Individual responsibility and climate change

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Abstract: Personal consumption is inseparably connected with the emission of greenhouse gases and thus contributes to climate change, which for many people is an issue that must be addressed. Hence, a possible response of individuals to climate change is to recognise the responsibility for their own contribution and to adjust their personal consumption. Thus, it will be asked, what is a level of personal consumption which, in both globally equitable and environmentally sustainable terms, does not contribute to climate change? This equitable and sustainable level is then compared with the present average consumption of people in industrialised countries. As an example, a quantitative assessment is presented of the greenhouse gases embodied in consumer items purchased by an average Australian citizen. A calculation kit is presented which enables the concerned consumer to obtain a personal greenhouse gas budget expressed in tonnes of carbon dioxide equivalent per year.

Keywords: climate change, international equity, individual responsibility, consumption, personal emissions calculator.

Introduction

This paper analyses the implications of climate change for individuals in industrialised countries in the context of environmental sustainability and international equity. First of all, a brief statement of the problem of climate change is given, and global inequalities in greenhouse gas emissions are described. International equity is then applied to these emissions on a per capita basis, yielding a sustainable and equitable emission level. It is evaluated, whether this level is likely to be achieved in the following decades through technological improvements or policy instruments. In addition, the role of changes in consumer behaviour as an individual, voluntary response to climate change is considered, using an extended concept of responsibility. Finally, the impact of unsustainable and inequitable consumption on climate change is quantified in form of a personal greenhouse gas budget typical for industrialised countries. Throughout the line of arguments the Australian situation is referred to as an example.

The global problem

It has been known to scientists for more than a decade that the present release of greenhouse gases into the atmosphere puts the well-being of future generations at risk. The concentrations of atmospheric greenhouse gases such as carbon dioxide (CO_2) and methane (CH_4) are projected to increase, resulting in a global warming of about 3°C over the next century. In the same period, a rise in the sea level of about half a meter must be expected, threatening millions of people living on low-lying islands and in coastal regions around the world.[1] Moreover, the geographic distribution of many ecosystems will shift causing reductions in biodiversity. The supply of water and food is likely to deteriorate drastically in some regions. The spreading of vector-borne infectious diseases such as malaria, dengue and yellow fever will directly affect human health.[2] Finally, many countries will suffer from more extreme weather patterns: the increase in the frequency and the intensity of severe floods and droughts will adversely affect agriculture, in particular in countries as vulnerable as Australia.[3,4]

Because of the long atmospheric lifetime of some greenhouse gases such as CO_2, time lags between abatement measures and climate stabilisation are in the order of decades. Even if emissions were maintained at present levels, the atmospheric CO_2 concentration and hence the global temperature would increase for at least two centuries. The sea level would continue to rise even beyond the time of global temperature stabilisation.[1,5] Climate models show that an immediate stabilisation of the concentration of CO_2 could only be achieved through an immediate reduction in its emissions by 50-70% and further reductions thereafter.[6,7]

Disparities

As with economic wealth, there are large global inequalities in contributions to climate change. About 20% of the world's population in industrialised countries causes about three quarters of the global greenhouse gas emissions. Average per capita emissions in Australia, North America, Europe or Japan are about ten times higher than those in South Asia or China.[8] This situation is illustrated in Figure 1.[9] Each column represents one of the regions noted below the horizontal axis. The column width is proportional to the population, while the height shows the annual per capita emissions of CO_2 in this region, respectively. Hence, the column area represents the total amount of CO_2 emitted annually from each region. Furthermore, each column contains contributions from four sources as explained in the figure legend.

It can be seen that per capita emissions vary over a wide range between 1 tonne (t) per year in South Asia and 20 t per year in North America. It should be noted that the values depicted in this figure represent CO_2 emitted from the respective region. This is not necessarily identical to CO_2 emissions associated with the corresponding regional consumption, because some emissions are embodied in exported and imported goods, which are exchanged between regions in international trade.[10] A major part of CO_2 emissions due to land use changes in South America and Southeast Asia, for example, is associated with land clearing for timber exports. If the per capita consumption (rather than the production) of CO_2 emissions was to be depicted, these emissions would have to be added on top of those of industrialised countries. It should be added that there are disparities, which are not shown in Figure 1. These are due to the fact that, in general, developing countries have smaller capabilities of adaptation to climate change and therefore are likely to suffer from more severe damage than industrialised countries.[6]

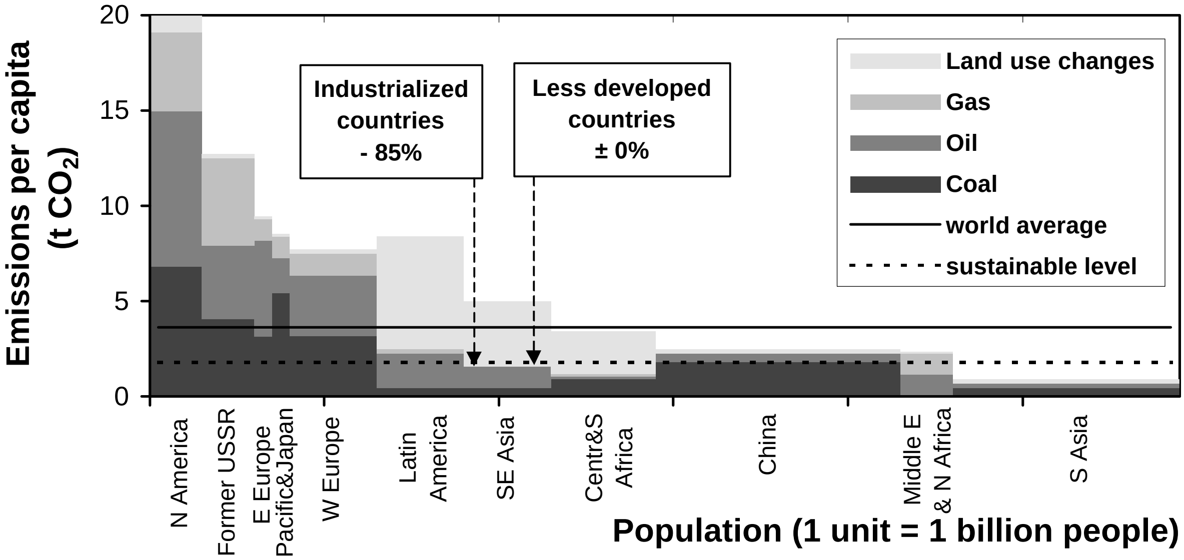

Fig. 1: 1990 per capita CO_2 emissions by region and source.[9]

Equity

The concept of global equity in the context of climate change is important to consider in order to gain legitimate agreements and cooperation in international negotiations. It can be interpreted in various ways.[11] Interregional equity takes into account the contributions to and the costs of climate change of people in different states (intra-national equity) or nations (international equity) at a given time, while intertemporal equity can include historical or cumulative emissions as well as emissions and costs in the future (intergenerational equity). It has been demonstrated that, for example, applying both interregional and intertemporal equity to global CO_2 emissions leads to 'emission debts' for industrialised regions and to 'emission credits' for developing regions.[12] Furthermore, equity can be applied to either the costs of damages and adaptation, or to the costs of mitigation of climate change. One way to distribute mitigation costs is to allocate a limit to departures from baseline emissions to each nation. This method, however, bears the danger of cementing international disparities.[13] Another way is to allocate emission limits on a per capita basis. A shortcoming of this approach is that developing countries would be able to obtain additional emission rights only because of their comparatively large population growth. An example for a political measure which is based on equity considerations is the equitable allocation of tradeable emission permits to all nations. This would endow developing countries with surplus emission rights, which could be sold to industrialised countries.

Because of its simplicity, international per-capita equity will herewith be applied to the present situation. Ideally, different limits should be assessed for different regions or nations, according to their specific vulnerability to climate change, mitigation costs, or resource requirements to meet people's basic needs. However, no such differentiation will be considered in this article, because the resulting differences in per capita emission limits are likely to be much lower than already existing disparities in per capita emissions.

In the previous years, global greenhouse gas emissions totalled about 42 Gigatonnes of CO_2 equivalent[14] (Gt CO_2-e; 1 Gt = 10^9 t) per year, while the global population was almost 6 billion, both figures rising steadily . Applying the concept of international equity in greenhouse gas emissions on a per capita basis means that a sustainable situation is reached if everyone on the planet caused an amount of emissions of not more than 50% of the present world average, given the results of climate models mentioned at the end of the first section. Hence, apportioning the same amount of pollution to everybody on the planet and at the same time reducing emissions by 50% leaves about 3.5 t CO_2-e emissions per year and per capita to be released. This “greenhouse gas budget” is both ecologically sustainable and globally equitable and will be referred to in the following as the “sustainable level”.[15]

Given the disparities in per capita emissions between industrialised and developing countries shown in Figure 1, a sustainable and equitable situation implies that industrialised countries would have to cut down emissions by 85%, while developing countries could more or less remain at the present levels. It is to ask how such reductions can be achieved. Commonly suggested means of curbing greenhouse gas emissions are (1) technological changes such as efficiency measures for the supply and end-use of energy and the introduction of renewable energy sources, and (2) political incentives such as tradeable emission permits, taxation and subsidisation, resource pricing, efficiency standard regulations, stimulation of research and development, encouragement of changes in consumer behaviour, and community education.

Technological response

The emission of CO_2 (22 Gt per year from energy use and 4 Gt net per year from land use changes such as deforestation) is the main contributor to all greenhouse gas emissions (42 Gt CO_2-e).[6] Therefore, changes in the energy sector are likely to have the largest effect amongst technological improvements. The amount of primary energy needed to generate one US$ of GDP in the United States has decreased from 70 MJ/US$ in 1860 to 20 MJ/US$ in 1990, which is due to the development of more efficient energy supply and end-use technologies. Simultaneously, the worldwide average of CO_2 emissions per unit of primary energy has decreased from 95 g CO_2/MJ in 1860 to 60 g CO_2/MJ in 1990. This reflects the continuous replacement of fuels of high carbon content, such as wood and coal, with low-carbon fuels such as oil, gas, or with non-fossil energy sources such as hydroelectricity or nuclear power.[9] In conjunction, these two effects lead to a global “decarbonisation” of GDP, which implies the possibility of economic growth at decreasing CO_2 emissions.

The potential of future reductions of CO_2 emissions due to improvements in energy efficiency, fuel mix changes and the introduction of renewable energy sources is summarised in Figure 2. The figures were adapted from the IPCC Working Group II Second Assessment Report. The diagram is divided into two parts: the top part depicts the situation in 1990 while the bottom part contains estimates for the year 2025. The white bars in either part represent renewable energy from various sources (see labels), while the underlying shaded areas represent the total energy use. The area of one square of unity height corresponds to 380 Exajoules (EJ; 1 EJ = 10^{18} J), which is the 1990 global annual primary energy consumption. Renewable energies can grow from 60 EJ in 1990 up to their maximum technical potential of about 180 EJ (130 EJ to 230 EJ) in 2025.[9] However, total primary energy consumption will grow as well. Depending on the scenario (see figure legend), future energy use will be around 680 EJ (590 EJ to 760 EJ) without any reduction measures taken, and around 520 EJ (440 EJ to 600 EJ) if mitigation measures are considered.[2] Hence, in an ecologically driven scenario, fossil energy consumption in 2025 would be around 340 EJ (= 520 EJ (total) - 180 EJ (renewable)), compared to 320 EJ in 1990. Taking into account the decarbonisation of fossil fuel use, future CO_2 emissions due to energy use would be at about 21 Gt CO_2, similar to 1990 emissions (22 Gt CO_2).

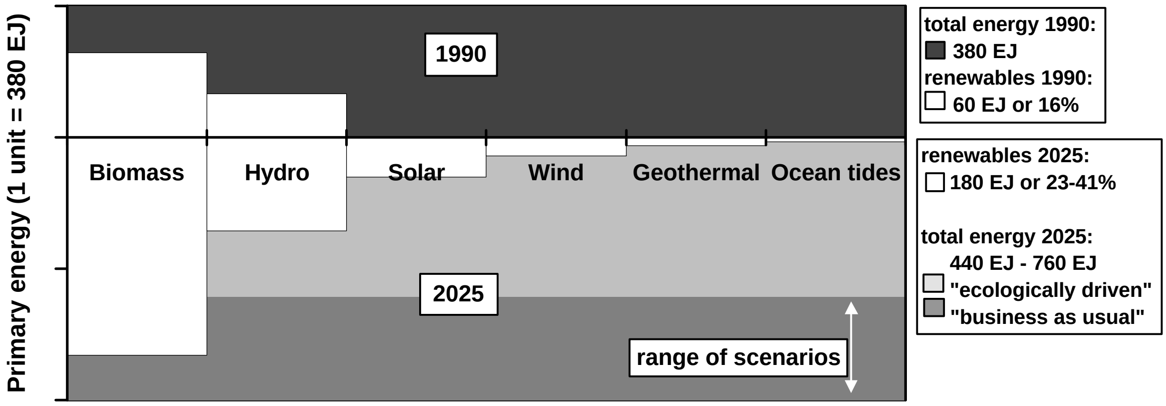

Fig. 2: Present and future use of primary energy.[2,9]

Nuclear energy, although not contributing to climate change, will not be considered here, because its future use will depend on its general acceptance, which in turn is facing setbacks due to problems associated with reactor safety, the management and long-term disposal of nuclear waste and the proliferation control of fissile materials. However, additional reductions of about 6 Gt CO_2 per year could be achieved through enhancing carbon sinks such as sequestering carbon in biomass through improved management of forests, agricultural lands and rangelands.[2] Assuming further, that emissions due to deforestation would be reduced by 50% to 2 Gt CO_2, and adding 21 Gt CO_2 from energy use, total annual CO_2 emissions in 2025 would be around 17 Gt CO_2. Hence, an ecologically driven scenario corresponds to a reduction of 1990 CO_2 emissions by a maximum of about one third.[16] Comparing this to the 50% reduction which is necessary to achieve a sustainable situation, as described earlier on, shows that technological measures on their own cannot achieve a sustainable situation.[17]

It should be pointed out that the reductions discussed in this section are based on projected technical potentials. A technical possibility, however, is no guarantee for the economic viability or political realisation of emission reductions. Instead, policymakers will have to provide an appropriate institutional and regulatory framework, which overcomes barriers and creates incentives for the implementation of the technological measures described before.[11]

Political response

A first political step in the prevention of climate change was taken in 1988 at the Toronto Conference on the Changing Atmosphere, where a target of a 20% reduction of 1988 CO_2 emissions by the year 2005 was recommended.[18] This was adopted by the Australian government as an interim planning target[19] for the National Greenhouse Response Strategy.[20] In 1992, the participants of the UN Earth Summit in Rio de Janeiro agreed on the “stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous interference with the climate system”.[21] The Framework Convention on Climate Change (FCCC) was signed after the summit. This time, the Annex I (industrialised) signatory countries committed themselves to taking measures aimed at reducing national emissions to 1990 levels by the year 2000. In April 1995, at the first session of the Conference of the Parties (COP) in Berlin, ministers decided that this target was inadequate for meeting the Convention's objective and that negotiations should be initiated on developing a new set of commitments applying to the post-2000 period (the ’Berlin Mandate’). While it became evident to Australian Governments that the likelihood of reaching any of the targets was quite remote[22], the second

COP held in July 1996 in Geneva already discussed a protocol or legal instruments for the limitation of greenhouse gas emissions to be adopted at the third COP in December 1997 in Kyoto. As a consequence, Australia did not endorse the inclusion of legally binding targets into the protocol.[23]

Even though the targets mentioned above exceed by far the sustainable level determined in the previous section, it is most unlikely that they will be met in Australia (and also some other OECD countries). Worse than that, Australian per capita emissions are steadily increasing by an average 1.5% per year.[24] A history of targets and the present situation is illustrated in Figure 3. The bars represent past and current greenhouse gas emissions in Australia as well as their future trends. The horizontal lines show the Toronto and Rio reduction targets applied to Australian emissions. In can be seen that neither of both targets is likely to be met in Australia. The dashed line at the bottom of the figure is the sustainable level calculated for the Australian population of about 17.7 million.

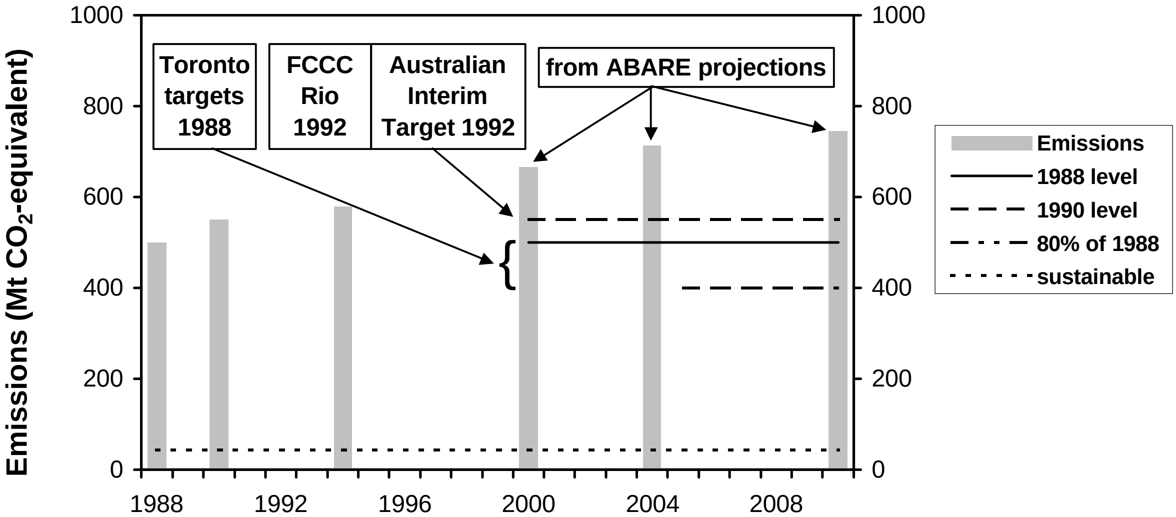

Fig. 3: Past and future greenhouse gas emissions in Australia in comparison to various political targets and the sustainable level. The emissions data were provided by the Australian Bureau of Agricultural and Resource Economics (ABARE).[24]

It has been demonstrated that the increase in Australian per capita CO_2 emissions over the past decade as well as the projected increase are mainly due to a growth in income and thus in consumption and industrial output (+2% per year forecast), which was only slightly offset by technological and fuel mix changes (-0.5% per year forecast).[25,26,27] A similar situation can be found for the energy consumption in the manufacturing sectors of the United States of America and Japan between 1973 and 1988, where large increases in production drove up energy consumption and hence CO_2 emissions, in spite of decreases in energy intensity due to technological and fuel mix changes. In most of the European OECD countries, however, changes in energy intensity slightly outweighed the production effect during the same period.[28]

A relationship which is similar to the one between the growth rates of emissions and income in Australia exists for the absolute values of emissions and Gross Domestic Product (GDP) worldwide. Figure 4 shows the relative location of various countries according to their per capita CO_2 emissions and GDP. Most countries lie in between two lines, which represent CO_2 intensities of 0.4 kg CO_2/US$ and 0.8 kg CO_2/US$. Countries above the upper line need a particularly large amount of CO_2 in order to generate one US$ of GDP, such as the former USSR (extensive resource waste and inefficient technology) and the United States of America (low energy prices). Countries below the lower line show sub-average CO_2 intensities such as France (high proportion of nuclear power) and Switzerland (service-oriented economy). Developing countries are accumulated in the lower left corner of the diagram. As in Figure 1, the per capita sustainable level is shown at the bottom of the diagram.[15] At an average CO_2 intensity of 0.6 kg CO_2/US$, this sustainable level corresponds to a per capita GDP (and hence per capita expenditure) of 3300 US$. Summarised, the figure shows that, in general, CO_2 emissions increase with increasing GDP.

It should be mentioned that, in contrast to an industrialised country like Australia, population growth is the dominant factor for emission increases in many developing countries. Their population is about three times larger than the one in industrialised countries, but their per capita emissions are about ten times lower. As a result, the impact on global emissions of an average population growth rate of 2% per year in developing countries is three times lower than the impact of an average 2% per year income growth in industrialised countries. A notable exception is China, where the government has planned for a GDP growth rate of 8-9% per year until 2000, and 5% per year from 2000 to 2020, resulting in a growth of energy consumption and hence emissions, which is likely to exceed the expected population growth (about 1.25% per year).[29]

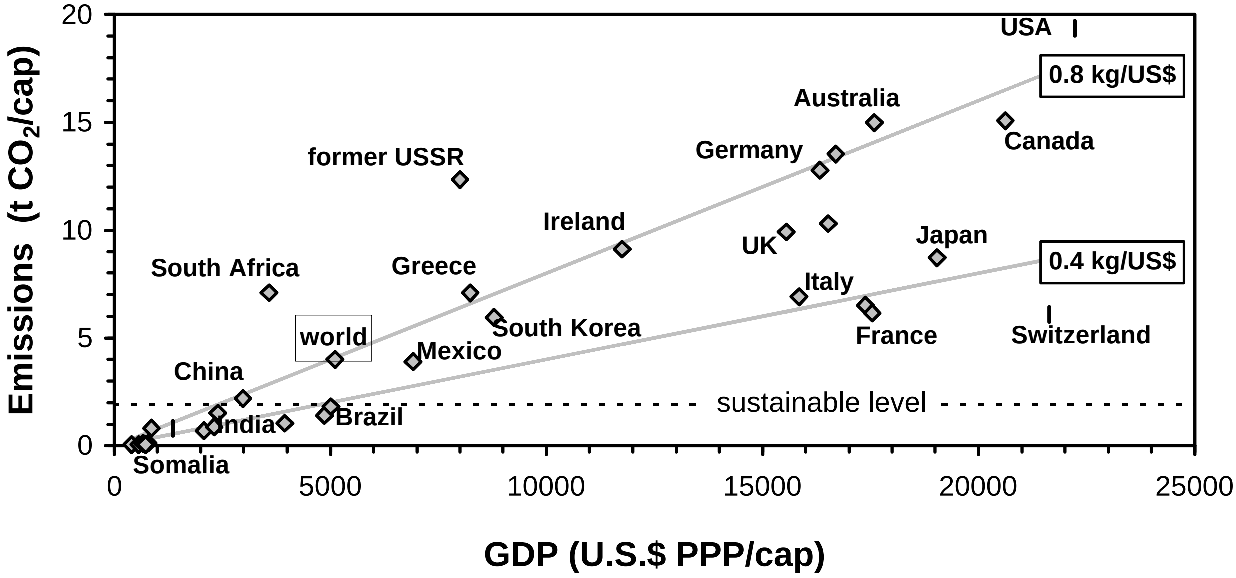

Fig. 4: 1991 per capita CO_2 emissions and Gross Domestic Product (in US$ at purchasing power parities, PPP) for various countries.[8]

Individual response

From the previous sections, two conclusions can be drawn, which are (1) that personal consumption in industrialised countries like Australia is the main constituent in both total global emissions and their growth rate, and (2) that it is unlikely that emissions in industrialised countries will be reduced to an equitable and sustainable level by technological and political measures.

In view of political inertia and the limited technical potential of curbing greenhouse gas emissions, these conclusions point to an alternative, individual response. This is to change the pattern as well as to reduce the amount of personal consumption. The motivation for such an individual response emerges from the recognition of the individual's entanglement in the global crisis and hence personal responsibility. Adjusting to an environmentally sustainable and globally equitable level of consumption can be an ethical option for people in industrialised countries who are concerned about global unfairness and environmental degradation, but disappointed about adequate political movement. Moreover, comparing personal consumption with the previously mentioned sustainable level of 3.5 t CO_2-e per year can be quite enlightening and it questions, who is actually willing to make the sacrifices that an environmentally rigorous policy would entail.[30] Finally, changes in consumer behaviour can gradually become more widespread, and then have a significant influence on global greenhouse gas emissions, and effectively supplement political and technological measures.

Individual awareness and concern about global unfairness and environmental degradation is a prerequisite for behavioural changes towards equity and sustainability. In fact, a growing number of people regard environmental issues as important. In Australia, for example, about 70% of the population older than 18 years consider environmental protection as important as economic growth. The people most concerned about the environment are aged between 25 and 34 years, preferentially female, with tertiary education and working in professional occupations.[31] There are, however, two inhibiting factors.

Firstly, in industrialised countries, concerns about climate change bear little relation to personal greenhouse gas emissions. This paradox was, for example, one of the results of a survey of households in Melbourne, Australia, undertaken in order to determine people's understanding of, and attitude towards climate change as well as their actions in response to their concerns.[32] It was found that people who had a clear understanding of the greenhouse effect produced as much CO_2 in their households as others. Furthermore, respondents who regarded climate change as a serious issue caused only slightly lower CO_2 household emissions (associated with lower electricity use) than those who did not share this concern. A significant reduction in CO_2 emissions was only observed in conjunction with lifestyle changes such as the reduction of car use and household heating. Another example is an Australian study on initiatives to promote sustainable consumption, which revealed that information and education as well as economic incentives exhibited only a low level of success in initiating changes in consumption patterns. However, the analysis of obligatory and coercive initiatives (especially those where avoidance was difficult) showed that consumers complied with the initiative program where they had no choice to act but in an environmentally responsible way.[33] These findings suggest that the provision of information to the general public alone does not motivate behavioural changes. It seems that only under certain circumstances is the mere desire for an intact environment turned into corresponding action. One prerequisite for voluntary individual action was found to be the individual belief in the efficacy of pro-environmental behaviour.[34] Moreover, it is argued that a sense of confusion and uncertainty arising from conflicting information from different sources[35] as well as a publicly perceived mistrust in the governmental institutions providing this information[36] are key obstacles for consistent action. In summary, it appears that feelings of lack of agency as well as political disaffection are the most significant inhibitors of environmentally conscious behaviour.[37]

The second problem lies in the common but misleading perception that personal responsibility for climate change is restricted to emissions from the individual household. This will be explained in the following section.

Responsibility

Some of the emissions such as from fuel use in private cars or in homes occur directly at the place of consumption. It is therefore not surprising that there is a spreading awareness in the general public of personal responsibility for these emissions, resulting in efforts to save energy in homes to reduce private car use. However, about two thirds of the emissions occur initially in factories or on farmland. That these emissions become embodied in consumer items is almost always ignored. It is argued here that, in accordance to Adam Smith’s classical statement, that “consumption is the sole end and purpose of all production"[38], the consumer who buys a product is ultimately responsible for the emissions this product has entailed in its industrial or agricultural production.

Breakdowns of Australian emissions into (1) production and (2) end-use categories differ noticeably. Figure 5 shows sectoral contributions to the production of greenhouse gases in Australia.[39] 54% of the greenhouse gases are emitted due to fossil energy use in factories, vehicles, homes, offices and shops. Another 39% stem from land use changes and enteric fermentation in animals, while the remainder of 7% is due to emissions from landfills and non-energy industrial processes.

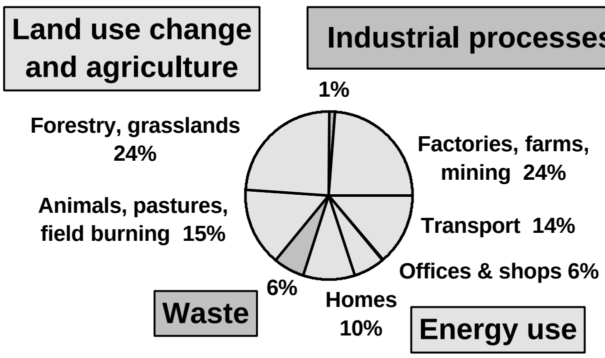

Fig. 5: Australian sources of greenhouse gas emissions.[39]

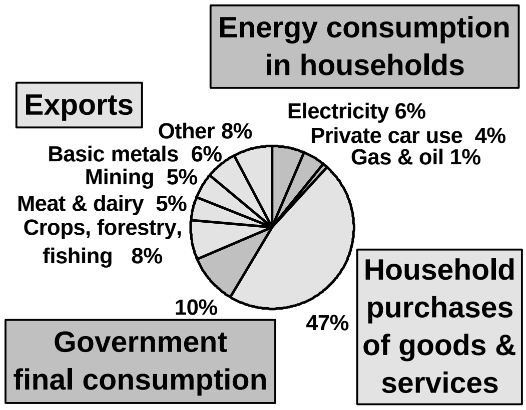

Fig. 6: Breakdown of 1994 Australian greenhouse gas emissions (nationally produced and imported) into end-use categories.[40]

The emissions occurring in industrial and agricultural production can be traced according to the intra-industrial flow of the produced commodities, and allocated to end-use categories. This procedure yields a breakdown as shown in Figure 6.[40] Greenhouse gases embodied in imported commodities are included in this chart, so that the total area (corresponding to 740 Mt CO_2-e) represents greenhouse gases produced on Australian territory as well as embodied in Australian imports. It can be seen that about 32% of these total emissions are embodied in export commodities, whilst government administration and defence accounts for about 10%. It must be emphasised that in Australia only 11% of the total occur through direct energy use by households, while a much larger portion of 47% is embodied in household purchases of goods and services.

Figure 6 also illustrates the difference between the nationally produced greenhouse gas emissions and the nationally 'attributable' emissions. The latter can be calculated from the produced emissions by adding the emissions embodied in imports, and subtracting those embodied in exports. It is these emissions that a nation must be held responsible for, and hence, they are also referred to as the 'greenhouse gas responsibility'.[30] In 1995, Australia produced about 530 Mt CO_2-e (total chart area in Figure 5), but attributable emissions were only about 450 Mt CO_2-e.[40] Hence, Australia is a net exporter of greenhouse gases. Considering the Australian population of about 17.7 million, about 30 t CO_2-e were produced per capita, while every Australian was responsible for about 25 t CO_2-e.

Figure 7 shows a breakdown of the Australian attributable greenhouse gas emissions according to their embodiment in government consumption and household consumption of various consumer items. 15% (70 Mt CO_2-e or 4 t CO_2-e/cap) of the total attributable emissions are needed for government administration and defence (which, as a form of service, can be regarded as an indirect consumption of households), while the remainder (380 Mt CO_2-e or 22 t CO_2-e/cap) is required to meet the direct consumption of Australian households. Within the latter, goods contain most of the embodied greenhouse gases (38% or 170 Mt CO_2-e or 9 t CO_2-e/cap, including food), followed by services (30% or 135 Mt CO_2-e or 7.5 t CO_2-e/cap, including transport services) and electricity and fuels (17% or 80 Mt CO_2-e or 5 t CO_2-e/cap, including petrol for private cars).

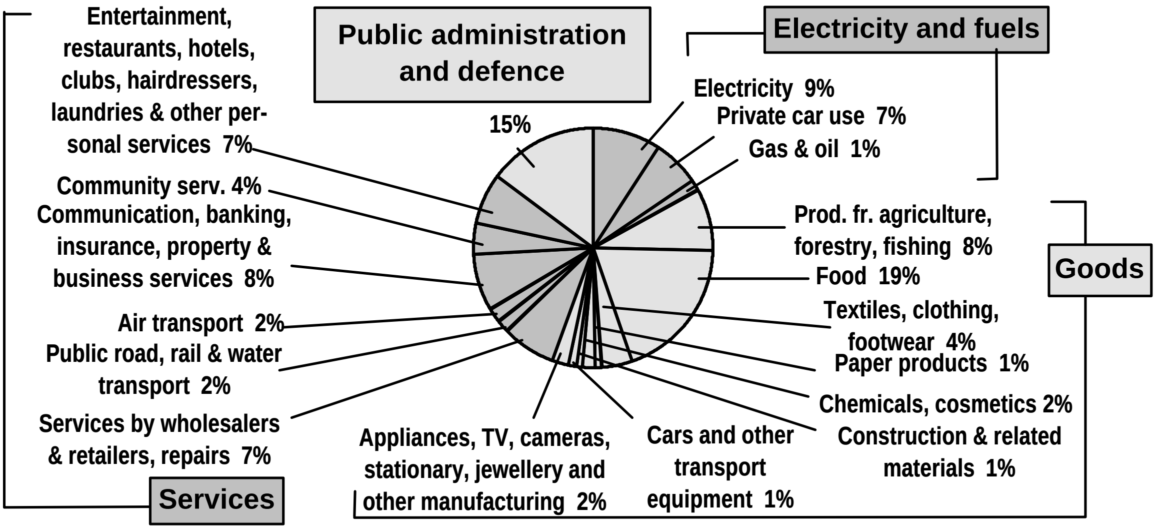

Fig. 7: Breakdown of 1994 Australian attributable greenhouse gas emissions into government consumption and household consumption of various consumer items.

The data presented in Figure 7 can be used to set up a calculation kit for assessing a personal greenhouse gas budget. Several more or less comprehensive ”greenhouse savers” are already available in Australia.[41,42,43] These are, however, incomplete, because they merely concentrate on electricity for refrigerators, stoves, lighting and other household appliances, energy for hot water and space heating, and fuel for transport (together only 11% of total attributable emissions). The only item mentioned not related to energy use is the recycling of paper, glass, plastic and clothes. It is therefore not surprising that, amongst actions to protect the environment, saving energy and fuel, as well as recycling of materials are those most commonly named by Australians.[31,32] In contrast, a comprehensive analysis of household emissions can be found in a questionnaire for the assessment of a personal CO_2 balance produced in Switzerland.[44] The design of such a calculation kit for Australian households is sketched in the following section.

Budgeting greenhouse gases

In order to determine our personal contribution to climate change, it is necessary to budget in "greenhouse prices" for consumer items rather than monetary units. These greenhouse prices have to include all emissions, occurring at any stage of the production process of these items.

Emissions can be allocated to production requirements of different order. For example, the emissions from using diesel to move a passenger train is a zeroth order (direct) emissions requirement for the consumer item “railway transport”. The emissions occurring in producing the locomotive and carriages of this passenger train are an indirect requirement of first order for “railway transport”. The production of the steel for this train causes emissions, which can be regarded as second order (indirect) requirements. This chain of requirements can be traced back to requirements of higher order (for example, emissions from producing the concrete to build the steel factory which produces the steel for the train which carries the passengers, and so on). An elegant method of calculating all emissions embodied in any consumer item (total requirements) is the input-output analysis. This method is able to incorporate not only requirements from national intra-industrial flow of goods and services, but also requirements from imports and from capital investment. Such an input-output analysis has been carried out for the Australian economy[40], yielding greenhouse gas intensities, that is amounts of greenhouse gases (in kg CO_2-e) embodied per A$ purchase value. Together with data from other sources [45-52] they form the basis of Table 1, which can be used to calculate a personal greenhouse gas budget in units of kg CO_2-e. Although the figures are valid for Australia, they are more or less applicable in other industrialised nations.

The first column shows "greenhouse prices" derived from data in Reference 40. For convenience, units from every-day usage (for example, kg for solid food, km for transport etc.) are chosen. The second column shows the consumption of an average Australian in these units. The third column contains the product of the figures in columns one and two. The sum of the figures in column three is the per capita emissions associated with an average Australian lifestyle.

Table 1 shows that almost two thirds of the total per capita emissions, that is 16 t CO_2-e, are embodied in the consumption of goods and services, including food. Amongst these items, beef products show extraordinarily high greenhouse gas intensities (≈ 8.9 kg CO_2-e / A$), because of the considerable amount of greenhouse gases from Australian land clearing and enteric fermentation in animals. Consequently, the consumption of meat and dairy products alone causes almost 6% of the total per capita emissions. Other outstanding items are the consumption of electricity, and the use of private vehicles.[40]

Tab. 1: A personal greenhouse gas budget calculator.

Work out your personal greenhouse gas budget !

It's easy. Just fill in the amounts (in $, kg, km, etc) you consumed during the last twelve months (in the second column), multiply them with the "greenhouse price" (in the first column) and enter the result in the third column. At the end, add up all emissions, fill in the total and compare yourself to the average Australian (see fourth column). You can find some interesting information on climate change on the back side of this sheet.

Item	"Greenhouse Price"	× amount consumed (in $, kg, kWh, MJ, km, etc)	= Personal emissions (in kg of greenhouse gases)	Average Australian (in kg of greenhouse gases)
Food				
Beef products	8.9 per $	____________ $	____________	1450 kg
Dairy and other meat products	2.6 per $	____________ $	____________	800 kg
Fruit and vegetables	1.4 per $	____________ $	____________	230 kg
Bread, flour and cereals	1.5 per $	____________ $	____________	340 kg
Margarine, oils and fats	2.0 per $	____________ $	____________	55 kg
Sugar, confectionary and all other	1.8 per $	____________ $	____________	800 kg
Beverages	0.8 per $	____________ $	____________	230 kg
Meals out	1.4 per $	____________ $	____________	1000 kg
Organic waste to landfill	1.6 per kg	____________ kg	____________	55 kg
Household Electricity and Fuels				
Electricity (conventional)	1.2 per kWh	____________ kWh	____________	3100 kg
Electricity (renewable energy)	0.1 per kWh	____________ kWh	____________	
Natural gas	0.1 per MJ	____________ MJ	____________	460 kg
Transport				
Bicycle	0.1 per km	____________ km	____________	5 kg
Bus and coach	0.2 per pass-km	____________ pass-km	____________	250 kg
Train	0.2 per pass-km	____________ pass-km	____________	150 kg
International Air	0.3 per pass-km	____________ pass-km	____________	200 kg
Domestic Air	0.8 per pass-km	____________ pass-km	____________	250 kg
Car (divide by no. of pass. to get your share)	0.48 per veh-km	____________ veh-km	____________	2700 kg
Goods and Services				
Goods excl. food (clothing, footwear, TV, books, paper, magazines, HiFi, video, household chemicals, cars, furnishing, appliances, recreational goods, construction materials, etc.)	1.5 per $	____________ $	____________	3300 kg
Services excl. transport (mortgage, rent, council rates, phone, mail, insurance, personal services, banking, accommodation, movies, concerts, sporting events, etc.)	0.7 per $	____________ $	____________	7400 kg
Growing trees you planted	-15.0 per tree	____________ trees	____________	
Government Administration and Defence			6100 kg	6100 kg
Net uptake by our common forests and soils			-4300 kg	-4300 kg
Total			____________	24600 kg

Compare yourself with :	
Average Australian	24600 kg
Average world citizen	7000 kg
Average person in India	1000 kg
Environmentally sustainable level	3500 kg

Please note that the estimates given in the table are averages over many different products and producers and thus only indicative for the type of consumption. Nevertheless, the overall total will in general be quite accurate. Abbrev.: pass-km=passenger-kilometer; veh-km=vehicle-kilometer.

What has climate change got to do with me?

Both scientists and politicians now admit that humans are slowly changing the earth's climate. This happens because of the emission of greenhouse gases (mainly carbon dioxide and methane) into the atmosphere, which causes global warming (about 3°C over the next 100 years) and a worldwide rise in the sea level (about ½ m). Climate change means that millions of people living on low-lying islands and in coastal regions will be displaced, water and food supply will deteriorate, floods and droughts will be more frequent and extreme, and some infectuous diseases such as malaria and yellow fever will spread.

In order to keep climate change at bay, emissions have to be reduced. Scientists say that annual emissions of 3500 kg per person worldwide is a level which stabilises the concentration of greenhouse gases in the atmosphere. About three quarters of the world's population emit less than 3500 kg per year. These are people living in developing countries like India. The average Australian emits about 25000 kg per year. This is too much, and moreover, it is not fair. We have to reduce our emissions for the sake of reducing the threat of climate change, whilst being fair to people in developing countries.

The personal greenhouse gas budget on the other side of this sheet can help you to find the areas where you can start reducing your greenhouse gas emissions most effectively. Here are some ideas that can make a difference:

- share, fix, borrow and swap, rather than buying things
- buy second hand, rather than buying new
- reuse and recycle, rather than throwing out
- consume services, rather than consuming goods
- buy locally grown, organic food, rather than buying conventionally grown or imported food
- eat fruit, vegetables, bread and cereal foods, rather than meat products
- join a renewable electricity scheme
- install a solar hot water system, rather than using an electric system
- use public transport, rather than using your car
- use trains and coaches, rather than flying
- plant trees
- spend creative time, rather than spending money
- increase quality of life, rather than standard of living

The effect of lifestyle changes on the annual per capita greenhouse gas budget can be estimated from Table 1. Firstly, the total amount of 25 t CO_2-e per capita can be reduced by about 9 t CO_2-e by 4 measures: (1) substituting meat, dairy and confectionary with other food items (- 2.5 t CO_2-e per capita), (2) joining a renewable electricity scheme; (- 3 t CO_2-e per capita), (3) using trains or coaches instead of domestic air transport, and using public transport instead of the private car for 75% of all trips (- 1.5 t CO_2-e per capita), and (4) purchasing 60% less new goods, for example by buying second hand, repairing or borrowing (- 2 t CO_2-e per capita). Additional reductions, which cannot be quantified here, can be achieved through an environmentally conscious choice of purchases. The amount of greenhouse gases embodied in food, for example, depends critically on the type of production and transport requirements. In the case of tomatoes, the primary energy required to produce and deliver one kilogram has been calculated to 2 Megajoules (MJ; 1 MJ = 10^6 J) for natural cultivation, 55 MJ for greenhouse cultivation, and 168 MJ for imports (in this case from the Canary Islands to Switzerland).[53] Similarly, recreational activities can exhibit a more or less high ”greenhouse price”, depending on whether they involve a great deal of equipment or not. Finally, the emissions associated with administration and defence can only be indirectly influenced by the individual through political activity. One example for a potential reduction of greenhouse gas emissions in government consumption is the demilitarisation of national outlays (’environmental peace dividend’).[54]

Conclusions

Because of its uncertainty, complexity, global scope, irreversibility, long-term effect and regional variability, climate change is posing considerable problems for impact analysis and decision making.[11] Technological improvements and policy instruments do not appear to be achieving a sustainable and equitable situation within the following decades. This is reflected in the difficulties, which Annex I signatory countries are facing in meeting reduction targets set within the FCCC. It is in this context that the important role of changes in individual consumption in industrialised countries must be emphasised. Especially in Australia, the general public has so far been insufficiently addressed about this issue (see for example Reference 55). As a consequence, even though awareness and concern about climate change as well as perceived responsibility are relatively widespread, these are rarely translated into consistent, adequate action and significant emission reductions. In addition, only a limited sphere of responsibility is generally identified, in which reducing the usage of household energy and cars, and the recycling of some materials are recognised as pro-environmental behaviour. Changing the pattern, or even reducing the consumption of goods and services is, however, always almost ignored.

It is proposed here that the concept of a personal greenhouse gas budget should be applied in communicating pro-environmental consumer behaviour to the general public. If designed as shown in the previous section, this budget is comprehensive in the sense that it contains both direct and embodied greenhouse gas emissions, including both domestically produced as well as imported commodities. Budgeting greenhouse gas emissions in this way clearly reveals that, in order to live an ecologically sustainable and globally equitable lifestyle, it is necessary to adjust to far lower levels of personal consumption. This reduction in ’standard of living’ does not necessarily correspond to a lower ’quality of life’. Instead, it is possible to live well in a less affluent society with a much lower material output and hence, without the present waste of resources. It is the sustainable and equitable situation, in which the needs of people in industrialised countries are still met, but without compromising the ability of both people in developing countries and future generations to meet their own needs.

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