28 February 2012

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for attention of the Ad Hoc Working Group on the Durban Platform
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Establishment of an Ad Hoc Working Group on the Durban Platform for Enhanced Action

Submission in response to FCCC/CP/2011/L.10, paragraph 8:
Requests Parties and observer organizations to submit by 28 February 2012 their views on options and ways for further increasing the level of ambition and decides to hold an in-session workshop at the first negotiating session in 2012 to consider options and ways for increasing ambition and possible further actions.

The purpose of this submission is to highlight the contribution of population growth to emissions growth and to vulnerability of communities to future climate change impacts.

We argue that

1. a sufficient global response to climate change must include measures to accelerate the stabilization of population numbers globally;
2. a number of options exist to support reducing birth rates through the climate change response framework, that enhance the rights and wellbeing of women, children and communities;
3. inclusion of population growth mitigation does not compete with other areas of climate change response, but increases the impact of all other measures; and
4. not including population growth reduction constitutes a moral hazard, by accepting much greater climate change than could otherwise be achieved, and by abandoning the goal of ending poverty.

We present three rights-based options for consideration by the Ad Hoc Working Group.

Contribution of population growth to emissions growth

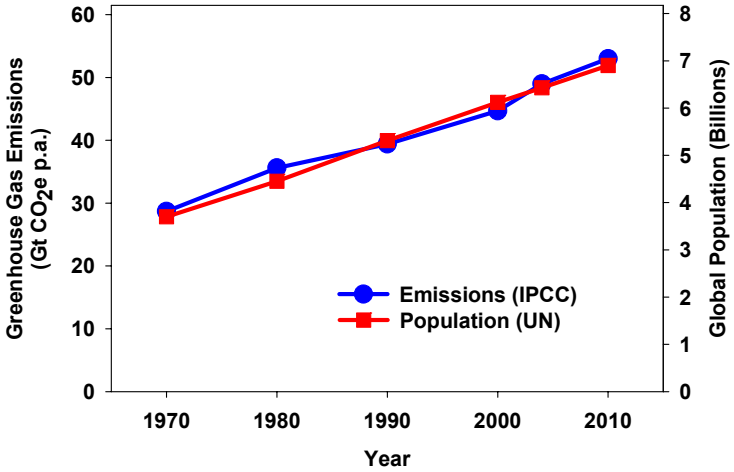

Figure 1. Global greenhouse gas emissions, as estimated by the IPCC, and global population estimated by the United Nations Population Division, since 1970.

The chart above shows that greenhouse gas emissions have been directly proportional to global population over the past forty years. Growth in emissions over the period was equivalent to 1.59% p.a., and growth in population was equivalent to 1.64% p.a. Per capita emissions globally were effectively unchanged. Other studies have shown that per capita emissions have been constant over this period in individual developed countries and regions.[i] The growth in per capita emissions in rapidly developing countries has been off-set by the dilution of national emissions by population growth in least developed countries.

It is often claimed that growth in affluence has had a greater impact on emissions growth. The IPCC discusses the 'Kaya Identity' composed of four contributing factors: total population (p), economic output per capita ($GDP/p), energy intensity of the economy (J/$GDP), and emissions intensity of energy production (CO_2e/J).[ii] The problem is that the last three terms are self-affirming, in a circular logic. Regardless of the real relationship between economic activity and emissions, these three terms would tell you that emissions rise in proportion to GDP, except to the extent they are mitigated by reducing energy intensity of the economy and the emissions intensity of energy. In fact the emissions intensity of meeting each person's physical requirements has changed little, while measured economic activity has been inflated by counting activities which did not previously involve monetary transaction and, via debt-generated capital, counting future production as wealth today – all emissions-free 'froth' on the macroeconomic data. This is not to say that per capita emissions can't be substantially reduced in the future, only that we should not draw false comfort from the 'progress' to date on emissions intensity of the economy.

We do not aim to detract in any way from the importance of changing consumption behaviour, energy technology and the protection of forests and soils. However, it is unlikely that sufficient change can be achieved in each of these areas to achieve the required emissions reductions, unless population growth is diminished as a matter of urgency. It is even less likely that such reductions will be achieved at the same time as lifting rapidly growing populations out of poverty.

This conclusion is affirmed in the IPCC's presentation of SRES scenarios of future emissions. Only those scenarios assuming a low population path achieved less than 2°C climate change.[iii]

It has been estimated that a lower population path could contribute 16-29 % of the emissions reductions needed by 2050. The contribution expands with time, accounting for 37-41% of total fossil fuel use by 2100[iv].

If anything, this is an underestimate, since the calculations don't consider the role of population growth rate to overall demand for physical resources. For each 1% population growth rate, between 10% and 15% of economic activity may be needed to expand capacity of housing, infrastructure and equipment, simply to maintain existing levels of service delivery and amenity to a larger population.[v] These construction and manufacturing activities are among the most energy and resource intensive sectors of the economy. Consequently, it might be assumed that an even greater proportion – perhaps upwards of 20% – of total emissions are generated on account of our 1.2% p.a. population growth rate. These emissions are not easily diminished by changes in lifestyle, but would be eliminated by ending population growth.

An ethical response to the population growth factor

Our position is that a large proportion of the current population growth is due to coercive pregnancy:[vi] the failure to provide women and couples the freedom to choose the timing and number of their children, and to inform them of the implications of their choice on the health, resource access and economic wellbeing of themselves, their children and their community.

The remainder is largely due to demographic momentum, which takes time to diminish after fertility reduction has been achieved.

Hence we reject Yvo de Boer's comment that including response measures aimed at slowing population growth 'takes you onto shakey ground morally'.[vii] The greater moral hazard is continuing to ignore population growth's contribution to climate change.[viii]

We also point out that such measures do not compete with any other emissions reduction efforts. The UN estimates that "for every dollar spent in family planning, between two and six dollars can be saved in interventions aimed at achieving other development goals."[ix] Furthermore, the same dollar increases the impact of every other mitigation and adaptation effort: every kW of renewable energy is a greater proportion of the total needed, every increase in agricultural production ensures food security for longer, less requirement for intensive agriculture means less nitrous oxide emissions and reduced dead zones in river plumes, fewer people are forced to live on vulnerable flood plains and steep slopes, fewer climate change refugees must be accommodated elsewhere.

Currently international support for family planning constitutes less than 0.3% of all official aid. This is about a hundredth of the support given to agricultural development. While it has been strongly argued that agricultural development assistance needs to quadruple,[x] placing only one percent of these resources into family planning would likely double the impact on food security, by halving the additional population yet to be supported.

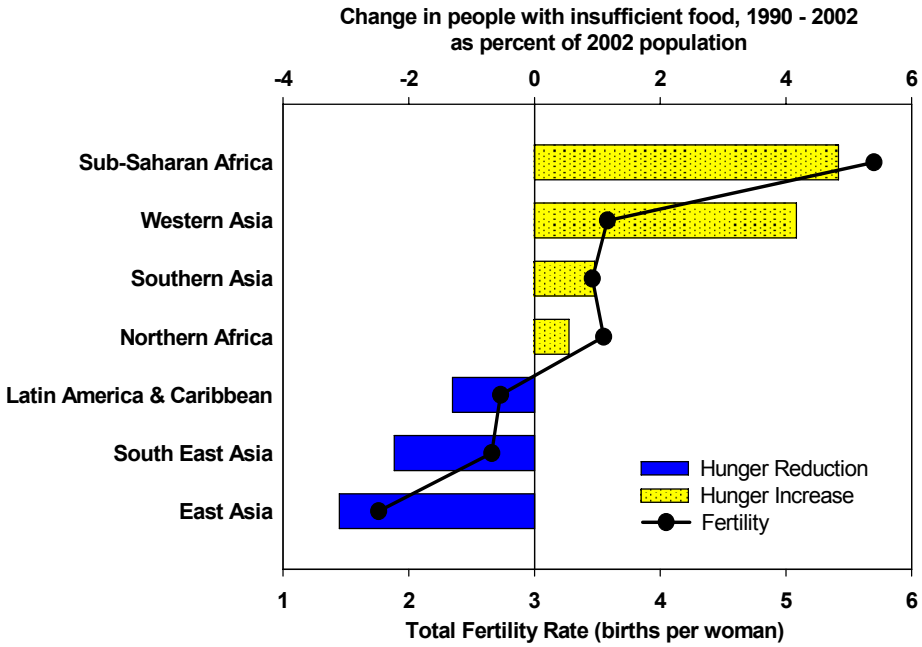

Figure 2. The change in proportion of people with insufficient food (derived from WHO data) and the total fertility rate, in developing regions of the world.

As Figure 2 shows, the extent of fertility reduction of nations and regions in the past correlates strongly with their recent food security status.

Correlation is not causation, and there is much detail lost in the regional groupings depicted here. However, there is increasing evidence that high population growth rates are driving poverty in least developed countries,[xi] and that the 'demographic transition' (whereby increasing wealth is correlated with declining family size) results from declining population growth rate enabling economic advance, to a greater extent than the other way around.[xii]

Efficacy of voluntary family planning measures

The efficacy of voluntary family planning programs, and of both financial assistance and political commitment for population stabilization, has been starkly demonstrated over the last decade, by the effect of their removal. Between 1995 and 2007, international assistance for family planning dropped from $723 million to $338 million.[xiii] As a proportion of total aid for population assistance, it dropped from 55% to only 5%, as the total program was expanded by the response to HIV-AIDS (Figure 3). This expansion also drew national capacity within developing countries away from family planning programs.

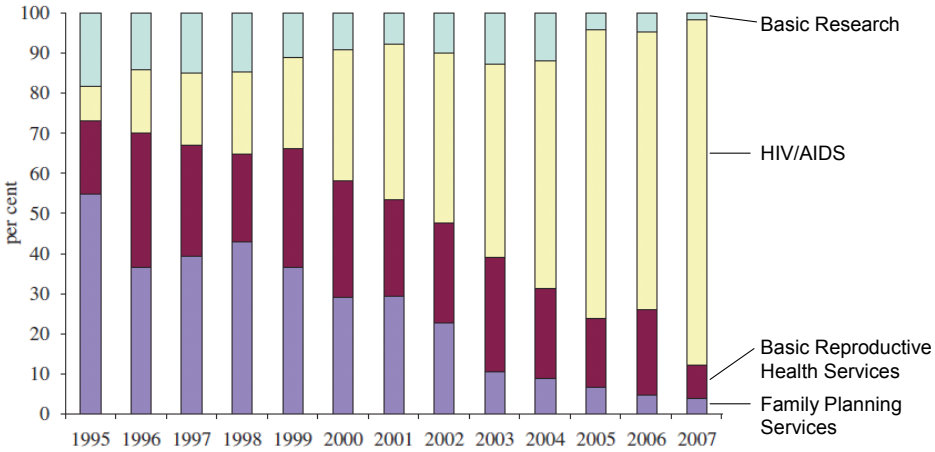

Figure 3. Allocation of international funding for "Population Assistance" (Sinding 2009)[xiv]

As a direct result of withdrawn resources, the fertility decline in many east African countries stalled.[xv] Globally, the success of family planning efforts throughout the 1970s and '80s could be seen in the 1988 peak in number of people added to global population, and the subsequent decline in that increment. Since 2003, that decline has halted, with more people being added to the planet in each of the last 8 years (see Figure 4). This shows that we are following a linear growth pattern, not slowing growth. The UN's current population projections do not reflect this reality. They maintain the assumptions of global fertility convergence used in previous projections, only adjusted upward for the greater-than-anticipated actual population. Hence the UN medium projection is lower than recent trends would suggest is likely, unless a significant policy change is implemented.

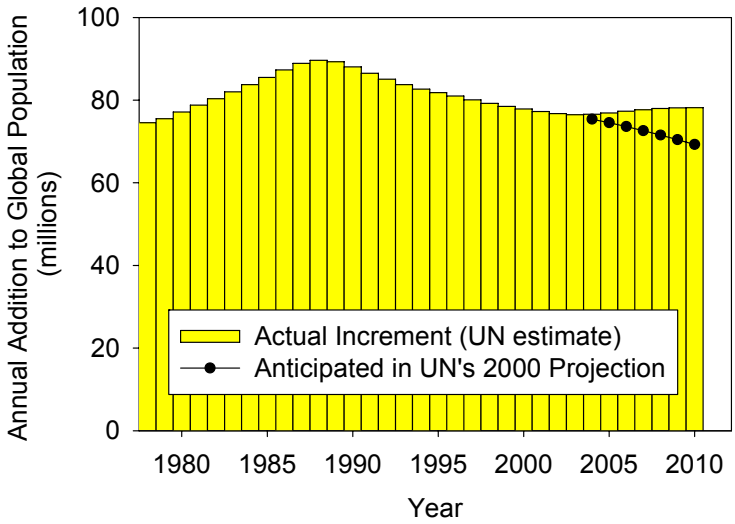

Figure 4. Annual increment in global population, according to estimates published in the UN 2010 revision.

Even linear growth (the same number added each year) requires fertility decline (constant fertility results in exponential growth, until mortality increases), and results in a declining growth rate (the same increment is divided by a greater total each year). Hence we should not be deceived that reported declines in fertility or global growth mean that stabilization is happening.

It should also be noted that, over this period of time, efforts were increased to address several other aspects of human development. The agenda of the Millenium Development Goals increased efforts and progress in reducing infant mortality, increasing girls' participation in education, and reducing some measures of poverty. These changes are claimed to encourage people to choose smaller families. Whatever impact they have had has been more than off-set by the reduction in family planning effort. It can no longer be argued that a focus on human development will stabilize population, without the need for a stated intention to do so.

Conversely, several countries have demonstrated that non-coercive voluntary family planning programs are effective even in poor, low-education settings. They are capable of halving births per woman within a decade, and reaching below replacement fertility levels within two decades. Such rapid decline can limit future growth to no more than double the current population, despite initially high demographic momentum. This is in contrast to several African countries that are currently doubling each 20 years.

Figure 5 shows plots generated by Gapminder World of total fertility rate (births per woman) against GDP per capita from 1969 to 2007, contrasting the path of India, Thailand and China. China and Thailand both adopted high-profile family planning programs in the late 1960s. India's population policy and family planning programs have been inconsistent, and at times ill-conceived, with resentment against coercive measures causing programs to be wound back. China's coercive one-child policy was not introduced until 1978, after the main decline in fertility which occurred under voluntary programs. The plots show that fertility decline preceded increases in wealth increase in both China and Thailand, and subsequently wealth increased faster than in India, whose fertility remained higher. Similar paths can be seen for all nations that have actively pursued voluntary family planning. Indeed, all nations that have moved from developing status to developed status since 1950 did so after reducing fertility rate and population growth. In each case, the low fertility has been sustained without

continued family planning promotion, because it is what women choose once they have had experience of it. Such charts are powerful evidence that birth reduction promotes economic development, to a greater extent than economic development promotes birth reduction.

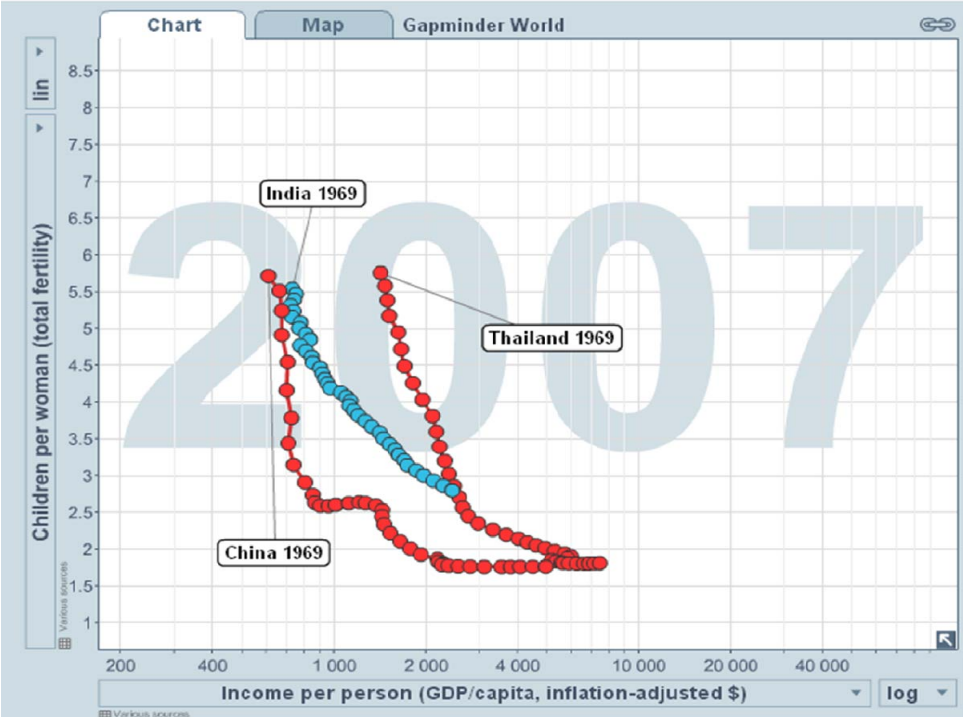

Figure 5. Comparison of the historic course of fertility reduction and per capita wealth, in India, China and Thailand, generated by Gapminder World simulation (www.gapminder.org)

Options for addressing population growth

Implementing any or all of the following suggestions would greatly improve the chance of avoiding dangerous climate change through mitigation actions. While each may be adopted alone, they would enhance each other's impact.

1. A paragraph in the preambular section or shared vision

Suggested text:
Recognises that population growth: increases total carbon emissions, especially in developed countries; increases the number of victims requiring adaptation measures, especially women in developing countries; inhibits economic development, notably in the least developed countries; thus worsens all problems of both mitigation and adaptation; and can be countered cost-effectively by meeting the unmet need for reproductive health care; by women's empowerment, gender-equality, and the right to family planning; and by non-coercive population stabilisation policies in all countries.

Simply including such a statement would go a long way toward reversing the neglect of family planning since the mid-1990s. It would give permission to governments and donors to renew voluntary measures aimed at population stabilization. The cost of required programs is very small, but without political commitment, they are neglected.

2. Inclusion among modalities for adaptation response

Suggested text:
[The new institutional arrangement will provide technical and financial support for developing countries in the following areas:]
non-coercive and culturally appropriate support for population stabilization by addressing barriers to universal access to information and resources for reproductive health care and family planning;

Among 41 National Adaptation Plans for Action (NAPAs) submitted in 2009, 37 identified population growth as a factor affecting climate change impacts, yet only six recognized family planning or reproductive health as part of an adaptation strategy, two included family planning and reproductive health in projects submitted for priority funding, and none were funded.[xvi]

Possible reasons for this omission are many, but include the lack of fit with guidelines provided to countries, and with criteria for project selection. Population growth impacts across all sectors identified as potential focus of projects, including food security, water resources, terrestrial ecosystems, coastal and marine systems, health, education and capacity building, disaster management, infrastructure, energy. Emphasis was also given to activities with outcomes measurable directly on climate resilience in the near term. By failing to fit in the boxes provided, and by having predominantly indirect and medium-term (but nonetheless large) impacts, priority could not be given to population measures.

Omission from the treaty text is thus a barrier. By acknowledging the link between population growth and community vulnerability to climate change, the text would enable measures of fertility reduction and population growth rate to be included directly as metrics demonstrating enhanced adaptation.

3. A framework for equitable distribution of effort based on low population projections

Several models have been put forward for setting a safe trajectory for greenhouse gas emissions, and allocating the entitlement to emit, or emissions reduction effort, to individual countries. All assume a top-down distribution of responsibility and effort. It must be agreed that the time for bottom-up voluntary commitments has passed. A fair system must establish entitlements, and enable sanctions against those who do not comply.

A widely accepted principle is that of ‘contract and converge’, in which developed countries are required to reduce emissions at a faster rate than the global requirement, while least developed countries may increase per capita emissions, with all converging on a similar low per capita rate. Other proposed models divide remaining ‘atmospheric space’ on a per capita basis, requiring developed countries to purchase surplus allowance from developing countries.

Still more strongly weighted in favour of developing countries is the concept of Greenhouse Development Rights, giving developed countries a negative allocation due to historical emissions. This system is problematic from both ethical and practical perspectives. Firstly, while seeking to punish developed countries for 200 years of culpable fossil fuel use, they simultaneously assert the right to follow the same development path. Secondly, they bestow on children the debts of their parents and grandparents. Thirdly, they ignore the contribution

of population growth to the emissions legacy of past people. Finally, they allocate emissions entitlements that the planet could not stand, but require that these are sold to developed countries to cancel their negative allocation. This is appealing to developing country leaders who would like to see the developed world at their mercy, but the sale of those entitlements is likely to generate resentment among ordinary people who do not directly receive the funds and feel that the rich are appropriating their development opportunities, even though these opportunities were never real.

Each of these proposals refers to the distribution of emissions on a per capita basis. Most do not elaborate on when the population should be counted. Kofi Annan and others, who have recognized the inevitable changes in population proportion due to different population growth rates, suggest a 'population base year', to avoid providing a perverse incentive for population growth.

We agree that the framework should not reward the neglect or encouragement of population growth. Even least developed countries should be expected to contribute via population growth reduction, if not by per capita emissions reduction – especially as this will benefit them significantly in terms of poverty reduction and avoided vulnerability to climate change impacts. However, we do not support the concept of a population base year. This is too harsh a penalty for least developed countries, whose demographic momentum will prevent them from ending population growth for some time.

A fair system would be to establish fair-share emissions trajectories for each country, based on a population-weighted portion of the global trajectory, using the IIASA Low Population Projection to forecast future populations of each nation.

We propose the IIASA low projection, because it is realistic and achievable by non-coercive measures to extend family planning access and equity for women. There may even be potential for nations to reduce growth more rapidly, and to benefit in terms of allowable per capita emissions allocation as a result. The IIASA low projection is somewhat higher than the UN's low projection, because the latter is not a realistic projection. It simply takes the UN medium projection, and subtracts 0.5 from the fertility rate in each country, across the whole time period. We can't reduce fertility rate by half a child per woman globally between today and tomorrow. It is merely an illustrative projection, not a plausible scenario.

A suggested framework for allocation of mitigation effort is elaborated in an appendix to this submission.[xvii]

Conclusion

It is not enough to mention population growth as an exacerbating factor increasing the challenge of climate change mitigation and food security, without acknowledging that future population is a variable that we can and should manage. Current policy settings are likely to result in higher populations than predicted in the UN medium projection, unless there is a calamitous increase in deaths. Political will needs to be restored for measures to reduce population growth. The climate change agreement is a powerful vehicle for achieving this. Without such commitment, the chance of avoiding dangerous climate change is extremely poor.

References

[i] Meyerson, F (2008) in Climate Change Science and Policy (eds Schneider, S., Rosencrantz, A. & Mastrandrea, M.) Ch. 17 (Island Press, Washington, D.C.). Cited in Smith K (2008) The population problem. Nature Reports Climate Change, 15 May 2008 | doi:10.1038/climate.2008.44, http://www.nature.com/climate/2008/0806/full/climate.2008.44.html

[ii] Intergovernmental Panel on Climate Change (2007) Climate Change 2007: mitigation. Contribution of working group III to the fourth assessment, technical summary.

[iii] Hoepf Young M., Mogelgaard K., Hardee K. 2009. Projecting Population, Projecting Climate Change: Population in IPCC Scenarios. PAI WORKING PAPER WP09-02, Population Action International. http://www.populationaction.org/Publications/Working_Papers/June_2009/WP0902.pdf

[iv] O'Neill BC, Dalton M, Fuchs R, Jiang L, Pachaui S, Zigova K (2010) Global demographic trends and future carbon emissions. Proc Natl Acad Sci 107:17521-17526.

[v] O'Sullivan J (2012) The burden of durable asset acquisition in growing populations. Economic Affairs February 2012, pp 31-37.

[vi] Bongaarts J and Sinding S (2011) Population policy in transition in the developing world. Science 333: 574-576. www.sciencemag.org

[vii] Levitt T (2009) Copenhagen and population growth: the topic politicians won't touch. The Ecologist, 15 Setember 2009.

[viii] Cafaro P (2012) Climate ethics and population policy. WIREs Clim Change 2012, 3:45-61. doi: 10.1002/wcc.153.

[ix] Department of Economic and Social Affairs, UN (2009) What would it take to accelerate fertility decline in the least developed countries? UN Popul. Div. Policy Brief No. 2009/1.

[x] Cribb, J (2010) The coming famine: the global food crisis and what we can do to avoid it. CSIRO Publishing, Collingwood Vic. ISBN 9780643100404.

[xi] APPG-PDRH (2007) 'Return of the Population Growth Factor: Its Impact on the Millennium Development Goals', All Party Parliamentary Group on Population Development and Reproductive Health, London: HMSO. http://www.appg-popdevrh.org.uk/.

[xii] O'Sullivan J (2012) Op. cit.

[xiii] Bongaarts J and Sinding SW (2011) Family planning as an economic investment. SAIS Review volume 31(2), 35-44.

[xiv] Sinding SW 2009. Population Poverty and Economic Development. Phil. Trans. R. Soc. B 2009 364, 3023-3030.

[xv] Bongaarts J. 2008. Fertility transitions in the developing world: progress or stagnation? Studies in Family Planning 39(2), 106-110.

[xvi] Mutunga C and Hardee K (2009) Population and reproductive health in national adaptation programmes of action (NAPAs) for climate change. Population Action International Working Paper 09/04.

[xvii] **Appendix – A Framework for Effort Sharing for Climate Change Mitigation**

Only a prescribed schedule, informed by our scientific understanding of what is required, can provide significant (even if not adequate) mitigation of climate change.

Firstly nations must commit to achieving a trajectory of global emissions which science says will give us a high chance of staying under 2oC warming. Some details need elaboration and negotiaion – what probability is defined as high, how soon we can peak, and what distribution of emissions between short-lived forcings, energy and process emissions, and landuse and landuse change, so that each has its own target trajectory. But we should settle on a global emissions trajectory that we agree is the upper limit. The trajectory would define the percentage change in emissions required in each year. It could be readily revised, in response to actual emissions each year and according to changes in scientific understanding of what is required. The treaty signatories would be agreeing to the setting of such a trajectory, not to its actual outcome locked in without change.

The above is essential. Anything less would be abandoning the commitment to a safe climate.

Then we need a system to distribute effort, including transfer payments from wealthier to poorer people. It must be something that is conceivably achieveable – there is no point demanding that developed countries cease all emissions tomorrow morning (as some proposals do). It would also be helpful if it can operate successfully without universal participation. If only some countries subscribe initially, it should not disadvantage them or reward the laggards, and should facilitate others joining in.

The following proposal is based on the principles of contract-and-converge, on comparability of effort, and on common but differentiated responsibilities. It deals with differentiation among nations as a dynamic continuum, not as a black-and-white division of developed and underdeveloped nations. It also places greatest burden on the high emitters within developed countries, acknowledging that there are wealth gaps within as well as between nations.

From our global trajectory, we would generate a 'fair share' trajectory for each nation based on their population, as a proportion of the global population. A fair share is not an entitlement, it is only a benchmark. The target change in emissions for any nation in any year would be the global percent change multiplied by the factor by which that nation's current per capita emissions exceeds its fair share. That is, if it currently emits twice the global per capita rate, then it must achieve twice the prescribed reductions. If it is very close to the global average now, it will need to reduce emissions at the global prescribed rate to avoid heavier obligations the following year. If a country currently has lower per capita emissions than its fair share a year hence, it has no responsibilities. But it would have an incentive for clean development, to ensure that it remains below the line and avoids economic impacts of obligatory emissions reduction measures. It would also be assisted in adaptation and clean development, as discussed later.

There are two qualifiers on the above formula, which add significant integrity and equity, and avoid some potentially perverse responses.

One is the choice of the IIASA's low population projection to set the trajectory of each country, as discussed above. The other is the use of consumption-basis accounting for emissions, not production-basis. This will be discussed in detail under separate headings below.

Countries emitting above their 'fair share' and unable to demonstrate sufficient emissions reductions in the first review period (3 years?) would be obliged to implement carbon pricing on an economy-wide basis, to reduce their emissions. There would be no international trade in permits, and the consumption basis system would ensure that the carbon price is trade-neutral, so each nation is free to set whatever price is necessary to drive reductions, regardless of the price applying in other countries. The main problem with an international cap-and-trade system is that it effectively enforces the global price to apply in all countries, which is highly inequitable and destroys the price signal. A price sufficient to change behaviour significantly in a developed country could have very adverse effects in sequestering resources away from the poor in developing countries. Even a low price, incapable of changing consumption behaviour significantly, can cause major redistribution of production to countries without a carbon price, and the consequent impacts on businesses and compensation measures derail the system.

The carbon price in advanced countries would provide revenue for international transfers, to assist less developed countries with adaptation and clean development. It is anticipated that at least half the revenue collected would be recycled back to citizens of the developed country, on an equal payment basis, effectively providing them with a free quota of emissions (which would diminish over time). It would be enough to fully compensate the poorest and the most conscientious people, so the burden of emissions reduction would be carried by those with high emissions and high income.

Because of this compensation, a high price can be set without adverse social impacts. This means that alternative technologies become genuinely competitive, and people have a real incentive to change their behaviour. It also means more revenue available. Some of the revenue remaining after reimbursements could be used to fund energy efficiency projects, or better public transport, or smart metering to better match energy demand with renewable sources, and this would 'increase elasticity of demand for emissions' by giving people lower-emissions options, hence speeding reductions and achieving them at a lower carbon price.

An internationally agreed proportion of the revenue would go to international assistance, via bodies such as the Adaptation Fund and a Clean Development Fund. Probably 20-25% would provide more than the funds currently sought. This would be gifted money, not exchanged for an increase in the emissions allowance of the developed country (as the current trading system does). Its effectiveness in reducing emissions would be the business of the Clean Development Fund, but it would not affect the integrity of real emissions reductions achieved in developed countries. Whatever emissions reductions achieved in the developing country would be additional to those achieved as a result of the price signal in the developed country.

Because the money is gifted, it can be given as incentives for practices that are known to be beneficial overall, but where the extent of benefit from individual units is hard to measure or to ensure in the long term, or where additionality is difficult to establish. Soil carbon and forest conservation are typical examples, along with more energy-efficient features of buildings. Relaxing the validation requirement on emissions reductions from such projects

means that the program can support a much wider range of beneficial behavioural change, and include individuals and small businesses as beneficiaries, who can't currently access the CDM because of its technical and bureaucratic demands that require projects to be large. Money can go to those who most need it, rather than those who can most readily demonstrate reductions.

Consumption basis emissions accounting and pricing

The Kyoto Protocol is based on emissions produced in each country, regardless of whether they are produced in the service of that country's population, or in the production of goods and services for people elsewhere. Consumption basis accounting is inherently fairer – on the 'user pays' principle. In general, most developed countries have more embodied emissions in their imports than in their exports. Europe's recent reduction in per capita emissions has been shown to be entirely due to shifting dirty production elsewhere, rather than cleaner consumption. Developing countries, particularly the rapidly industrialising and those with large natural resource exports, produce a significant proportion of their emissions (up to 30%) on behalf of exports for people in developed countries, rather than for the consumption of their own people. It is inequitable that they are held accountable for these. But they must accept that the constraints put on consumption of emissions-generating products in developed countries will reduce demand for their exports, and their competitive advantage will depend on how much they can clean up the production process.

Consumption basis emissions accounting removes many of the obstacles for comparability of effort. The different economic structure of different nations has much less impact on consumption patterns than on production patterns.

Consumption basis carbon pricing is a step further than consumption basis accounting. It means that the carbon tax is born by the consumer, not the producer. In this sense, it is equivalent to applying value-added tax (VAT, also known as goods-and-services tax GST). This is the only way to have an effective price signal, since it is the consumer who is making the choices. In practice, it means taxing all emissions at source in the country, but rebating exports and taxing imports on an equivalent basis. There has been some emotive protest at suggestions to tax imports from developing countries, but this misunderstands the tax. It is a tax on the consumer in the developed country. It is not discriminatory, it only cancels the discrimination between domestic and imported products that a domestic carbon price creates. The import would be just as competitive with domestic items as before. If no information is supplied on embedded emissions, the tax would be set on the basis of domestic equivalent products (unless the UNFCCC were to choose to maintain a schedule of assumed embedded emissions in categories of product, to avoid any accusations of protectionist pricing). If cleaner production can be demonstrated, the tax would be reduced.

By exempting exports, the importing country has the opportunity to tax the embedded emissions in them and benefit from the revenue (as long as they apply the same price to all other domestic and imported equivalents). If the importer is a developing country, why should they have to pay the carbon price on equipment produced in a developed country? It is much fairer if exports are exempt.

But by far the most powerful feature of consumption-basis pricing is that, because it is trade neutral, there is no need to compensate businesses for the trade impact. The price can be

much higher, without anyone losing competitiveness. Whether or not other countries have a similar price, or no price at all, is irrelevant, just as it is for value-added tax or goods-and-services tax. Therefore, the price can be set domestically to whatever level is needed to contain emissions demand within the cap set by the agreed trajectory. The price would also apply across the whole economy, not just to the few large emitters who are deemed rich enough to be able to carry the cost and administrative burden of a cap-and-trade system. This way the consumer gets a consistent price signal, and makes decisions based on emissions reduction, not on tax avoidance.

The design of a national carbon pricing system is the business of individual nations, not of the international agreement, although the agreement would establish general criteria. In an ideal system, a carbon tax would be set at whatever level was necessary to achieve the prescribed reductions. It would be reviewed and adjusted regularly, in the same manner as interest rates. If reductions are not being met, it would be increased. If they are exceeded, it would be held constant. It would be levied on all fossil fuels and lime at the point that they enter the economy (mine or port), as well as on significant sources of methane or other GHGs. It doesn't matter where or by whom they are burned or oxidised, it is simply assumed that they ultimately will be. So downstream businesses don't have the burden of measuring their emissions. If they engage in sequestration, they can get a payment on the amount sequestered and would obviously have a burden of measurement and validation attached to that, but they would not have the burden of having to trade credits in a volatile market.

Every business would be obliged to pass on the full amount of tax paid to their clients, with the amount stated on their invoice alongside VAT or GST. So everyone downstream simply has a task of accounting, not emissions measurement, and it would be fully automated. Businesses report to Treasury all the carbon units on which tax is paid, and all the units they have charged to clients, and demonstrate that all units have either been passed on or held in inventory. For most businesses, this would be largely automated. The consumer would see on their receipts exactly what the embedded emissions were in all goods and services, so they would have powerful information to make the most effective choices to avoid emissions. This would be a much more comprehensive tally of embedded emissions, counting not only the materials and process, but the packaging, transport, marketing, design and management of the buildings and equipment involved from resource extraction to retail. At each step, decision-makers would have the information they need to target the most effective emissions reductions.

A cap-and-trade system is far less effective and more cumbersome than cap-and-tax. It effectively responds to one 'market failure' by creating a whole separate, even more flawed market, with its own currency (emissions permits). International transfer of ownership of emissions reductions risks double counting. Trading highly secure stored carbon (unburned fossil fuels) for less secure forms (biomass) carries risks of unanticipated emissions in future, which, if they are counted, will be attributed to the country containing the biomass, rather than to the country that bought the credits. This is only the tip of the iceberg of perverse incentives and hidden outcomes in the international cap-and-trade model.