilometers per annum (variables consistent with the calculations provided above for the average profile of cars available to households in the bottom income decile), we get average annual CO_2 emissions of 2.5 tons per car, which in turn translates to a weighted average of 200 g/km. As with distance travelled by cars owned by middle decile households (above), this study assumes that the emission levels of cars owned by households in the middle deciles are distributed on the continuum between the top and bottom deciles in a linear and even fashion. The weighted averages for emission

[22]With average income per household at approximately 2,500 NIS, travelling 1,000 kilometers per month in a car that consumes ca. 15 liters of gasoline per 100 km would represent expenditure of almost half the household's income.

[23]<http://www.cleangreencars.co.uk>.

[24]<http://www.cleangreencars.co.uk/jsp/co2_manufacturer.pdf>.

[25]<http://www.globes.co.il/news/article.aspx?did=1000579257>.

[26]Using data from Clean Green Cars (2009) for Nissan Pathfinder 264 g/km, Land Rover 247 g/km, Chrysler 212 g/km, giving an average for the segment of 235 g/km for 2009 and, respectively, 246 g/km for 2008 and 258 g/km for 2007. This gives a weighted average for the three years of 246.3 g/km.

[27]0.22 cars per household, 201,800 households.

[28]<http://www.carbonfootprint.com/calculator.aspx>.

Table 4. Carbon Inequality (per capita emissions from PVU) as Multiplier of Consumption Inequality by Income Decile, Israel 2009

Decile	*Carbon Inequality Index (PCU)*[1]	*Total household Spend (NIS)*[2]	*Persons per household*[3]	*Spend per capita (NIS)*	*Spend inequality index*	*Carbon inequality (PVU) as a multiplier of Spend inequality*
Top (1)	27.2	21130	2.7	7825	6.20	**4.39**
2	23.2	17245	3.1	5563	4.41	**5.26**
3	18.8	14690	3.2	4590	3.64	**5.16**
4	15.5	13160	3.3	3988	3.15	**4.92**
5	8.24	12333	3.4	3627	2.87	**2.87**
6	7.85	10970	3.6	3047	2.41	**3.25**
7	5.15	9996	3.7	2702	2.14	**2.41**
8	5.08	9448	3.9	2423	1.92	**1.65**
9	2.50	7902	4.3	1838	1.45	**1.72**
Bottom (10)	1	6560	5.2	1262	1	**1**

Explanations and sources
[1]Source: Table 3 above.
[2]CBS 2010a: 288, Table 5.27.
[3]CBS 2010a: 297, table 5.32.

levels by income decile (PUV) appear in Table 3 (fifth column from the left).

The average distance traveled per year and average emission level for cars owned in the upper income deciles, together with the average distance traveled per year (12,525 km) and average emission level (200 g/km) for cars owned by households in the bottom decile were inserted into Table 3 as bases for the Carbon Inequality Index (CaII: emissions from PVU). As with the Carbon Inequality Index (CaII: emissions from DEC), the CaII: emissions from PVU takes average CO_2 per capita emissions (PVU) in the bottom income decile as a standard, and calculates the ratio between it and average per capita emissions in the upper decile.

Carbon inequality (CO_2 emissions PVU) as a multiplier of inequality in total spend

The Carbon Inequality Index (CO_2 emissions from PVU) calculated in Table 3 was divided by the overall Spend Inequality Index (the total per capita spend in the upper income deciles divided by total per capita spend in the bottom one). This ratio, presented in the right hand column in Table 4, indicates the extent to which Carbon Inequality (CO_2 emissions from PVU) is a multiplier of spend inequality. The multiplier effect—4.39 in the case of the top decile—is even higher than the respective figure for domestic electricity consumption.

CONCLUSION: THE CLIMATE JUSTICE CHALLENGE

The challenge of reaching agreement on mitigation and adaptation measures to reduce the risks associated with the post-normal climate condition (PNCC) requires serious consideration of climate injustice. Whereas the main thrust of environmental justice studies tends to look at the uneven distribution of the hazardous results of environmental faults, this article focused on unequal responsibility in terms of causing hazards in the first place. And whereas most of the literature on differentiated contribution of CO_2 emissions privileges between-countries comparisons, I tried to focus here on within-country analysis.

The methodology used to attribute quantified CO_2 emissions from domestic electricity consumption and from the use of private vehicles to different populations (in this case income deciles in Israel) can and should be used to make similar comparisons involving other spheres of economic activity, other countries, regions, and, not least, different criteria for population groupings.

The results calculated for the particular case of Israel, which indicate 24.2 and 27.2 fold differential between the upper and the bottom income deciles in terms of per capita CO_2 emission from domestic electricity consumption and private vehicle use respectively, and the ensuing figure suggesting that CO_2 emission functions as a multiplier of existing monetized inequality between these deciles by a factor of approximately four, suggests that regulating CO_2 emission will impact different populations in profoundly different ways. Whether administered as carbon tax, as an incentive for efficiency or reduced consumption or as per-capita, per industry or per production unit emission quota; and whether or not such quotas become tradable in more or less efficient markets, data presented here suggests that sticks as well as carrots cannot apply equally to all population groups. A wealthy suburban household in a well to do community in North America or Western Europe, once faced with sanctions and incentives linked to CO_2 emission cuts, is likely to effectively reduce its CO_2 emissions, trim its expenditure, capitalize on tax incentives, improve its health, and feel good about itself without substantially altering its life style, not to mention damaging its economic standing. A household in a mobile home park in the USA, on the other hand, (not to mention ones in Brazilian Favelas, Southeast Asia slums or African shanty towns), if ever faced by a binding demand or, for that matter, with putative incentives, to reduce its CO_2 emissions would probably find that doing so is difficult, quantitatively negligible, harmful economically, or all of the above combined.

As the international community and national and local governments get busy designing new legal, administrative, and fiscal tools for emission cuts to help propel them to the post-Kyoto era, they need to take on board differentials of magnitude, composition, and elasticity between the carbon footprints of different populations. In the best traditions of social and environmental justice, and in the interest of facilitating fair, ambitious, binding, and workable arrangements, the economic, social, cultural, and political consequences of reducing carbon footprints[29] must be calculated for each group separately.

AUTHOR DISCLOSURE STATEMENT

This article is based on a study undertaken at the Department of Sociology and Anthropology at Tel-Aviv University in collaboration with the Association of Environmental Justice in Israel (AEJI). The project was supported by funding from the Minerva Centre for Human Rights and the Institute for Social Research at Tel Aviv University. A summary version, coauthored with Carmit Lubanov and including specific policy points for Israel, was published in December 2010.

REFERENCES

Adger, W.N., N.W. Arnell, and E.L. Thompkins 2005. Adapting to climate change: Perspectives across scales. *Global Environmental Change* 15: 75–76.

Baer, H. and Singer, M. 2009. *Global Warming and the Political Ecology of Health: Emerging Crises and Systemic Solutions*. Walnut Creek, CA: Left Coast Press.

Bryant, Bunyan. 1995. *Environmental Justice*. Washington, D.C.: Island Press.

Bullard, R. D. 1994. *Unequal Protection: Environmental Justice and Communities of Color*. San Francisco: Sierra Club.

CBS (Central Bureau of Statistics) Israel. 2009. *Motor Vehicles 2008.* Jerusalem: Central Bureau of Statistics (in Hebrew). <http://www.cbs.gov.il/publications09/1381/word/intro_h.doc>.

CBS (Central Bureau of Statistics) Israel. 2010a. *Statistical Abstract of Israel, Number 61, (2009).* Jerusalem: Central Bureau of Statistics (in Hebrew).

CBS (Central Bureau of Statistics) Israel. 2010b. *Motor vehicles 2009.* Jerusalem: Central Bureau of Statistics (in Hebrew).

CBS (Central Bureau of Statistics) Israel. 2010c. *Kilometers Travelled Survey 2009.* Jerusalem: Central Bureau of Statistics (in Hebrew).

[29]See for example, Timmons-Roberts and Parks (2006); Rabinowitz (2009).

Cole, Luke and Sheila R. Foster. 2001. *From the Ground Up: Environmental Racism and the Rise of the Environmental Justice Movement*. New York: New York University Press.

Crate, S. and M. Nutall 2008. *Anthropology and Climate Change: From Encounters to Actions*. Walnut Grove, CA: Left Coast Press.

Haselkorn, Shachar. 2009. "How many cars do importers sell to leasing companies?" *Ynet*, May 21. <http://www.ynet.co.il/articles/0,7340,L-3719335,00.html>.

Hoffman S.M and A. Oliver-Smith (eds.) 2002. *Catastrophe & Culture: The Anthropology of Disaster*. New Mexico: SAR Press.

Israel Electric Corporation (IEC). 2010a. *Environmental Report for the Year 2009.* Haifa: IEC (in Hebrew). <http://tinyurl.com/5tjpfpo>.

Israel Electric Corporation (IEC). 2010b. *Statistical Report for the Year 2009.* Haifa: IEC (in Hebrew).

Hohner, J. Andrew and Nia Robinson. 2008. *A Climate of Change: African Americans, Global Warming and a Just Climate Policy for the U.S.* Oakland, CA: Environmental Justice and Climate Change Initiative.

Jamieson, D. 2007. "The Moral and Political Challenges of Climate Change." In: S.C Moser and L. Dilling (eds.). *Creating a Climate for Change, Communicating Climate Change and facilitating Social Change.* Cambridge: Cambridge University Press, 475–482.

Nickels, S., C. Furgal, M. Buell, and H. Moquin 2006. *Unikkaaqatigiit–putting the human face on climate change: perspectives from Inuit in Canada*. Ottawa: Université Laval and National Aboriginal Health Organization.

Orlove. B.S., K. Wiegandt and B. Luckman (eds.) 2008. *Darkening Peaks: Glacier Retreat, Science and Society*. University of California Press.

Rabinowitz, D. 2009. *Here it comes: how shall we survive climate change.* Tel-Aviv: Hakibbutz Hameuchad Publishing Group (in Hebrew).

Roncoli, C., T. Crane, and B. Orlove 2008. Fielding Climate Change in Cultural Anthropology. In Crate, S. and Nuttall, M. (2008) *Anthropology and Climate Change*: From Encounters to Actions. Walnut Grove, CA, Left Coast Press, 87–115.

Rhodes, Edwardo Lao. 2003. *Environmental Justice in America*. Bloomington, IN: Indiana University Press.

Schlosberg, David. 2007. *Defining Environmental Justice: Theories, Movements, and Nature*. New York: Oxford University Press.

Shrader-Frechette, Kristin. 2005. *Environmental Justice: Creating Equality, Reclaiming Democracy*. New York: Oxford University Press.

Singer, M. 2009. Beyond global warming: interacting ecocrises and the critical anthropology of health. *Anthropology Quarterly* 82, 795–820.

Singer, M. 2010. Eco-nomics: Are the Planet-Unfriendly Features of Capitalism Barriers to Sustainability? *Sustainability, 2*, 127–144.

Timmons-Roberts, J. and Bradley C. Parks. 2006. *A Climate of Injustice.* Boston: MIT Press.

United Nations Framework Convention on Climate Change (UNFCCC). 2010. *National greenhouse gas inventory data for the period 1990–2008.* <http://unfccc.int/resource/docs/2010/sbi/eng/18.pdf>.

Vásquez-León, M., C.T. West, and T.J. Finan 2003. A comparative assessment of climate vulnerability: agriculture and ranching on both sides of the US-Mexico border. *Global Environmental Change 13*: 159–173.

Wilk, R. 2008. Consuming Ourselves to Death: The Anthropology of Consumer Culture and Climate Change. In Crate, S. and Nuttall, M. 2008, *Anthropology and Climate Change: From Encounters to Actions*. Walnut Grove, CA, Left Coast Press, 265–276.

World Resources Institute (WRI). 2008. *Climate Analysis Indicators Tool. Cumulative Carbon Dioxide Emissions, 1850–2007.* <http://cait.wri.org/cait.php?page=cumul&mode=view&sort=val-desc&pHints=shut&url=form&start=1850&limit=0&update=Update>.

Address correspondence to:
Dan Rabinowitz
Dept. of Sociology and Anthropology
Faculty of Social Sciences
Naftaly Building, Room 626
Tel-Aviv University
Ramat-Aviv
Tel-Aviv
Israel 69978

E-mail: msdan@post.tau.ac.il