

## DOCUMENT 3: Further considerations

3(1)

### IPCC Emissions Scenarios: The Case for a Review

Ian Castles

In letters sent to the IPCC Chairman, Dr. Pachauri, in August 2002, I criticised the use in the IPCC Special Report on Emissions Scenarios (SRES) of nominal exchange rates, rather than purchasing power parity rates, for expressing the GDP of different countries in a common unit of measurement. My letters acknowledged that there are large differences in income per capita between countries and regions of the world but argued that, as a result of the use of an invalid method of comparison, the authors of the report had greatly overstated the scale of these differences at the beginning of the projection period. They had thereby been led to overstate the growth in average incomes in developing countries that would be required to achieve the much more even distribution in global income that is envisaged in most of the scenarios. Prospective levels of emissions in these countries had probably been overstated as a result.

The IPCC has made no formal response to these arguments. However, the IPCC's Data Dissemination Centre (DDC) at the Centre for International Earth Science Information Network (CIESIN) at Columbia University, which manages the dissemination of socioeconomic data and applications relating to the SRES under the guidance of the IPCC's Technical Group on Climate Impact Assessment (TGCIA), now provides the following explanation on its website (<http://sres.ciesin.columbia.edu.tgcia>):

'The SRES report, in the majority of cases, expressed economic growth using GDP estimates converted into a common currency of US dollars using market exchange rates... This was done in full recognition of the fact that the preferred measure of wealth and poverty is to adjust GDP using purchasing power parity (PPP) estimates - a practice initiated by the World Bank in 1996... PPP estimates more accurately capture the command over resources in poorer nations. As such, they would be the preferred income measure for environmental impact and vulnerability studies as well... The reason the SRES report adopted market-based GDP is because most greenhouse gas emissions models in the peer-reviewed literature, including the models used in SRES, are run based on market GDP. Since the terms of reference of the SRES required that it review and reflect the emissions scenario literature, SRES GDP projections are also mostly market-based. In any event, the disaggregated GDP data supplied to CIESIN from the SRES marker models was in market exchange rates, so we have restricted our country level numbers to market exchange rates as well' ('Country level GDP Downscaled Projections', p. 1).

The statement that the use of market exchange rates to measure relative output and incomes in the SRES was 'done in full recognition of the fact... that PPP estimates more accurately capture the command over resources in poorer nations' is puzzling. It appears to imply that claims in the report about the dimensions of current disparities, which are based entirely on comparisons made at market exchange rates, were known to be misleading at the time that they were made.

The statement that the practice of adjusting GDP using purchasing power parities was initiated by the World Bank in 1996 is inconsistent with the reference in SRES to the fact that the UNDP's Human Development Index, produced since 1990, includes as one of its components 'income as measured by real GDP per capita at PPP to represent command over resources to enjoy a decent standard of living' (SRES, p. 115). This statement correctly reflects the UNDP's approach, as outlined in the *Human Development Report 1990*:

'The GNP figures typically used for international comparisons do not adequately account for the distorting effects of official exchange rates. To overcome these inadequacies, we use here the purchasing-power-adjusted GDP estimates developed in the International Comparison Project, a collaborative effort of the UN Statistical Office, the World Bank, EUROSTAT, OECD, ECE and ESCAP, now being expanded by USAID' (p. 13).

The explanation that 'the terms of reference of the SRES required that it review and reflect the emissions scenario literature' is also puzzling, because the rate of growth in global output projected in most of the SRES

scenarios (including those that yield the lowest projections of emissions) is substantially higher than that assumed in almost all of the scenarios in the literature. (This point was documented in the text of my presentation to the TGCIA Experts Meeting on 10 January and is further elaborated below).

The DDC now provides projections of GDP converted at exchange rates for all countries at 5-year intervals to the year 2100, for each of the four IPCC marker scenarios. In my presentation to the TGCIA Experts Meeting on 10 January, I questioned whether these estimates were of any value, since they would encourage researchers to base their work on faulty data.

The explanation accompanying the new disaggregated estimates states that 'One initial finding of the downscaling exercise is that the regional growth rate methodology is unacceptable for some countries with high initial incomes that also happen to lie within very high SRES GDP growth rate regions'. It acknowledges that the resulting projections for the Republic of Korea and for eight smaller countries imply 'unacceptably high incomes in 2100', but says that the data for these countries cannot be excluded from the spreadsheets because this would introduce large regional discrepancies within SRES.

In fact the disaggregated estimates now available on the IPCC's DDC reveal that the SRES projections of GDP in 2100 are 'unacceptably high' not only for the nine countries in respect of which this is acknowledged in the explanatory notes, but for many other developing countries and countries in transition. The problem is attributable in part to the regional growth rate methodology, but the more important cause is the extremely high growth in the income of poor countries that is projected in the A1 and B1 scenarios (which is attributable in turn to the overstatement of income disparities at the beginning of the projection period).

The dimensions of the problem can be illustrated by the case of South Africa. In 2000, this country's GDP per head, converted from nominal values using exchange rates, was only 12% of the US level. By 2050, the A1 marker scenario projects that the per capita income of South Africans on this basis will have reached more than four times the US level in 2000, and about twice the level that the US will have reached in 2050. And by 2100, this scenario projects that the per capita income of South Africans will be approaching twenty times the US level in 2000, and more than four times the US level at the end of the 21st century.

In the case of the B1 marker scenario (and other scenarios in the B1 family, one of which yields the lowest levels of emissions in the course of the century), the projected levels of average income in both countries in 2100 are somewhat lower than in the A1 marker scenario, but the level of affluence of South Africans exceeds that of Americans by an even wider margin than in the A1 projections. The total output of goods and services in South Africa in 2100, according to these downscaled A1 scenario projections, will be comparable to that of the entire world in 1990.

Other countries whose average income levels in 2100 are projected to be higher than those of the US in that year under the DDC downscaling exercise for the B1 scenario include Germany, Italy, France and Japan among the OECD90 countries; the Russian Federation and the Baltic States (Estonia, Latvia and Lithuania) among the countries in transition; the Republic of [South] Korea, the Democratic People's republic of [North] Korea, Malaysia, Singapore and Hong Kong among Asian countries; and South Africa, Libya, Algeria, Tunisia, Saudi Arabia, Israel, Turkey and Argentina among the 'Africa, Latin America and the Middle East' group of countries.

Under the A1 scenario, the US is projected to have slipped even further down the ladder of relative affluence by 2100. The disaggregated projections on the CIESIN website imply that the countries that will by then have reached higher levels of average real incomes than the US under this scenario include most of those listed in the preceding paragraph together with (among others) Thailand and the United Kingdom.

However, the disaggregated A1 scenario projections imply that average incomes in the US will be nearly twice as high as in Australia, which shows the lowest rate of incomes growth of all major OECD countries under both the A1 and the B1 scenarios. Among the developing and transition countries which are assumed to enjoy higher average incomes than Australia in 2100, according to the A1 projections published on the CIESIN web-

site, are China, Indonesia, Thailand, the Republic of Korea and Malaysia in Asia; South Africa, Zimbabwe, Algeria, Tunisia, Libya, Gabon, Namibia, Swaziland, Botswana and Mauritius in Africa; Brazil, Mexico, Venezuela, Argentina, Chile, Uruguay and Panama in Latin America; Iran, Saudi Arabia, Israel and many smaller countries in the Middle East; the Russian Federation, Ukraine, Belarus, Poland, Hungary, Romania, Bulgaria and the Czech and Slovak Republics among transition countries; and Papua-New Guinea, Fiji, New Caledonia, Vanuatu and Samoa in the Pacific.

Many of these countries are assumed to have higher average incomes than Australia in 2100 under the B1 scenarios also: this is true, for example, of Zimbabwe. Although no one can say with certainty that per capita incomes in Zimbabwe will **not** exceed those in Australia in 2100, it is difficult to believe that the SRES authors would consciously have made such an assumption - and it is unlikely that the SRES would have been accepted by reviewers and governments if the full implications of the GDP assumptions had been exposed.

What are the implications for the SRES projections of emissions of these very high projected rates of growth in economic activity? It is not possible to be precise without undertaking a major reworking of the scenarios. But there is no obvious reason for supposing that the overstatement of prospective growth rates and output levels in developing countries would NOT have led to a significant overstatement of projected emissions.

The SRES Summary for Policymakers (SPM) claims that the 40 SRES scenarios 'together encompass the current range of uncertainties of future GHG emissions arising from different characteristics of these models, in addition to the current knowledge of and uncertainties that arise from scenario driving forces such as demographic, social and economic, and broad technological developments that drive the models, as described in the storylines ...' (p. 3).

The implication of this statement, and of similar statements in the body of the SRES, is that the preparation of new scenarios is unnecessary, because the resulting projections of emissions would differ only marginally from the existing set and (in particular) would not result in a significant reduction in the projected levels of emissions in the scenarios with the lowest emissions profiles.

The scenario that yields the lowest cumulative total of CO<sub>2</sub> emissions through to the end of this century is the BIT MESSAGE scenario, and this is also the scenario which was identified by Dr. Tom Wigley, in his presentation to the TGCI meeting on 8 January, as representing the low extreme of possible variation 'in terms of the 2100 forcing pattern.'

But there are a number of reasons for believing that the BIT MESSAGE scenario does not by any means establish a reasonable lower bound: lower emissions levels can be projected on the basis of assumptions that are fully defensible. The following list provides some indication of the range and extent of modifications to BIT MESSAGE that would be necessary if this scenario is to be used as a measure of the lower bound of 'the total range of possible variation':

**1) The BIT MESSAGE scenario assumes a far higher rate of growth in output per head in developing countries than does the bulk of the literature in the scenario database (see SRES, p. 79 ff):** The literature review showed that the median average annual rate of GDP per capita growth in developing countries was about 2.5% in each of the periods 1990-2020, 2020-2050 and 2050-2100 (Figure 3-10 on p. 119). The rates of growth in these periods that were assumed in BIT MESSAGE were, respectively, 4.2%, 4.6% and 2.6% (derived from tables on pps. 529-30). A rough calculation suggests that, as a result of the far higher growth rates assumed in the first half of the century, the cumulative level of output in the developing countries for the century as a whole exceeds the median level in the literature by a factor of about 3.

**2) So far as the first half of the century is concerned, the BIT MESSAGE scenario also assumes a substantially higher rate of growth in output than is envisaged in the B1 storyline itself:** The storyline postulates that, by 2050, global per capita output will be about US\$13,000 (p. 182), which is similar to the level of \$12,755 assumed in the preliminary B1 marker scenario (Table VI-4 on p. 368, line 3). However, the final B1 IMAGE and the BIT MESSAGE scenarios assume that average global GDP in 2050 will be \$15,600, over

20% higher than in the preliminary marker scenario (pps. 506, 526).

**3) The higher growth in output that B1T MESSAGE assumes in the first half of the century, over and above that postulated in the B1 storyline, is entirely attributable to faster growth in developing countries:** For 2050, projected per capita GDP in the ASIA region was 27% higher, and in the ALM region 57% higher, in B1T MESSAGE than in the preliminary B1 Marker (SRES, pps. 371-72, 529-30). An indication of the impact of this difference on projected emissions is that cumulative CO<sub>2</sub> emissions in these two developing regions from 1990 to 2050 in B1T MESSAGE are 78 GtC, or almost 30%, greater than in the original quantification of the B1 storyline in the preliminary marker for this scenario (pps. 371-72, 529-30).

**4) The B1T MESSAGE scenario assumes a higher rate of global population growth in the first half of the century than many demographers now believe to be likely:** James Hansen's 'An Open Letter on Global Warming' quotes demographer Joel Cohen's guess that 'Assuming business as usual ..., I would not be surprised by any population in the range 7-9 billion [in 2050]' (Natural Science, 26 October 2000, pps. 9-10). On this basis the B1 scenario population projections may be well above the lower end of the range of possible outcomes. It is possible that further evidence in support of this proposition will emerge from population projections that are soon to be released by the UN Population Division.

**5) The global level of CO<sub>2</sub> emissions in 2000 was well below the standardized base for that year reported for all [40] SRES scenarios, including B1T MESSAGE:** For fossil CO<sub>2</sub> emissions, the standardized increase for the decade 1990 to 2000, calculated in the way explained in Box 5-1 (p. 243), was 0.91 GtC, or 15%. The most widely quoted estimate of the actual increase for the nine-year period 1990-99 (that published by the US Department of Energy-sponsored Carbon Dioxide Information Analysis Centre) is 0.35 GtC, or 6%. On average, therefore, the four unadjusted marker scenarios appear to have overstated actual growth in fossil CO<sub>2</sub> emissions in the 1990s by a factor of about 2: a surprisingly wide margin having regard to the fact that trends in emissions for the greater part of the decade were already known at the time that the projections were produced. Whatever the reasons for this, the effective base for all of the SRES projections of CO<sub>2</sub> emissions (i.e., the standardized figure for the year 2000) is too high, by a margin of at least 5%.

**6) The decrease in methane emissions in industrialised countries between 1990 and 2000 was much greater than projected in the standardized scenarios, including B1T MESSAGE:** For the OECD90 region, the standardized scenarios show a fractional increase in CH<sub>4</sub> emissions between 1990 and 2000. Data submitted to the UNFCCC by OECD countries show an aggregate decrease of about 8% during this period. For the REF region, the standardized scenarios show a decrease of 17% between 1990 and 2000. Partial information on the UNFCCC database suggests that there was a decrease of more than 30% in this period.

**7) Contrary to some assessments, the B1T MESSAGE scenario projects a significant growth in global emissions of methane during the next half century:** The scenario reports a projected increase of 44% in global CH<sub>4</sub> emissions between 2000 and 2050, compared with an increase of only 11% in the B1 IMAGE marker scenario which uses the same (high) projections of economic growth. In 'Proceedings of a Workshop On Air Pollution as a Climate Forcing, Edited by James E. Hansen' (provided to the TG CIA Expert Meeting), it is stated that there has been significant progress in reducing methane emissions in the US and the European Union, and that 'Such efforts, if international, will clearly stabilise methane abundances, avoiding the large increases projected in some of the SRES scenarios' (p. 2).

**8) Again contrary to some assessments, the B1T MESSAGE scenarios projects significant growth in global emissions of CO:** The scenario reports a projected increase of 66% in these emissions between 2000 and 2050, compared with a DECREASE of 46% for the B1 IMAGE marker scenario. According to the Workshop Proceedings cited in 7) above, 'Control of CO emissions ... is a clear indirect reduction in CH<sub>4</sub>' (p. 2).

It is stated in the SPM (p. 9) that 'The SRES scenarios cover most of the range of carbon dioxide..., other GHGs and sulfur emissions found in the recent literature and SRES scenario database'; and that 'The SRES scenarios extend the IS92 range [of cumulative emissions between 1990 and 2100] towards higher [carbon]

emissions..., but not towards lower emissions. The lower bound for both scenario sets is approximately 770 GtC.'

The obvious question that arises is why the SRES scenarios did NOT extend the IS92 range towards lower emissions. The B1T MESSAGE scenario that yields the lowest cumulative level of emissions in the SRES set assumes a higher level of global average income, both in 2050 and 2100, than do ANY of the six IS92 scenarios (SRES Technical Summary, Table TS1, p. 33). Presumably a scenario that incorporated more realistic assumptions about the prospective growth in incomes in developing and transition countries, but which was otherwise similar to the B1T MESSAGE scenario, would have yielded significantly lower levels of cumulative emissions than B1T MESSAGE. Why was such a scenario not developed as part of the SRES set?

In my view, the 8 reasons given above, taken together, establish a strong case for reworking the B1T MESSAGE scenario, as part of a more general reexamination of the methods and results of the SRES.

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## SRES and IPCC: Further Concerns

David Henderson

### Introduction

In this note I raise some additional queries and concerns about the SRES emissions scenarios, as also the IPCC process of which they form part. The note follows on from, and complements, what is said in the text that formed the basis for my presentation to the TG CIA in Amsterdam, and which forms Document 2 (2) above.

My further concerns fall under four headings:

The neglect of the past.

The treatment of the period from 1990 to 2000.

Questionable presumptions.

Overstating consensus.

### SRES: the neglect of history

It is a surprising feature of the SRES that in a document surveying the long term future, which contains over 300 pages of main text and presents 40 different scenarios prepared by six different modelling groups, there is no chapter which systematically reviews the evidence of the past. The starting point for any such quantitative future-oriented inquiry should be a clear and careful survey of earlier developments and trends, going right up to the present day. Such a survey should be both factual and analytical. It should contain facts and figures, tables and diagrams, and a commentary designed to bring out the main features of past changes, to review the causal influences that may have been at work, and to consider how far the evidence thus presented can be used to throw light on future possibilities. It should serve not only as a basis for reflecting on the future, but also as an authoritative source of public information about the past.

### SRES: treatment of the period 1990-2000

The starting point or base year for the SRES was 1990, and all the scenarios generated model-based results for the decade 1990-2000 as well as for the 21<sup>st</sup> century. But by the time the SRES was published, in 2000, the decade of the 1990s was itself becoming past history. Even allowing for the lag between events and the published data that relate to them, and between the completion of a MS and its final publication, it would have been possible for the scenario work to take account of what had actually happened over most of the decade of the 90s. Indeed, these recent developments could and should have found a place in an opening chapter reviewing the past.

As it is, the SRES treatment of developments over the 1990s seems curiously detached from what actually happened. Consider for example the growth of world GDP. For publication in 2000, the SRES could probably have drawn on the IMF data that were available by April 1999. These would have yielded firm estimates for the change in world GDP over the period 1990-97, a still provisional figure for growth between 1997 and 1998, and the Fund projections for changes over the two following years. Combining these would have yielded a preliminary but soundly based estimate for growth over the whole decade of the 1990s: it would in fact have shown prospective world GDP in 2000 as 36.5 per cent above the 1990 figure. (The final outcome now appears as 39.4 per cent, since the IMF's April 1999 projections for the final two years of the decade proved to be too low).

Actual developments in the 1990s, as distinct from model-generated data, appear not to figure in the SRES.

Instead, a wide variety of derived figures for world GDP in 2000 is offered, without reference to the recorded course of change since 1990. For example, across the various MESSAGE scenarios, produced by the International Institute for Advanced Systems Analysis, the figure shown for the increase in world GDP, as between 1990 and 2000, varies between 20.6 per cent and 35.4 per cent, as compared with the 36.5 per cent referred to above which was available in early 1999. Neither the spread of these scenario figures nor their relationship to actual events over the decade is the subject of comment, and the same applies to other scenario families in the SRES. Consideration of the reasons why some model results diverged substantially from actual developments over the decade – in respect of energy consumption and CO<sub>2</sub> emissions, as well as GDP – could well have been given in the Report, both as part of the assessment of past trends and in commenting on the properties and performance of different models.

### **IPCC and SRES: questionable presumptions**

In some IPCC work, as in other writings on environmental issues, there is a tendency to portray the growth of GDP and advances in technology as separable and countervailing influences on ‘sustainability’. Such a tendency is to be seen most clearly in the continued use of the dubious ‘IPAT’ identity:

$$\text{Impact} = \text{Population} \times \text{Affluence} \times \text{Technology}$$

In this formulation, which is given a respectful airing in the SRES (p. 105), a picture is presented in which increases in GDP bring with them, inexorably, the menace of greater Impact: in this respect, they are to be viewed as sources of concern. On the positive side, by contrast, there is the influence of new and improved Technology, which appears as an independent mitigating factor

This is a confused way of viewing ends, means and interrelations. It casts economic progress as a problem, rather than as a goal and an achievement; it leaves out of account the fact that gains in material welfare have gone together with, and indeed have partly comprised, a range of substantial environmental improvements; and it mistakenly presents ‘Technology’ as a separate influence, generated outside the economic process. It is as though talented men (and occasionally, women) in white coats, acting in their professional capacity from motives unconnected with the pursuit of material gain and profit, can fortunately be made available, given sound government policies, to rescue humanity and the planet from the consequences of economic growth. But ‘Technology’ and ‘Affluence’ are doubly inseparable. Not only is technological change a prime source of economic growth, but it is itself largely driven by the perception of profit-directed opportunity; and indeed, technological advances which people show themselves unwilling to pay the costs of are *prima facie* not worth introducing.

Under this and (as I think) some other headings, the IPCC milieu tends to take for granted, and lend support to, ways of viewing economic events, relationships and goals which are by no means established and agreed. These questionable presumptions, though they enter into the IPCC process, have their origins outside it: some have been endorsed by member governments and international agencies. There is here a general problem, which involves not just the IPCC but governments and the academic world as well – a problem of determining whether and how far there is broad agreement that can serve as a basis for policy, and if so, what form that agreement can be said to take.

### **IPCC: overstating consensus**

Since its establishment in 1988, the IPCC has come a long way. It has brought to completion and publication a series of extremely detailed and broadly agreed reports, covering a wide range of extraordinarily complex issues and spanning several forms of expertise; it has secured for these reports and their conclusions, as also for its procedures, the broad approval of its many and diverse member governments; it has informed the thinking of those governments and prompted decisions by them; and it has now established both a provisional set of conclusions and a well defined process for continuing its work on the issues of climate change. Its participants and supporters might understandably claim that it has created a world-wide consensus on the nature of the problems, the kinds of actions to be taken on them, and the conduct of future inquiries into them.

I think there is a risk of overstating the extent to which consensus exists, or should necessarily be aimed at given the present state of knowledge and range of informed opinion. Despite the IPCC’s achievements, it would be wrong to draw the conclusion that its status, ways of thinking and procedures should now go unchallenged. It may be that the natural wish of member governments for the IPCC to establish and present to them a consensus view has been pushed too far.

In its economic aspects, partly for reasons that Ian Castles and I have sketched out in these three documents, the work and preconceptions of the IPCC are open to question, in ways that have gone largely unnoticed by the many participants in the process, official and unofficial. As I have noted in Document 2(2), peer review provides no real safeguard against such failures of perception if the peers are drawn from the same milieu. To be made more professionally watertight, the IPCC has to extend its economic and statistical milieu, by involving a wider range of interests, viewpoints and expertise. Mere numbers are not enough.

Whether and how far the same argument may apply to other aspects of the IPCC's work, where other disciplines are involved, is not for me to judge; but the Panel and its member governments should perhaps consider the possibility that here too the now existing milieu, if it is fair to use the term, could usefully be broadened.

As to the member governments themselves, my impression (it is no more) is that the extent of the consensus that has been arrived at, and the readiness to endorse presumptions that others would question, has been made possible by the fact that, not surprisingly, the officials concerned have been largely drawn from the ministries, departments and agencies that are concerned with environmental issues. They too form a milieu. Its members bring to bear their own specialised knowledge and expertise, but within it economic aspects are not always well perceived or professionally handled. Hence my argument, as put in Document 2 (2), that other departments of state, with economic and statistical knowledge and expertise, should be ready and able to play a part in the IPCC process.

It may be that the IPCC and the professional groups associated with it, official and unofficial, are in danger of becoming victims of their own success. In some important respects, the networks and procedures that have been created appear as more limited, and less free from bias and presuppositions, than is generally realised. Broader professional involvement could admittedly bring with it new disagreements and new elements of complexity and uncertainty, thus putting consensus in question. But it would strengthen the basis of knowledge and understanding which the IPCC has rightly viewed as essential to its work and reputation.

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