Teaching Responsibility for Climate Change: Three Neglected Issues

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A B S T R A C T

Based on a review of NSW and Victorian education materials, we conclude that the following three issues are neglected within education about climate change, and should be included in future syllabuses: (1) there are large disparities in per-capita greenhouse gas emissions between industrialised and developing countries. Hence, international equity and its implications for Australians must be addressed. (2) There is a considerable gap between the outcome of Australian emissions abatement, and reductions, which are necessary to achieve an ecologically sustainable and internationally equitable emissions level. Given the absence of adequate technological and political incentives, the potential of individual responses must be further explored. (3) Responsibility for climate change is not restricted to emissions from households and private cars, but must be extended towards emissions associated with the personal consumption of goods and services.

Introduction

Climate change is considered to be one of the most serious threats to the global environment. Since environmental education aims, amongst other goals, at developing "practice in decision making, and self-formulating of a code of behaviour about issues concerning environmental quality" (International Union for the Conservation of Nature 1970), it is essential that individual responsibility for climate change along with effective abatement strategies is adequately addressed in education. This is especially true for teaching school students, since (1) they will be the generation which are likely to face some of the repercussions of climate change and will need to continue the care and repair of the environment which has begun in our generation, and (2) they are likely to be more accepting than adults of the certainly radical changes that a truly sustainable future demands.

The concept of climate change is new to centrally developed Australian syllabuses, and most states and territories have only begun to consider it a priority in such key learning areas as 'Science and Human Society and its Environment' (Board of Studies New South Wales 1998). However, despite this concept being in an early stage of its development, we propose that three important issues are not adequately addressed in education material: firstly, with the exception of being mentioned in passing in some geography and TAFE (Technical And Further Education) courses, it is not emphasised that, apart from being ecologically unsustainable, present greenhouse gas emissions are internationally inequitable, and that moving towards international equity holds drastic implications primarily for people living in industrialised countries such as Australia, where the most unsustainable lifestyles prevail. Secondly, the size of the gap between present Australian per-capita emissions and ecologically sustainable and internationally equitable emissions has not been made clear. Thirdly, only a limited individual responsibility for climate change can be concluded from available education material. This responsibility is restricted to the reader's immediate surroundings such as the household and the private car, while abatement strategies aimed at encouraging more encompassing lifestyle changes involving the reduction of personal consumption are not considered.

The global problem

In 1995 it was acknowledged by the leading body of experts in the field, the Intergovernmental Panel on Climate Change, that "the balance of evidence suggests that there is a discernible human influence on the global climate" (IPCC 1995a). This influence is expressed in the increase of atmospheric concentrations of greenhouse gases, which cause global warming and sea level rise, threatening coastal regions and the supply of water and food, and spreading vector-borne infectious diseases such as malaria, dengue and yellow fever (Houghton *et al.* 1996, Watson *et al.* 1996, McMichael *et al.* 1997). In particular Australian agriculture is likely to suffer from the increase in the frequency and the intensity of severe floods and droughts (Colls 1993, Smith 1993, Watson *et al.* 1998). Because of the long atmospheric lifetime of the greenhouse gas CO_2, time lags between abatement measures and climate stabilisation are in the order of decades. Even if emissions were maintained at present levels, 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 (Houghton *et al.* 1997). Climate models show that an immediate stabilisation of the concentration of CO_2 can only be achieved through an immediate reduction in net emissions by 50-70% and further reductions thereafter (IPCC 1994, IPCC 1995b).

Issue: Disparities and equity

As with economic wealth, there are large global inequalities in contributions to climate change. About 20% of the world's population in industrialised countries cause about three-

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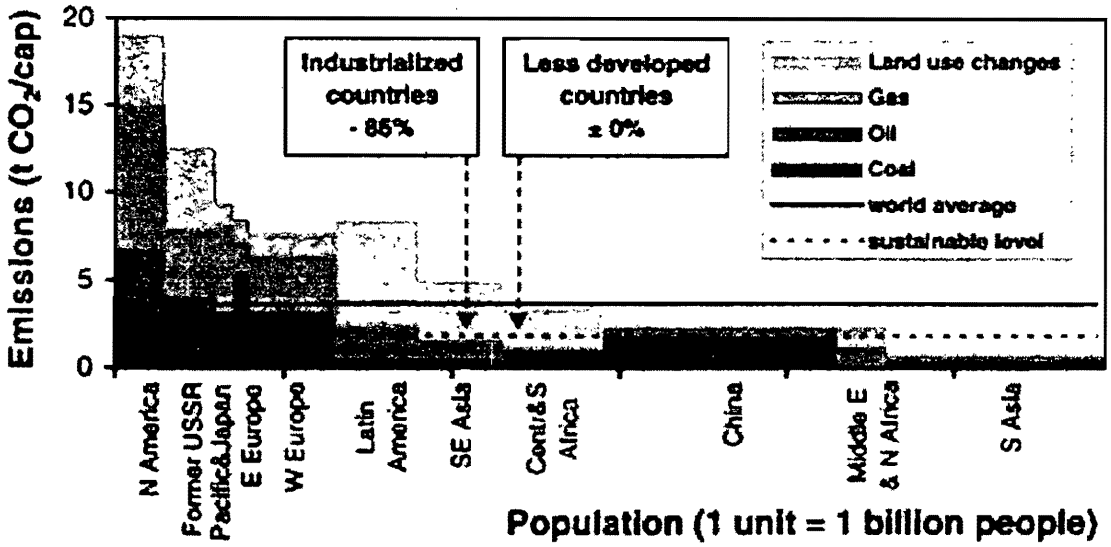
Fig. 1: 1990 per-capita CO_2 emissions by region and source (after Nakicenovic 1996)

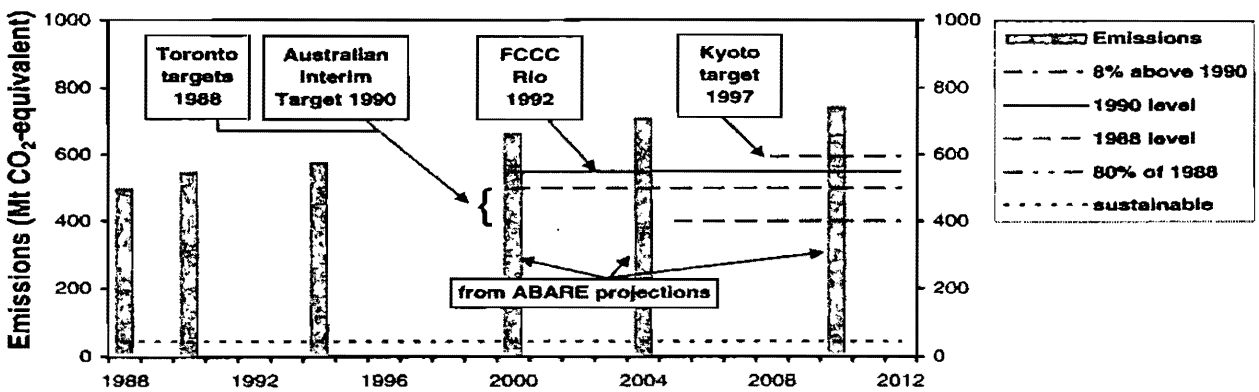


quarters of the global greenhouse gas emissions. Average per-capita emissions in Australia, North America, Europe or Japan are about ten times higher than those in South Asia or China (United Nations Department for Economic and Social Information and Policy Analysis 1994). The column areas in Fig. 1 represent the total amount of CO_2 emitted annually from world regions. This is not necessarily identical to the CO_2 emissions associated with the corresponding regional consumption, because some emissions are embodied in exports and imports between regions (see Wyckoff *et al.* 1994). A major part of the 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 to those of industrialised countries, thus increasing the gap between rich and poor. There are disparities, which are not shown in Fig. 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 (IPCC 1995, Bruce *et al.* 1996).

In the previous years, global greenhouse gas emissions totalled about 40 Gigatonnes of CO_2-equivalent (Gt CO_2-e) per year, while the global population was almost 6 billion, both figures rising steadily. Applying international equity in greenhouse gas emissions on a per-capita basis means that a sustainable emissions level is reached when nobody causes an amount of emissions of more than 50% of the present world average, given the results of climate models mentioned earlier. Hence, apportioning the same right to pollute 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 (compare with proposals by Byrne *et al.* 1998 and Den Elzen *et al.* 1992). This "greenhouse gas budget" is both ecologically sustainable and globally equitable and will in the following be called the "sustainable level".[1]

Given the disparities in per-capita emissions between industrialised and developing countries shown in Fig. 1, a sustainable and equitable situation implies that industrialised countries such as Australia would have to reduce emissions by 85%, while developing countries could more or less remain at the present levels. How does this situation compare with

Fig. 2: Historical and projected greenhouse gas emissions from Australia compared to various targets and the sustainable level for the Australian population (after Bush *et al.* 1997). As emissions increased, so did the targets. Note: ABARE = Australian Bureau of Agricultural and Resource Economics



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past and likely future emissions in Australia?

Issue: Australian political response and emissions

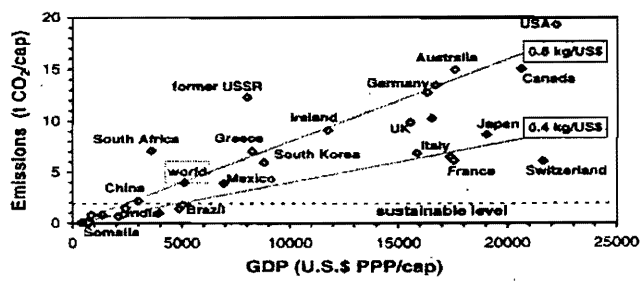
A first political step in the prevention of climate change was taken in 1988 at the Toronto Conference on the Changing Atmosphere, where a target of a 20% reduction of 1988 CO_2 emissions by the year 2005 was recommended (World Meteorological Organisation 1988). This was adopted by the Australian government as an interim planning target (Kelly *et al.* 1990) for the National Greenhouse Strategy. 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" (United Nations 1992). The Framework Convention on Climate Change (FCCC) was signed after the summit. This time, the Annex I (industrialised) signatory countries committed themselves to take 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 to develop 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 (State of the Environment Council 1996), the second COP held in July 1996 in Geneva had already discussed a protocol or legal instruments for the limitation of greenhouse gas emissions to be adopted at the third COP. Although Australia did not endorse the inclusion of legally binding targets into the Geneva protocol (Hill 1996), it managed to negotiate an 8% increase over 1990 emissions levels at the third COP held in Kyoto in December 1997 (see Hamilton *et al.* 1999b).

Even though the targets mentioned above significantly exceed the sustainable level determined earlier, it is uncertain whether they will be met in Australia (compare Andrews 1999). Australian per-capita emissions are steadily increasing by an average 1.5% per year (Bush *et al.* 1997, see Fig. 2). This increase is mainly due to a growth in income and thus in consumption and industrial output (+2% per year), which was only slightly offset by technological and fuel mix changes (-0.5% per year; see Common *et al.* 1992, Melanie *et al.* 1994, Wilson *et al.* 1994, and Hamilton *et al.* 1999a). Wealth is also the main indicator for emissions worldwide (see Fig. 3). Most countries show CO_2 intensities between 0.4 kg CO_2/US$ and 0.8 kg CO_2/US$. Countries above the upper boundary need a particularly large amount of CO_2 in order to generate 1 US$ of GDP, such as the former USSR (extensive resource waste and inefficient technology) and the USA (low energy prices). Countries below the lower boundary 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. At an average CO_2 intensity of 0.6 kg CO_2/US$, the sustainable level corresponds to a per-capita GDP (and hence per-capita annual expenditure) of 3300 US$.

Individual response

Governments can in principle steer a country's development towards sustainability. However, bearing in mind the outcome of Australian climate change abatement efforts, and assuming that the introduction of alternative technologies such as renewable energy will not sustain current industrial societies (see Trainer 1997), we argue that it remains the responsibility of Australians to ensure that their lifestyles result in ecologically sustainable and internationally equitable greenhouse gas emissions. Individual responses such as adjusting to a sustainable and equitable lifestyle can effectively supplement political and technological measures while being an ethical option for people in industrialised countries who are concerned about global unfairness and environmental degradation, and who are disappointed about the lack of adequate political changes. Assessing personal emissions and comparing these with the previously introduced sustainable level of 3.5 t CO_2-e per year can be enlightening and it questions, who is actually willing to make the sacrifices that an environmentally rigorous policy would entail (Proops *et al.* 1993).

Fig. 3: 1991 per-capita CO_2 emissions and Gross Domestic Product (GDP, in US$ at purchasing power parities, PPP) for various countries (after United Nations Department for Economic and Social Information and Policy Analysis 1994).



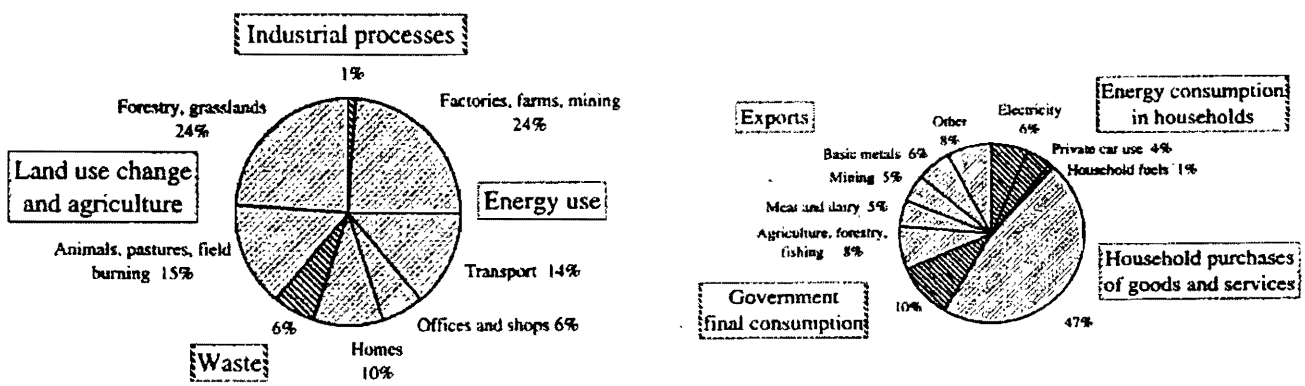
Awareness and concern are a prerequisite for behavioural changes. While a growing number of people are concerned about the environment (see ABS 1997, and EPA NSW 1997), there seem to be some factors inhibiting individual action. Firstly, in industrialised countries, concerns about climate change bear little relation to personal greenhouse gas emissions. This paradox was one of the results of a survey of Melbourne households, undertaken to determine people's understanding of, and attitude towards climate change as well as their actions in response to their concerns (see Stokes *et al.* 1994). 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 (DEST

1991), which revealed that education and 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. These findings suggest that the provision of information does not necessarily motivate behavioural changes in the community. As a consequence, the Environment Protection Authority in New South Wales (EPA NSW) has recognised the need to have a better understanding of the environmental knowledge, skills, attitudes and values of the community in order to develop strategies to solve environmental problems (EPA NSW 1997). Research in school education circles has come up with similar findings, as shown by Connell *et al.* (1998), who investigated the beliefs, knowledge, education and influences of secondary schòol students in Brisbane and Melbourne. Similar studies were conducted by Gambro *et al.* (1996) in the USA, Szagun *et al.* (1993) in Germany, Wals (1994) in the Netherlands, Szagun *et al.* (1995) in Russia, Yeung (1998) in Hong Kong, and Glazar *et al.* (1998) in Slovenia. The emphasis in NSW school education is therefore now centred on students developing skills to work for the environment and take action in addition to understanding environmental issues (compare Environment Australia 1999). It is hoped that if students can develop these attitudes from a young age, they will carry these values into their adult life and into future decisions for the next generation.

In the case of adults, 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 (Eden 1993). Moreover, it is argued that a sense of confusion and uncertainty arising from conflicting information from different sources (Harrison *et al.* 1996) as well as a publicly perceived mistrust in the governmental institutions providing this information (Hinchliffe 1996) 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 (Macnaghten *et al.* 1997). While adults in general may be lacking in taking overt action for the environment, current research suggests that younger people are more likely to be committed to taking more care in the future. An investigation into the environmental understandings of the adult population in NSW revealed that people under the age of 25 saw a future for the environment and believed that they had some empowerment to take effective action on its behalf. People over 50 tended to feel that there was little which could be done and were more pessimistic about the environment's future (EPA NSW 1994). As a consequence, most education programs and projects managed by government agencies, and integrated with each education departments' curriculum priorities, emphasise the personal responsibility and ability of young people to assist in environmental enhancement rather than presenting environmental issues as a major insoluble problem which is too big for all of us to even contemplate.

The achievement of educational outcomes is not confined to the formal classroom situation or through traditional teaching methods following a fixed and sometimes restrictive syllabus document. Environmental education in particular is often characterised by student involvement in special programs and projects requiring their active participation in activities which lead to an enhancement of the environment. These programs are often based on cooperation between schools, communities, and government and non-government agencies. Programs such as Landcare, EPA educational materials, and publications by the National Parks and Wildlife Service are well accepted by teachers and used as effective support materials for teaching and learning. One particular program, which has experienced increasing growth and success since 1996, is the Greenhouse Parks Program managed by the Hawkesbury-Nepean Catchment Management Trust (1999a). The success of the program has attracted the attention of the New South Wales Government Cabinet Office leading to a grant to the Trust of A$20,000 in 1998. At the end of 1999 the Greenhouse Parks Program was working with 55 schools throughout the Hawkesbury-Nepean Catchment and the Sydney-Illawarra

Fig. 4: 1994 Australian greenhouse gas (1) production and (2) consumption (after National Greenhouse Gas Inventory Committee 1996 and Lenzen 1998).



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Region. The key objectives of the program are to increase community understanding and involvement in the issues related to the greenhouse effect, to increase the understanding of distinctions between actions that address the greenhouse effect and those associated with natural resource management and general environment issues, to facilitate the mass planting of locally sourced seedlings and the ongoing maintenance of carbon sinks, and to provide education through school-based curriculum activities and on-site energy audits. The program, to this stage, has led to the following successful outcomes: (1) development of a curriculum-based manual to implement greenhouse gas reductions within schools and a poster depicting the greenhouse effect, (2) planting of 13,000 seedlings in 32 parks, (3) development of a methodology for carbon accounting in mixed species plantings of Cumberland Plain and Sandstone vegetation communities, and (4) refinement of the network support processes for schools and councils. This is an excellent result for a program which has the difficult but valuable task of linking community-based education and action relating to climate change and energy efficiency with broader natural resource management issues such as revegetation, biodiversity, and water quality.

Given the important role education materials play in communicating responsibility, it is essential that they present a complete view of the manifold and complex ways in which humans affect the environment, yet without disempowering the individual student. However, selected NSW and Victorian education materials present climate change in a way which creates the common but misleading perception that an individual is only responsible for emissions occurring directly from their household, their car, or their place of work or study. Recommendations for reducing personal emissions concentrate on the relatively minor aspect of electricity and fuel use while missing the more important issue of reducing goods and services consumption as an efficient way to abate climate change. This will be explained in the following.

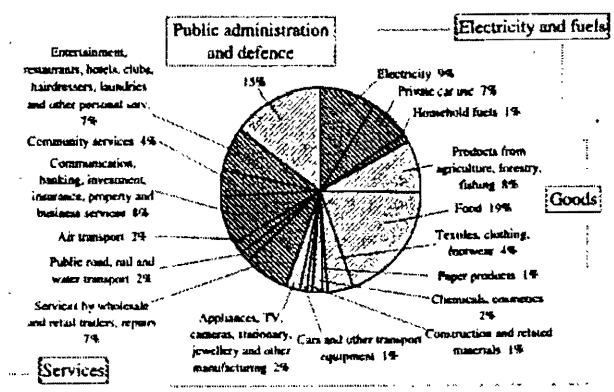
Issue: Responsibility

Some 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 of personal responsibility for these emissions, resulting in efforts to save energy in homes or to reduce private car use. However, about two thirds of Australian emissions occur initially in factories or on farmland. It is argued in this article that, in accordance with Adam Smith's classical statement that "consumption is the sole end and purpose of all production" (Smith 1776), that the consumer who buys a product is ultimately responsible for the emissions this product has entailed in its production.

Breakdowns of Australian emissions into (1) production and (2) consumption categories differ noticeably (see Fig. 4). 54% of the *produced* greenhouse gases (Chart 1; total 575 Mt CO_2-e) are 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 from landfills and non-energy industrial processes. The emissions occurring in production can be traced according to the inter-industrial flow of the produced commodities, and allocated to final consumption categories. This procedure is often expressed using the view that emissions become 'embodied' in consumer products. Embodied emissions can be calculated using an economic technique called input-output analysis, which employs national statistical data on inter-industrial transactions and on emissions of industry sectors. The mathematical framework of the approach used in this work has been described in detail elsewhere (Lenzen 1998). The results of an input-output analysis are shown in Chart 2 of Fig. 4.

It can be seen that 32% of *consumed* emissions (total 740 Mt CO_2-e, including imports) are embodied in exports, whilst government administration and defence account for about 10%. Only 11% of total emissions occur through direct energy use by households, while a much larger portion of 47% is embodied in household purchases. *Attributable* emissions can be calculated from embodied emissions by subtracting 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' (Proops *et al.* 1993). Australian attributable emissions are about 500 Mt CO_2-e (see Fig. 5), and every Australian is responsible for 28 t CO_2-e. 15% of attributable emissions are needed for government administration and defence, while the remainder is due to the direct consumption of Australian households. Within this remainder, goods form the main part of Australians' greenhouse gas responsibility, followed by services, electricity and fuels.

Fig. 5: Breakdown of 1994 Australian attributable greenhouse gas emissions.



Summarising the previous sections, we conclude that the consumption of goods and services by citizens of industrialised countries such as Australia is the largest single driving force for both the level and the increase of global greenhouse gas emissions. As a consequence, it is this driving force which has to be attended to in the education about abatement strategies. Recommendations for end-use emissions reductions should concentrate on changing the pattern and the amount of personal consumption. This result is consistent with the 'Brundtland Report' (World Commission on Environment and Development 1987), which identified the industrialised

countries' consumption and the gap between rich and poor as the main causes of environmental degradation.

Climate change in education materials

Various education materials published in NSW and Victoria (HNCMT 1999b, VAEE *et al.* 1998, NRMA 1998, Environment Australia 1997a, NSW Department of School Education 1997, Futureworld 1997, Choice Education and EPA NSW 1996, EPA NSW 1996, DEST 1995, Australian Academy of Science 1995, Cramp *et al.* 1995, EPA Victoria 1994, DPIE 1993, EPA Victoria 1992a, EPA Victoria 1992b, Gough 1992, Greenhouse Unit, Department of Conservation and Environment Victoria *et al.* 1991, Commission for the Future 1989, Dufty *et al.* 1989) were surveyed with regard to their treatment of equity, sustainability and responsibility in the context of climate change. The selection of these materials was carried out on the basis of the following hierarchically narrowing criteria: The material must (1) be published and available in NSW or Victoria, (2) preferably be less than 10 years old, (3) discuss educational issues explicitly in the context of climate change, *(4) not only deal with the* greenhouse effect, but also with emission sources, (5) quantitatively demonstrate present global emission inequity, (6) describe a sustainable emissions scenario, (7) deal with personal impacts on greenhouse gas emissions and quantify emissions for a number of household activities, (8) provide a globally equitable and environmentally sustainable per-capita emissions level, (9) quantify emissions associated with goods and services consumption. We were neither seeking to analyse the texts in terms of political, social, cultural, or gendered discourses, nor searching for patterns of particular text features that might position the reader in particular ways (for which there are several useful tools such as content analysis, critical literacy, and discourse analysis). We were searching for presence or absence of a particular, discrete topic. A careful working through the selection criteria was sufficient to reveal absence of the content we were looking for. We can of course not guarantee the completeness of our selection with respect to criteria (1) and (2). However, an effort was made to collect all materials that were available to us through literature searches, personal communication with institutions dealing with environmental education, and further references in already collected material.

Given these constraints on completeness, we were unable to locate materials in which a sustainable emissions level along with present Australian per-capita emissions are quantified, or which address ecologically sustainable and internationally equitable emissions in another way. However, there are several publications available in Australia containing more or less comprehensive 'greenhouse savers' or 'scorecards', which attempt to assess the greenhouse gas responsibility of individuals (criterion 7). While being clear, instructive and helpful, they concentrate on electricity for refrigerators, stoves, lighting and other household appliances, energy for hot water and space heating, and fuel for transport. As an example, the 'School Greenhouse Saver' (EPA Victoria 1994) dedicates only two out of 23 pages to emissions which are not related to direct energy use, such as from the manufacture of paper, packaging, textbooks and school furniture. A similar disproportioning can be found in 'Global Warming – Cool it!' (Environment Australia 1997a) which is intended as a nation-wide home guide to reducing greenhouse gases. 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 (see Stokes *et al.* 1994, and ABS 1997).

In contrast to the publications mentioned above, a comprehensive analysis of household emissions can be found in a questionnaire for the assessment of a personal CO_2 balance (Hofstetter 1992) produced in Switzerland, which accounts for direct as well as embodied CO_2 emissions. In Switzerland, about 50-60% of personal CO_2 emissions are embodied in goods and services. This portion is lower than in Australia, because of the relatively high direct emissions due to space heating in Swiss buildings. On the last page, the questionnaire states the sustainable and equitable annual emissions target of 2 t CO_2 per capita[1], and provides a list of per-capita emissions in other countries.

The concept of extended responsibility as described above has not yet been considered in environmental education in Australia. In the 1960s there was much emphasis on presenting environmental problems as the responsibility of industry and, to a lesser degree, government. Since the release of environmental education statements and policies in different states and territories in the late 1980s the emphasis reverted to individuals needing to take more responsibility. Schools are not in the position to change major political attitudes but they can influence the minds and attitudes of students to some extent. Most educationists realise that presenting a problem that is beyond the power of students to solve is a pointless exercise and may even lead to their feeling powerless and depressed about the situation. As a result, schools now present programs which show students that they can make a difference even if it is only in a small way. 'Act locally and think globally' is the criterion that is employed. While senior students are presented with environmental problems such as greenhouse gases on a more global scale it is not beyond their comprehension to realise the power of consumerism and its impact on the productive process. However, since the topic of climate change is relatively new to the curriculum, the concept that those who buy a product are ultimately responsible for the emissions the product has entailed, has yet to be embedded in most syllabuses.

As new syllabuses are being developed, central study boards are considering the concept as a content area for students to study. Examples include the Victorian Certificate of Education 'Environmental Studies' study design, the Stage 1 'Environmental Studies' extended subject framework in South Australia, and the Stage 6 'Earth and Environmental Science' and the 'Human Society and its Environment' K-6 syllabuses in NSW. In most cases, however, climate change is offered as

an optional content area rather than as a mandatory study (see Board of Studies NSW 1998 and SSABSA 1991). The emphasis is on outcomes (understanding, values and attitudes, decision-making skills, action) and a number of optional content areas could lead to the achievement of these outcomes. An exception is the Victorian Certificate of Education study design (Board of Studies Victoria 1994), which recommends the inclusion of global warming into the 'Environmental Studies' course. This study design also explicitly addresses aspects of equity, sustainability, consumerism, and personal impacts and action such as "factors contributing to international differences in resource consumption", "the capacity of the environment to sustain life including human population", "the long-term environmental implications of economic development", "tracing the various processes involved in the use of [...] resources [...], for example, extraction, harvesting, processing, consumption, disposal", and "formulation of individual conservation strategies designed to reduce atmospheric modification".

There is an increasing attraction for teachers to select the climate change option. In 1998 the Australian Greenhouse Office contracted the Australian Science Teachers Association to develop support materials for the teaching about greenhouse gas emissions and their effects on climate change. Furthermore, curriculum developers are required by their State Government to implement a 2-year action plan ensuring that Measure 2.11 (School-based greenhouse education) and Measure 2.12 (Training for key professions/occupations) as outlined in the National Greenhouse Strategy (Australian Greenhouse Office 1998) are in place by 2001. The NSW Government, through its Cabinet Office, promoted these

Fig. 6: A personal greenhouse gas calculation kit (after Lenzen 1998, ABS 1995a, ABS 1995b, Lenzen 1999, and Australian Academy of Science 1995). Greenhouse prices include all embodied emissions. The greenhouse price for organic waste to landfill differs from values in Environment Australia 1997a. The value in the kit was calculated (see Environment Australia 1997b) assuming that 51% of degradable matter is converted into CH_4 (1.81 kg CO_2-e/kg), and 49% into CO_2 (0.22 kg CO_2-e/kg). It also includes previous sequestration of CO_2 during biomass growth (-0.45 kg CO_2-e/kg), and transportation of waste to the landfill site (0.01 kg CO_2-e/kg).

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"	x 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 $	_____	$	_____	600 kg
Beverages	0.8 per $	_____	$	_____	230 kg
Meals out	1.4 per $	_____	$	_____	1000 kg
Organic waste to landfill	1.6 per kg	_____	kg	_____	80 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.

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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**

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measures by asking the Department of Education and Training to include the topic of climate change in all relevant syllabuses through its contact with the NSW Board of Studies. As new syllabuses come up for revision, the topic is to be considered. However, not many syllabuses are amended annually, making the inclusion of climate change a relatively slow and infrequent process. Given the numerous demands on syllabus developers, the topic will continue to be overlooked in many quarters for the next few years. Under the guidance of the NSW Cabinet Office, schools in that state will be subject to a three year implementation plan with identifiable milestones to achieve the objectives of NGS Measure 2.11. We suggest that, as a part of this plan, sustainable emissions, international equity, and extended responsibility, be adopted into school education about climate change. An example of new education material, a student's calculation kit for assessing a personal greenhouse gas budget is shown in Fig. 6. Note that this kit is based on broad product groups and does not accommodate environmentally conscious choices.[2] However, it can be extended, if desired, to more than 100 products.

Conclusions

Because of its complexity, global scope, irreversibility, long-term effect, regional variability, and the uncertainty of its impacts, climate change is posing considerable problems for impact analysis and decision making. Technological improvements and policy instruments do not appear as though they would achieve a sustainable and equitable situation over 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. Even though awareness and concern about climate are relatively widespread in Australia, 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, almost always ignored.

It is proposed here that extended responsibility for direct as well as embodied greenhouse gas emissions should be applied in communicating pro-environmental consumer behaviour to school students. Most syllabuses highlight greenhouse gas emissions in general rather than mandating it as a specific term. This allows teachers the freedom to include extension topics such as consumerism as the situation might demand it. Textbooks are a major influence on the actual details of topics to be taught; hence it is the responsibility of authors to ensure that they have considered the latest information and research. We suggest using a comprehensive personal greenhouse budget calculation kit, which accounts for emissions from fuels and electricity as well as from the consumption of domestically produced and imported goods and services. We believe that budgeting greenhouse gas emissions in this way will demonstrate to students that, in order to live an ecologically sustainable and globally equitable lifestyle, it is necessary to adjust to lower levels of personal consumption. Furthermore, keeping a personal greenhouse budget helps to identify their most important emissions. If designed as shown in Fig. 6, it also offers the student a broader choice of reduction measures. These include for example buying second-hand items, sharing and borrowing, or consuming services rather than goods, in addition to traditional measures such as saving energy. Nevertheless, it is important to convey, that a reduction in 'standard of living' does not necessarily correspond to a lower 'quality of life'. Instead, it should be pointed out that it is possible to live well in a less affluent society at much lower production levels and hence, without the present environmental degradation

Notes

1 In international policy, the term "sustainable" is used in a broader sense including aspects of justice, welfare, development and equity. Here, "sustainable level" shall be used in the restricted sense of equitable emissions, which lead to a stabilisation of global CO_2 concentrations. If equity and sustainability are only applied to CO_2 rather than to all greenhouse gases, the sustainable level is 2 t CO_2 per capita. Note that this figure is shown in Figs. 1 and 3, since they refer only to CO_2.

2 The primary energy required to produce and deliver one kilogram of tomatoes has been calculated (Gysi *et al.* 1990) to 2 MJ for natural cultivation, 55 MJ for greenhouse cultivation, and 168 MJ for imports (in this case from the Canary Islands to Switzerland).2

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