CAN THE OFFICIAL STATISTICAL COMMUNITY PROVIDE GREATER SUPPORT TO THE IPCC?

Dennis Trewin
Statistical Consultant

1. Introduction

There has been little engagement between the IPCC and the official statistical community. I will not discuss why this might have been the case. Rather I will look forward and argue that improved engagement will be of benefit to both parties in the IPCC's Fifth Assessment Round (FiAR) and that we should explore, with the IPCC, how we official statisticians might better engage with them. There is no point in doing this unless official statisticians have something tho offer. But I am sure as a consequence of this Conference it will be clear that official statisticians have a lot to offer.

I am assuming the scenario approach will be used in the FiAR as it was in the Third and Fourth Assessment Rounds. If so, the official statistical community could be of particular assistance to the development of the scenarios. The IPCC has indicated it will be reviewing the scenarios for the FiAR so it is a good opportunity to have some influence. Regardless, some key official statistics, such as population and economic growth, will be key inputs into the climate models which use the scenarios.

The structure of this paper is as follows. First, I will provide some background to the way the IPCC produces its climate projections. I have assumed that not everyone at the Conference has close familiarity with their work. Those who are familiar with their work can bypass this part of the paper. I will then briefly describe some criticisms of the use of statistics in the last round as a basis for discussing how the official statistical community can assist with the FiAR.

I should say up front what I mean by official statistics. There was some debate as to whether the term 'Official Statistics' or just 'Statistics' should be used to describe the Conference. Critics of the former title suggest the title implies National Statistical Offices only. They suggest it ignores the role played by international statistical organisations or the statistical departments of the Ministries. This is not intended. They should be regarded as part of 'Official Statistics', at least for the purposes of this Conference. If the description had just been 'Statistics' it could have been interpreted as including statistical modellers, biometricians, and the like at universities and research institutions. They play an important role in the analysis of climate change but their work is not part of the deliberations of this Conference. (A statement published by the American Statistical Association, and posted on this Conference web site, outlines that role.) I understand steps have been undertaken by the IPCC to engage more closely with this section of the statistical community.

2. My Credentials

My main credentials for writing a paper of this type are:

i. I was Australian Statistician (CEO of Australian Bureau of Statistics from 2000 until early 2007).

ii. I am Chairman of the Global Executive Board of the International Comparison Programme which is responsible for the production of purchasing power parities. These have the potential to be used to good effect in the FiAR.

iii. I have been a member of the Australian State of the Environment Committee for the last 10 years. It is responsible for producing an independent report on the State of the Environment every 5 years.

3. Background to the IPCC Climate Change Models

According to the IPCC's Summary for Policy Makers, temperatures are expected to increase by about 0.2 degrees per decade over the next two decades for a range of scenarios. That is, temperatures are expected to increase by nearly 0.5 degrees by 2030.

A lot of the projected increase is due to past actions and an increase of about 0.3 degrees would be expected even if greenhouse gas concentrations could be maintained at 2000 levels.

Beyond the next two decades, different outcomes result from the different scenario groups. The 'worst case' A1FI scenarios projects temperature increases of 2.4 to 6.4 degrees (with a best estimate of 4.0 degrees) by the end of the century. Sea levels are projected to increase by 0.26 to 0.59 metres over the same period. Their 'best case' B1 scenario projects temperature increases of 1.1 to 2.9 degrees (with a best estimate of 1.8 degrees) by the end of the century. Sea levels are projected to increase by 0.18 to 0.38 metres.

The following box provides a brief description of the scenario families. It is derived from the IPCC's Summary for Policy Makers.

The scenarios are used to provide inputs into the climate change models. They are not predictions or outcomes – they are intended to be plausible descriptions of how the 21st Century might evolve. The scenarios use a wide range of assumptions about future demographic change, economic growth and technological change. The assumptions range from the very optimistic to the very pessimistic. They are based on the peer reviewed literature. The "best estimates" mentioned above are based on some form of average across the scenarios. The upper and lower limits are based on the most pessimistic and optimistic estimates respectively.

In the Third Assessment Round, the scenarios excluded explicit polices to reduce emissions. In the Fourth Assessment Round, the scenarios included those which incorporated actions that reduced carbon dioxide emissions and stabilised concentrations.

Climate Change Scenarios

The scenarios are based around six basic storylines.

A1 – This describes a future world of very rapid economic growth, global population that peaks in mid century and declines thereafter, and the rapid introduction of new and efficient technologies. Economic convergence among the regions is assumed with a substantial reduction in regional differences in per capita income. There are three subgroups within the A1 family distinguished by the direction of their technological emphasis.

A1FI – fossil intensive energy sources

A1T – non-fossil energy sources

A1B – balanced across all sources

A2 – This describes a very heterogeneous world with emphasis on self reliance and preservation of local identities. Continually increasing population is expected. Economic development is primarily regionally oriented and per capita economic growth and technological change more fragmented than in other storylines.

B1 – Similar to A1 but with a rapid change in economic structures toward a service and information economy with reductions in material intensity and the introduction of clean and resource efficient technologies.

B2 – This storyline has an emphasis on local solutions to economic, social and environmental sustainability. Population continues to increase but at a slower rate than A2. Intermediate levels of economic development are assumed with less rapid and more diverse technological change than in the A1 and B1 storylines.

4. Some Criticisms of the Fourth Assessment Round

These are summarised below and expanded in the following paragraphs.

1. The first criticism is the so called Castles/Henderson criticism. Because exchange rates rather than purchasing power parities are used to compare the size of economies in the climate change models, the economic growth of developing countries (where exchange rates tend to be undervalued compared with purchasing power parities) has an upward bias where economic convergence is assumed as is the case in many of the scenarios (see next point). This is explained in more detail below.

2. The second criticism is the economic convergence assumption in many of the scenarios. For example, in the A1 scenario average incomes are predicted to converge by nearly 2% per annum which is much higher than historically has been the case. For the A2 scenario the convergence is a much more realistic 0.5% per annum. (For the B1 and B2 is assumed convergence is somewhat

higher than that assumed for the A2 scenario but a lot lower than for A1.) While there is likely to be a move in this direction, the most likely outcome is that most of the developing countries of today will still be behind the more developed countries and hence the global growth rates will be overstated.

3. The population growth rate assumptions used in the climate change models reflect the growth rates of 20 years ago not those of today. During this time, global population growth has decreased from 2.5% per annum to 1.2% per annum.

The first criticism is the one that has had most public debate. I will try to explain what happens as a result of using market exchange rates rather than purchasing power parities. The main impact is at the starting point for the models – 1990. Because market exchange rates are used to compare the size of developing economies, there is a tendency to under-estimate the size of developing economies compared with the developed economies which in turn are over-estimated. This is because market exchange rates tend to under-estimate the 'true' comparative costs of developing countries (ie goods and services seem relatively cheap in developing countries). So, with a lower base than there should be and the economic convergence assumptions, growth rates tend to be exaggerated for developing countries. The impact is clearly shown for scenarios A1 and B1 in Table 1 below where more rapid economic convergence is assumed and the growth rates seem high compared with the World Bank for example.

Table 1 Comparative Annual Growth Rates in GDP (on a per capita basis)

Scenario/Source	Annual Growth Rate (%)
A1	3.1
B1	2.4
US Department of Energy	1.9
B2	1.8
World Bank	1.8
International Energy Authority	1.5
A2	1.0

The economic growth rates for the A1 and B1 scenarios are much greater than for the US Department of Energy's, World Bank's or IEA's economic projections. I believe the reason is what I have outlined above ie the non-use of purchasing power parities, combined with convergence assumptions for many scenarios. In fact the data set above indicates that the economic convergence assumption rather than the non-use of PPPs may be the main reason for the high level of economic growth implicit in these scenarios.

The differences are greatest for the so-called Africa/Latin America/Middle East region (which comprises most of the developing countries) where the growth rates in the A1 and B1 scenarios are clearly above the upper end of the projections from the DoE, World Bank and IEA whilst the A2 and B2 scenarios fall near the centre. This reinforces my argument that the non-use of PPPs, together with the convergence assumption, may be leading to an upward bias in the economic growth assumptions in the A1 and B1 scenarios. This, in turn, will lead to estimates of excessive growth in projected energy demand.

The impact of these flaws may not be as great as perceived. The 'bias' affects both economic growth rates and energy intensity in compensating ways as GDP is the denominator in energy intensity ratios. Also a high proportion of the greenhouse gases are already in the system. Independent sources suggest the overall impact may result in an upward bias of up to 0.5 degrees in the best estimate from the relevant scenarios.

I turn now to the third criticism about population growth assumptions. The official population projections produced by the international community are not used because they are not in peer reviewed literature. Yet they are probably more authoritative and up-to-date than most in the literature. Population growth has slowed remarkably in recent years and many of the peer reviewed projections would not have caught up to this more recent trend. This has been driven by changes in Africa and Asia in particular. In both continents, fertility rates have declined substantially and in Africa mortality rates have increased because of the AIDS epidemic. Mortality has also increased in the former Soviet countries chiefly because of lifestyle reasons. The differences for the regions mentioned above are so great that some commentators have suggested they stretch credibility. The IPCC have noted this in their report and indicate that they plan to incorporate lower population projections in the scenarios being developed for the fifth report.

The annual growth rate from the medium United Nations population projections is 13 to 19% lower than those in B2 and will be even lower than those in A2. However they are broadly consistent with those in A1 and B1. In fact they show a peak slightly early than the medium UN projection. Scenarios A2 and B2 assume continually increasing population whereas A1 and B1 assume a population that peaks mid century.

It is interesting to note that difference between the best estimates of temperature by the end of the century for A1 and A2 as well as B1 and B2 is 0.6 degrees. This might give an order of magnitude estimate of the impact of the different population assumptions.

Does it matter? I believe it does matter. If the assumptions within the climate change model are systematically on the high (or low) side, then the predictions from those models are likely to be systematically on the high (or low) side. The models are not linear so this cannot be stated with absolute certainty but it is highly likely. In a paper I presented to the OECD World Forum in 2007, I showed that by restricting the range of scenarios to those reflecting more recent economic and population growth (the B1 family), climate change projections to the end of the century are 1.3 – 2.5 degrees, with a most likely outcome of 1.8 degrees compared with the IPCC projections of 1.3-6.2 degrees. The lower level of climate increase is still very important but the policy interventions may be very different to those that would be necessary for the more extreme temperature predictions. Policy interventions do have a cost and unnecessary expenditure on addressing climate change may be at the expense of policy interventions on health, education or even other aspects of the environment.

The IPCC has been incredibly successful in organising the collective effort of many of the world's top scientists. It has been also been incredibly successful in its advocacy role. It has had a fundamental role in convincing global and national policy makers that climate change is an issue that has to be addressed. That battle has largely been won. I would argue that its major challenge now is to provide the best possible evidence base to support policy makers as address impacts and adaptation and mitigation strategies.

Eleven of the last twelve years rank among the 12 warmest years in recorded temperature history. The trend increase is about 0.2 degrees over the decade. The IPCC says this is consistent with the predictions from climate change models. Others say the trend in temperature increase over the last decade has been more like 0.1 degrees and less than what is predicted by climate change models. Temperature trends are extremely difficult to estimate over such a short period. The differences are largely due to the treatment of 1998 which was an extremely warm year due to a strong El Nino effect. If my conjecture is right you would expect the climate change models to over-estimate the trend because the economic and population growth assumptions, on average, are on the high side. But there is insufficient evidence to indicate whether this is correct or not.

5. Where might the official statistical community assist?

The models used to assess future climate change, and the scenarios on which they are based, are very complex. I will not pretend to be across the detail. My main purpose in this section is to identify those areas of official statistics which are of greatest importance for this work. Before doing this, it is useful to think of energy related emissions as being a function of population growth, per capita GDP growth, changes in energy intensity, and changes in the carbon intensity of the energy that is used.

Energy is not the only source of greenhouse gas emissions but they are the main source. There are other sources of greenhouse gases such as agriculture which need to be considered as do sinks such as forestry. Land use is an important consideration to climate change projections.

I discuss six main areas of potential use of official statistics – (a) population projections, (b) economic growth projections, (c) purchasing power parities, (d) energy efficiency and carbon intensity ratios, (e) land use statistics, and (f) the cost (in GDP terms) of emission mitigation strategies.

There are other areas of interest such as the extent of industry restructuring (eg from high energy use manufacturing to low energy use service industries) and expenditure shares on energy and transport. Energy price data might also be important to many forms of analysis. These data will be available in developed statistical systems and perhaps more could be done to aggregate data at the national level.

(a) Population projections

I would suggest the population projections produced by the United Nations Population Division are far more authoritative and up to date than the peer reviewed literature and these projections should provide the basis for the scenarios used in the FiAR. The global population projections also have regional dissections. In fact they are available at the country level.

They are authoritative and up to date because there is widespread consultation as part of each update of the projections. For example, a Technical Working Group comprising many of the world's leading demographers was established to assist the UN Population Division with the 2300 projections. Furthermore, a

range of projections are produced using different assumptions on future fertility rates, mortality rates, etc. The main scenarios are the high, medium and low projection but if necessary, it would not be difficult to make alternative projections using different assumptions.

The best source for the purposes of the IPCC would be "World Population to 2300". The estimates are also available on www.unpopulation.org. They are an extension of the 2002 revision of the World Population Projections.

As a matter of interest, the medium projection shows a peak at 9.22b in 2075 before slowly declining and slowly decreasing. In effect, the global population is expected to stabilise at about 9 billion with this projection. The distribution of population will change dramatically over this period. Over this century, Europe's population will decline from 12.0 to 5.9% of the global population whilst Africa's share will increase from 13.1% to 24.9%.

The high projection shows a steadily increase in global population with some decline in the rate of growth whereas the low projection shows a lower peak population and earlier at 2040.

The majority of National Statistical Offices have demographers. It should be possible to assemble a panel of demographers (which could include some of those involved in the 2300 World Population Projections) to assist with the development of population projections to be used in the scenarios.

(b) Economic Growth Projections

I would suggest the World Bank's estimates of global economic growth provide a more authoritative and timely source of economic growth than the peer reviewed literature. These estimates are produced as part of annual process of developing "Global Economic Prospects". The main emphasis is on the central scenario but the process also includes low growth and high growth scenarios. The current projections are to 2030. They are compiled using a Linkage model developed by the World Bank and, from what I understand of the Linkage model, it may not be difficult to extrapolate economic growth assumptions beyond 2030.

Some of the key assumptions in their model include demographic trends, savings and investment behaviour, technological change, productivity improvement and the extent of globalisation of these variables. Their model is multi-sectoral and multi-regional so estimates can be produced at those levels.

These central estimates suggest continuing economic convergence but nowhere near full convergence. It is estimated to be about 0.3% per annum, higher than this in the Asian region but lower in the African and Latin American regions.

For the central economic growth estimates, the growth rates for high income countries are estimated to be 2.5% and, for developing countries, estimated to be 4.2%. This is somewhat slower than recent experience. On a per capita basis, these growth estimates will be lower of course. Global population growth rates have been about 1.2% in recent years.

The World Bank provides estimates of the size of the global economy on a purchasing parity basis using the $US as a numeraire. The size of the global economy has been revised downwards as a consequence of the recently released purchasing power parity estimates. These were calculated from the 2005 round of the International Comparison Programme (ICP). The reasons for the reduction are shown in the following box.

The base year for the climate change models used in the Fourth Assessment Round was 1990. Perhaps, the base year will be shifted for the FiAR. In simplistic terms, I wonder if a way of overcoming the Purchasing Power Parity controversy is to adjust the size of the relative economies using purchasing power parities. This could be the starting point for the models. The economic growth rate, population growth rate, and other assumptions within the scenarios could then be applied to the climate change models.

The official statistical community might be able to assist with the application of purchasing power parities. They are also the main source of much of the input data that is used in the models of economic growth. This includes data on demographic trends, investment and productivity.

BOX – REDUCTION IN THE SIZE OF THE GLOBAL ECONOMY

The main reason for the reduction is the reduction in the size of the Chinese and Indian economies compared with previous estimates.

China had never been included in the ICP. Purchasing power parities were estimated on the basis of a small research study in the early 1980's. These were extrapolated up until the end of 2007 when revised estimates of purchasing power parities became available. These were the first purchasing power parity estimates for China to be based on actual data. It appears that the extrapolated estimates of purchasing power parities were lower than what they should have been.

The last prices collected for India were in respect of 1985. These have been extrapolated forward. Again it appears that the extrapolated prices were lower than they should be.

The rapid development of China and India may have led to upward pressure on prices. There has been rapid growth in investment and a significant proportion of this has been in imported capital equipment.

(c) Purchasing Power Parities (PPPs)

PPPs in respect of 2005 have recently been published. These are much better based than previous estimates. The amount of money spent on data collection and data compilation was considerably more than in previous rounds. Proper governance arrangements were put in place that ensured there was close coordination between the global and regional bodies involved in the International Comparison Programme. More detailed data was collected. Considerably more countries were involved in data collection, hence the purchasing power parities were much more data based. For example, data was collected in China for the first time ever and data was collected in India for the first time since the mid 1980s.

In the absence of actual price data, PPPs are based on imputations and the lack of validity of PPPs based on actual data. It is not surprising that there have been significant revisions upwards in PPPS for India and China and consequently revisions downwards in the per capita GDP for both countries.

PPPs are published by the World Bank. They are available on their web site as well as in printed form. The official statistical community, especially the World Bank, can assist with the provision of PPP data and how to apply these PPPs in practice.

It may not be necessary to all scenarios. But it may be prudent to use them in some benchmark scenarios so the impact of not using PPPs can be properly assessed.

(d) Energy Use and Carbon Intensity

Energy use and energy efficiency ratios, and their change over time, are important inputs into the climate change models. These statistics are available through official statistics. They are available through the UN Statistics Division and/or the International Energy Authority. Ratios based on per unit of population and per unit of GDP are both available. The energy statistics are dissected by a range of energy sources. But these data bases only reflect some of the data that is available. The OECD countries, in total, use most of the provided energy. Much more detail is available on energy use than is indicated in these summary statistics.

For example, a range of energy production and energy use statistics with sectoral breakdowns are available from most OECD countries. Energy efficiency ratios can be derived from this data. Some countries have produced energy accounts which might be of use, even if only on a case study basis.

Many countries will also have data on energy source and how that has changed over time. This facilitates the estimation of changes in carbon intensity.

The IEA also provides data on energy prices and carbon dioxide emissions from fuel consumption. The latter are available on a per capita basis, per unit of GDP basis, and per unit of GDP(PPP) basis.

The FAO produces statistics on biomass at the national level. The use of biomass for energy is generally of greater importance to developing countries.

(e) Land use cover data

FAO is the main source of land use and land cover data. It maybe somewhat limited for the purposes of the IPCC but, for many countries, more detailed data may be available through the National Statistical Offices. They also have other data that is either linked to a spatial framework, or has that potential, which might be useful for climate change analysis. This includes data from their population censuses, agriculture censuses and economic censuses or business registers. This data is useful for climate change analysis in a variety of ways. It may be easier to work with an intermediary such as CIESIN, Columbia University to present the available data consistently at the global level. Some imputation will be necessary as the data is incomplete.

(f) The cost of emission strategies

NSOs have a range of data resources that are useful for these purposes. This includes the System of National Accounts. Input-output tables can be particularly useful for analysing 'what if' effects such as the introduction of emission trading and other emission strategies. Likewise, environmental accounts can also be useful for these purposes.

These data are not available for all countries but it may suffice to have country level studies of the impact and extrapolate the results of these studies.

Reductions in economic growth will be important in adjusting the economic growth estimates used in the scenarios. Knowledge of this is also important from a national policy perspective.

6. A Way Forward

Effective use of official statistics could make a real difference to (a) the scenarios that underpin the climate change models, and (b) parameters used in climate change models. In reality official statistics are essential ingredients to climate change models but it is not clear that they have been used as effectively or extensively as they might have been. It is well known that quality is best addressed at the source rather than through remediation. In a similar light, it may be best that an official statistician with the appropriate background and knowledge and links to the broader statistical community. work with the IPCC on (a) the development of the scenarios to be used in the Fifth Assessment Round, and (b) the Working Group that is involved in application of the climate change models to ensure an appropriate level of engagement.