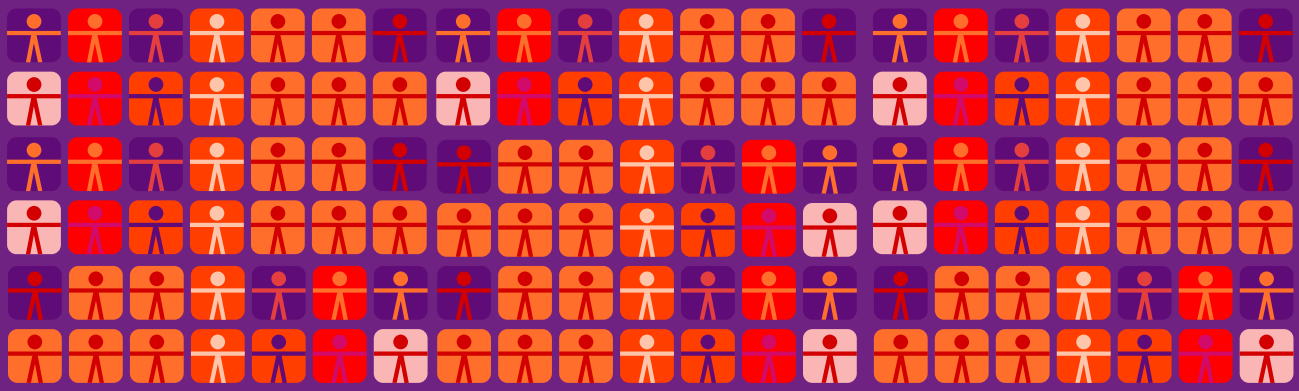
~ ANTHONY RAE FOUNDATION ~

Global Population to 2050 and beyond:
sources, analysis and discussion



Briefing from ARF/Analysis – July 2013

After an introduction about some historically controversial population writings, the first part of this briefing sets out the demographic facts and figures, then the second part reviews current issues and debates. It has been prepared on a commission from Friends of the Earth and is also published by ARF/Analysis. You can access the many live links to sources and data it contains if you read the PDF version that can be downloaded from www.anthonyrae.com.

Introduction: Who's afraid of the 'Population' issue?

1. Discussion of global population issues can be seen as controversial and sometimes in the past it has been, and still occasionally is. But it need not be, nor should be if environmentalists are to be able to engage with all components of what has been said to constitute a 'Planetary Emergency'[1]. So the purpose of this briefing is to make available to environmental organisations and individuals a synthesis of the global population 'issue' to allow them to participate in discussions about it in an informed and confident way.[2]
2. In order to create the 'space' for those conversations it's emphasised from the outset that the intention is not to take some campaigning stance around population issues (although it does reach the one conclusion that earlier 'peaking' of global population would be desirable). Rather it is to set out the numbers, forecasts and sources, and then a review of the current issues and debates, to ensure that a more expert understanding of the subject can be put into use.

continued page 3

Summary

- Discussion of population issues can be seen as controversial but need not be. This briefing presents the demographic data and sources, and reviews recent debates about global population trends so that the population 'issue' can be included within a wider sustainability analysis in an informed and confident way.
- The key concept for the understanding of population trends is 'demographic transition': the transition from high birth and death rates to low birth and death rates as a country or world region experiences development. The three basic components of population change - fertility, mortality, and migration – interact to direct the course of past and future change. Historically the first two are both consistently reducing but the fact that the former has typically lagged the latter by decades produces the circumstances whereby global and country populations develop an upward momentum.
- Global population rose dramatically in the 20th century, quadrupling from 1.65 billion to 6.1 billion. This platform has predetermined continued future growth in the 21st century but 'transition' continues as fertility decreases everywhere. **The UN has three forecasts for the 2050 population: a central Medium scenario 9.6bn; High 10.9bn; and Low 8.3bn.** At 2100 the Medium scenario slows towards a peak at 10.85bn but with a dramatic divergence also between the High (16.6bn) and the Low (6.8bn) scenarios – the latter just below the world's population in 2013 (7.15bn) but now heading downwards.
- 21st century population increases particularly in sub-Saharan Africa and to a lesser extent in Asia, and also in the USA. It is forecast to decline in China, and is already reducing in parts of Europe and Japan. Fertility rates are declining towards (or below) 'replacement rate' in every global region. Countries with declining population will face new challenges with ageing.
- Population density in 2050 will be high in a few counties (e.g Bangladesh 1402 persons/km^2, Philippines 524, India 493, Nigeria 477, Netherlands 414, against a global average of 70) whilst in most African countries it is low but increasing. Population density is not a problem per se, but could be problematic if combining with low GDP or pressures on ecologically rich areas.
- In terms of the ongoing debate as to whether 'population' or 'consumption' is a more significant threat to environmental limits, the briefing concludes (as does the recent Royal Society report) that **both** are significant and should not be set in opposition to each other. A growing and wealthier global population places particular challenges for global carbon budgets and two significant responses are important: reduce the carbon intensity of economies radically whilst encouraging demographic transition. A 2050 population below the UN Medium growth projection – so early rather than delayed 'peaking' - is desirable.
- It is not morally acceptable to use coercion to reduce population sizes. A wish to reduce future global population growth could be achieved by achieving universal access to family planning, together with empowerment of women and education. At the same time the economic development of lesser developed countries with rising populations, or high population densities compared to available agricultural land, would ensure that they have access to development without negative impacts on biodiversity or carbon sinks.

3. Nor does the briefing wish to take sides within contemporary and ongoing debates around population, or a position towards either end of what can be a polarised spectrum, which stretch from views that the planet has a carrying capacity of just 1-2 billion (with all its implications) to 'the myth of over-population'. Such positions can be adopted from motivations that are substantially ideological; and of course the controversy can sometimes be embedded in the very terms of analysis, as in 'carrying capacity'. [3]

4. However there will be areas either of emerging consensus, or what might be described as 'universal values' - e.g support for female education and empowerment, which then have consequences for human fertility – which ought to represent a meeting point between a wide spectrum or organisations. In general it would be helpful if this approach could contribute to reducing the gap between opposing positions, and foster what might be a growing consensus.

Population Controversies – past and present

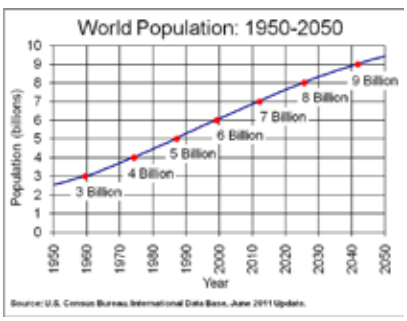
5. Controversy in the historical debates around population growth starts with Malthus at the end of the 18th century and was revived in the more recent past by Paul Erlich. Fred Pearce [4] is retrospectively dismissive of Malthus, on the grounds that his thesis that population would increase geometrically but food resources only arithmetically - making a painful check of population growth inevitable - has subsequently been disproved, ignoring the fact that Malthus as the founder of modern demographic studies was writing in the very decades when we now know that the total fertility rate (TFR) in England was at its absolute peak but about to begin a relentless descent. The Erlichs' publication in 1968 of ***The Population Bomb*** - with its fortunately unrealised prediction that "In the 1970s hundreds of millions of people will starve to death in spite of any crash programs embarked upon now" - relit the same fuse[5]. In 1972 ***Limits to Growth*** sought to illustrate the proposition that "a population growing in a limited environment can approach the ultimate carrying capacity of that environment" by the pioneering use of computer modelling. [6] Polarised responses to the prospect of future global growth remain standard currency. [7] Beyond the theoretical analyses, in the real world, population control programmes imposed by governments in China and India had disturbing and violent characteristics**.**

6. Today the focus of controversy amongst environmentalists is different: "The idea that growing human numbers will destroy the planet is nonsense. But over-consumption will" (Fred Pearce [8]; and also George Monbiot) is the current strong assertion which also requires examination.

Population Analysis

Sources

7. The United Nations Population Division has a wide range of data resources for its 2012 ***World Population Prospects***, including datasets for ***global*** population scenarios to 2100 [9]; and individual country ***current*** population and fertility rates, and ***future*** population projections and detailed datasets of many demographic factors. - which can also be aggregated by region. For the UN interpretation of these projections see the 25 'key findings' of the 2012 World Population Prospects first report [10], as also discussed in the 2011 ***World Demographic Trends*** [11] There is a useful online charting tool for comparing the historic/ current data of individual countries provided by Google Public Data Explorer.[12] Individual country



trajectories to 2100 are available on an interactive map.[13] In October 2009 the Royal Society published a theme issue on 'the impact of population growth on tomorrow's world'.[14] The many Wikipedia articles on aspects of demographic analysis and global population are generally reliable. There's a discussion from December 2011 around the current issues of debate and controversy between Hania Zlotnik director of the UN Population Division, Chandran Nair author of *Consumptionomics,* and Fred Pearce author of *Peoplequake* [15].

8. The main research for this briefing was mostly concluded before the publication in April 2012 of the Royal Society report ***People and the Planet*** [16], the demographic analysis of which in chapter 3 confirms the position taken here and provides a recommended parallel narrative. The report also includes reference to recent modelling about the relationship between population and consumption.

Concepts

9. The three basic components of population levels - fertility, mortality, and migration – interact within and across country boundaries to direct the course of past and future change. Historically the first two are both consistently reducing but the fact that the former has typically lagged the latter by decades produces the circumstances whereby global and country populations develop an upward momentum.

10. The key concept for the understanding of population trends is **demographic transition**: 'the transition from high birth and death rates to low birth and death rates as a country develops from a pre-industrial to an industrial system'. The connection between stages of demographic and economic development should be noted. All countries classed as 'developed' have already passed through their demographic transition; now their 'less' and 'least developed' counterparts are proceeding down the same path but also with very considerable national variation. "In 2010, there were 18 countries in the developing world with populations of at least 50 million. Together they accounted for 63% of the world population and include China and India, .. nine countries in Asia, the five most populous countries of Africa plus Brazil and Mexico. Those 18 countries are at very different stages of the transition to low fertility." [17]

11. As the transition proceeds, the lag between mortality and fertility produces 'a generational population bulge that surges through society'; and also a **demographic dividend** as the economically productive proportion of the population grows more rapidly than the general population, and as the dependency ratio (number of both younger and older dependants per household) falls, which in the right political and market circumstances feeds through to higher economic productivity. At a certain point towards the end of demographic transition fertility will reach **replacement rate**, at which adults have just enough babies to replace themselves and at which global population growth trends towards zero; with regional variations this is around 2.1 children per woman.

12. But the rate of demographic transition is not preordained, and is influenceable to the extent that individuals, families, communities and countries choose to do so. The speed at which downwards transition occurs can be advanced, so it is the factors that influence that choice that become critical to future population outcomes. In addition to declining child mortality these include increases to: household income; agricultural productivity (less need for children's labour); female labour participation rate; literacy, particularly for women; and the availability of contraception.

13. The migrant share of global population has remained stable at around 3% in recent decades, though with a corresponding increase in absolute numbers (around to 215m in 2010). The current assumption is for a slight decline in future migration to More Developed Regions. Refugees constitute a decreasing proportion, now around 8% of international migration.[18]

Numbers and Forecasts

(i) Global population – historic

Date	Global population	% of 2000AD total
1AD	250m	4%
1800 AD	978m	16%
1900 AD	1650m	27%
2000 AD	6115m	100%

14. To establish the right reference frame within which to consider the issue of future population growth, we need first to understand the course, scale and rate of the historic growth. What helps to remove an analysis of population from current controversy is the extent to which the platform for future growth in the 21st century had already been predetermined during the course of the previous (20th) century. By 1900 global population had increased over two millennia to a little over 1.5 billion. But then between 1900-2000 it quadrupled as a result of the lagged interaction between two of the basic demographic components - fertility and mortality - as modern medicine ensured that developing country death rates started their long-term reduction some 50+ years before birth rate reductions [19] Whilst perceptions of the 20th century may be of death pandemics caused by war, genocide or famine these probably reduced the longterm increase by no more than 5%.

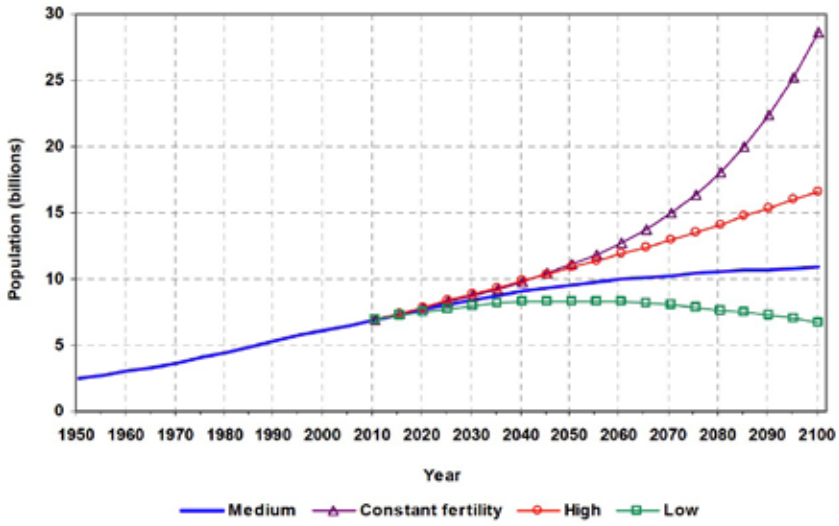
(ii) Global population – forecasts

15. However by 2000 total fertility rates for all categories of country had been reducing for some decades: for developed countries (since the 1950s), developing (1970s) and least developed (1980s).[20] Global yearly incremental increases reached a peak in the late 1980s, now run at around 75 million per annum, and are forecast to reduce to 50m per annum by 2050 [21] As a result each successive future billion will now take longer to be reached [22].

16. Nonetheless, when these worldwide downward trends are combined with the 6 billion scale of the 20th century 'legacy' population, and continuing increases in future life expectancy (from 69 years in 2005/10 to 76 years in 2045/50[23]), the consequence for the global population - whichever the scenario modeled - is that it will inevitably continue to rise for a number of decades. [24] But by how much is still to be determined, by the interaction between fertility and mortality and the diverse factors influencing them.

17. So the UN 2050 forecasts [25] display a considerable 2.5 billion range between modeled scenarios - Medium

World population according to different fertility rates



Source: World Population Prospects 2012 Figure 1, page 5pdf

9.55bn, High 10.85bn and Low 8.34bn – with the gap between the Medium and Low variants of 1.2bn. By 2100 the range between the scenarios widens to 9.6bn - almost the magnitude of the central forecast (Medium 10.85 billion, High 16.65bn and Low 6.75bn. A fourth 'constant fertility' scenario, where current fertility levels remain undiminished, reaches 28bn by 2100). The extent of the spreads in both 2050 and 2100 points to the opportunity for fertility reduction[26], but also to a continuing threat of unsustainable growth because whilst under the Medium scenario global population only increases by another 0.82bn it still has not completely peaked by 2100 [27].

If the analysis of this briefing reaches any conclusion that might shape the direction of policy, it is that whilst the UN Medium scenario is self evidently not just preferable but essential compared to UN High, it is the case that further movement in the direction of UN Low is also desirable.

18. These conclusions are only reinforced by a comparison between the biennial UN projections since 2003, which reveal a consistent tendency for each successive projection to be revised upwards, along with a substantial volatility in their forecasts of individual country fertility. The statistical appendix to this briefing demonstrates that these six revisions have added nearly 1 billion to the 2050 Low scenario (up from 7.41 to 8.34bn) whilst all of the 2100 projections have increased by between 19-23% - in just 10 years. We will comment later on the recension of the fertility forecasts. These changes do not cast doubt on the validity of the UN data [28]; rather the uncertainty they inject into what future revisions may reveal over the next decade must act to increase the policy emphasis on activity that will have the effect of moving 2050/2100 population outcomes in the direction away from UN High and Medium, and towards UN Low – as a precautionary approach.

19. Taking a very longterm view through to 2300 the UN high and low scenarios reveal "that even relatively small deviations from replacement-level fertility maintained over the long run can lead to dramatic changes in the size of the world population. … [In] the Low scenario, where fertility remains a quarter of a child below the fertility of the medium scenario from 2050 to 2300, [this] produces a world population that reaches a maximum in 2040 at 8 billion and then declines steadily to 1.6 billion in 2300." [29]

20. In terms of the location of population growth, this is overwhelmingly in Asia and Africa; all other global regions are already at or below broad replacement rate. The UN 2050 forecasts for Asia show a spread of potential increases from 4.2 billion now to between 4.5-5.9bn, and for Africa from 1bn to between 2.1-2.7bn. Thus a 1.4 billion increase in these two global regions is 'inevitable' but a proportion of a further 2 billion may be influenceable, although there will be challenges in doing so consequently limiting the potential reduction to a smaller number. In terms of the changing contributions of individual countries, around 2030 India overtakes a then peaking China to reach 1.7bn in 2050, with the sharp acceleration of African countries led by Nigeria: 160m now, 440m in 2050. [30]

(iii) Fertility Rates

21. The fertility rate ('the average number of children that would be born to a woman over her lifetime' in ordinary circumstances) differs markedly between global regions depending on their demographic stage; however all regions are exhibiting sustained decline. The replacement rate - at which global population growth would trend towards zero - is generally understood to be just above 2 lifetime births per woman but in fact again there are global variations relating to cross-country differences in mortality e.g in East Africa it is nearly 3[31]. The current UN projection is that: "In the medium variant, global fertility declines from 2.53 children per woman in 2005-2010 to 2.24 children per woman in 2045-2050 and 1.99 children per woman in 2095-2100." [32] In 2005-2010, the 75 countries with below-replacement fertility already accounted for nearly half of the world's population.

Fertility Rate	1950	Now	2050 forecast
Africa	6.6	4.7	3.1
Asia	5.8	2.2	1.9
Latin America	5.9	2.2	1.8
North America	3.4	1.9	2.0
Europe	2.7	1.6	1.8
World	**5.0**	**2.5**	**2.2**

22. The past and future global reduction in fertility rates - with all development regions converging towards replacement rate by 2100[33] – can first be observed at individual country level using the Google Public Data Explorer, which presents their fertility trajectories between 1960-2010 in the form of charts[34]. Progressively adding the data for a selection of countries - China, India, Bangladesh and Indonesia here; then for the UK, US, Germany and Japan here; then Egypt, Pakistan, Ghana, Ethiopia, Nigeria and Niger here - allows us to appreciate the spread of such example trajectories manifest today. A comparison by global regions is also possible.

23. A UN dataset[35] then allows us to observe the continuation of this dominant downward trend through to 2050. Global TFR drops from 2.5 now to 2.24 in 2050. Of the two asian population giants, China's fertility rate is forecast to remain constant at 1.7-1.8 whilst that for India reduces from 2.5 to 1.9. As further examples, the US TFR remains stable at 2.0 and the UK's at 1.9; and Germany's increases from 1.4 to 1.6 – so all of the above are by then below replacement rate.[36] The picture in sub-Saharan Africa (sSA) is different however and equally significant. Niger has the highest TFR at present -7.6, but its current population is only 18m; by 2025, with forecast fertility reduced slightly to 6.8, that increases to 28m; by 2050 TFR is down to 5.0 and population up to 70m. Although its density then would still be only at the world average, this projection is troubling in view of the country's particular development and environmental circumstances.[37] With variations this circumstance will be replicated in many parts of sSA.

24. Niger and sub-Saharan Africa also illustrate the volatility that can be found within the UN population and TFR projections for individual countries (see paragraph 18 above). Between the 2010 and 2012 revisions this resulted in the forecasts for Niger's population shifting from 55m to 69m in 2050, and from 139m to 204m in 2100. The statistical appendix sets out the shift in the projections for some 20 sSA countries, together with other examples for countries in Asia and Europe, where the forecasts have changed in both directions; and also the scale of the absolute change anticipated between now and those future dates. Again this suggests that for policy makers, whether environmental or social, the focus of attention should be on Africa.

25. There are also substantial fertility variations within a country, and between urban and rural areas; for example in India.[38] Because of similar variations in mortality rates, the date at which a country reaches its particular replacement fertility rate (RR) is an aggregate calculation; in the case of India the aggregate RR is forecast for 2011-16, with southern Indian states already below RR but 'the two most populous states of Uttar Pradesh and Bihar are not expected to attain replacement fertility until about 2030'. In the case of adjacent Bangladesh the forecast date for attaining RR is around 2025[39]

(iv) Population density

26. How important should population density be in an overall analysis (the UN data and forecasts can be reviewed here)? As a first response: it's not very clear. Against a world average of 51 persons per sq. kilometre now - moving to 70 in 2050 - there are very wide variations between countries (these global figures exclude water and Antarctica; more importantly they also don't take account of habitability or agricultural/biodiversity constraints). The following table provides a simple commentary on the range of country densities:

Country and population characteristics *(fertility rate in 2010)*	**population density per sq.km 2010**	**population density 2050**
Hongkong: the most densely populated urban settlement	6746	7659
Bangladesh: population 151m heading to 202m in 2050, fertility rate now at 2.2 and reducing. Low-lying & prone to flooding	1049	1402
Netherlands: fertility below RR* - 1.77	407	414
India: fertility in shallow descent - 2.50	367	493
Japan: fertility substantially below RR - 1.41	337	287
Phillippines: fertility reducing despite anti-contraception ideology – 3.07	311	524
UK: fertility currently exhibiting an upwards blip – 1.88; largest contributor to EU population growth element	254	300
Germany: fertility substantially below RR - 1.42	233	203
Nigeria: fertility slowly descending from a high point – 6.0	173	477
China: fertility below RR in 1990s, now – 1.66	142	144
France: fertility at RR – 1.99	115	133
Kenya: fertility in shallow descent - 4.41; important biodiversity location	70	167
Ireland: fertility at RR – 2.0	64	85
World– average fertility now 2.5	51	70
Tanzania: fertility in shallow descent - 5.24; important biodiversity location	48	137
All Least Developed countries – 4.20	40	87
United States: fertility just below RR – 1.97	33	43
DRCongo: fertility reducing from a high point – 6.0	27	66
Brazil: fertility now below RR – 1.82	23	27
Sweden: fertility below RR – 1.92	21	27
Zambia: fertility in shallow descent - 5.71	18	59
Russia: fertility substantially below RR - 1.53	8	7
Canada: fertility well below RR - 1.66	3	5
Australia: fertility below RR - 1.88	3	4

*RR = replacement fertility rate

Source: http://esa.un.org/unpd/wpp/unpp/panel_population.htm

27. Isolating population 'density' as a sole interpretive factor, then in isolation no country with the sole exception of Bangladesh appears to be faced - either now or in the 21st century future - with what could be termed a population density 'crisis'. Indeed the counter argument is that Africa uniquely suffers from under-population, and would benefit from and could sustain increased densities. [40]

28. However, before reaching this conclusion, critical additional filters would need to be applied: these figures do not relate to the habitable area within a state (such a dataset does not appear to be readily available; a proxy of the amount of 'arable land' is used in the next section), and secondly there will be a wider range of factors which for each country determine the 'sustainability' of its future population size, including the type of agricultural production, water availability, space for biodiversity, etc.[41]

29. Should migration (the third basic component of demographic change) be introduced into an analysis of population density? It would seem premature and largely unnecessary to do this, and recent related studies as to the extent to which climate change might necessitate enforced migration have so far been inconclusive. Migration does of course occur for other, positive economic or social reasons according to nationally determined policies.

30. Amongst developed countries the UK stands out as having a relatively high population density combining with a rising fertility rate and population projection [42]; only four countries (South Korea, Netherlands, Japan, Belgium) have higher densities but stable or falling population projections. The Foundation will publish a separate analysis of UK population issues in 2014. By contrast three countries with ultra low densities (Russia, Canada, Australia) occupy around 25% of the global land area.

(v) 'Vulnerable' countries and regions

31. At the global level there is some likelihood that future population trends across the 21st century will peak and then reduce but at regional and individual country levels the positions revealed by detailed 2050 forecasts might be more challenging. What is disguised by a potential peaking of global population between 2050-2100 is the striking shift in balance by 2050, and still more by 2100, between Asia (and China in particular) and sub-Saharan Africa (sSA).

Region	2010 population (millions)	2050 UN Medium	2100 UN Medium	2050 UN Low	2100 UN Low
Asia	4165	5164	4712	4482	2739
China	1360	1385	1086	1209	608
sub-Saharan Africa	831	2074	3816	1842	2559
sSA as % of Asia	20%	40%	81%	41%	93%

Source: WPP 2012 database

32. At present the populations of Asia and China dominate that of sub-Saharan Africa, but by 2050 the China/sSA balance has been more than reversed; by 2100 the sSA population is relatively close to the entire Asia one. Across the entire 2010-2100 period 79% of global population increase occurs in Africa. In this demographic re-ordering the Chinese population has 'collapsed', the sSA one soared. There must be some concern however as to whether sub-Saharan Africa, with its current bottom place in the GDP and economic league table, will be in a position to overcome the multiple vulnerabilities of, or alternatively to exploit, this demographic surge.[43]

33. Then there are a small number of developing countries where projected population increases could potentially combine with other economic or environmental factors to create both human and/or ecological vulnerability. Setting population size and growth rate, GDP/capita and agricultural potential alongside each other illustrates possible but varying risk for a number of example countries:

Country	Population 2010 (millions)	Popul 2050-forecast Medium	Popul % increase 2010-50	GDP per capita 2008-12 Current $	Arable land %	Density in 2050
India	1206	1620	34%	$1509	49%	493
Bangladesh	151	202	34%	$743	55%	1402
Pakistan	173	271	57%	$1189	24%	341
Afghanistan	28	57	104%	$543	12%	87
Egypt	78	122	56%	$2781	3%	122
Ethiopia	87	188	116%	$357	10%	170
Uganda	34	104	206%	$487	22%	441
Kenya	41	97	137%	$808	8%	167
Tanzania	45	129	187%	$532	4%	137
Mozambique	24	60	150%	$533	5%	75
Madagascar	21	55	162%	$465	5%	95
DR Congo	62	155	150%	$231	3%	66
Nigeria	160	440	175%	$1502	33%	477
Niger	16	69	331%	$374	33%	55

Sources: Population: http://esa.un.org/wpp/unpp/panel_population.htm GDP: http://data.worldbank.org/indicator/NY.GDP.PCAP.CD Arable land: https://www.cia.gov/library/publications/the-world-factbook/geos/xx.html 'Geography'

34. However, as with 'density', no simplistic conclusions can be drawn from a simplified analysis. Rather the wider question should be: who should have responsibility for managing population risk, and population policy? It certainly should be a principle - as well as a statement of fact - that the population futures of individual countries are the responsibility of their respective governments and peoples, and it is for them to decide whether they wish to influence the scale of future growth. But, in view of the essential interaction between economic and population development, is it not equally a global responsibility to ensure that the sub-Saharan Africa countries in particular receive the benefit of improvements to education, health and welfare - as embodied in the Millennium Development Goals - in order to forestall any anticipatable competition or collision in decades to come between population, human aspirations and needs, and sustainability within environmental limits.

Issues and Discussion

35. The burden of the previous analysis is that, in the 2010s, the actual demographic aspects of population change are in essence not controversial (which is not the same as saying that 21st century outcomes should not be a cause for concern or attention). But nonetheless there are still related issues where the emphasis of different factors is to be argued over, or where there are apparent choices to be made or at least debated. Environmentalists should explore these and also judge the extent to they need to be engaged in analysis and action on population related subjects.

Current UN perspective

36. The conclusion to the UN 2011 Demographic Trends report is expressed in this precautionary and activist tone:

> "According to the projection scenarios discussed above, current population dynamics would produce excessive population growth if maintained over the long run. To have a reasonable chance of stabilizing world population, fertility has to drop to below-replacement level and maintain that level for a lengthy period in order to counterbalance the expected increases in longevity. "
>
> "The rapid population increases in recent decades are occurring on a planet that is increasingly showing signs of strain. If a population that adds a billion new inhabitants every 12 or 15 years is to be averted, global fertility must eventually reach and maintain replacement level. However, as Justice Holmes remarked: 'The way in which the inevitable comes to pass is through effort.' The reduction of fertility may be inevitable, but considerable effort is still required to make it a reality over the next few decades." [44]

37. The message that we can take from this is that the UN body concerned with global and country demographics believes that future trends cannot be assumed to be benign, and will require positive interventions to secure. Whether organisations or individuals wish to take an informed position on global population futures – rather than acknowledging that these are matters of national and household 'sovereignty' – is for them to judge but there should surely be little disagreement with support for those millennium development goals which act indirectly on family size such as reproductive health, and female empowerment.[45] We noted in paragraph 17 above that the UN central scenario does not peak at 2050 but continues a decelerating increase to 2100; in paragraphs 55-60 below we debate the benefits of a lower population in 2050, and therefore also 2100, and an earlier peak.

'Population' versus 'Consumption': which makes the greater impact?

38. The starting proposition is easily stated: a small (or smaller) number of wealthy people can consume more – therefore with greater environmental impacts, relatively or absolutely – than a larger, and faster growing, number of poorer people. The consumption imbalance between developed and developing countries is a fundamental feature of today's world - applying to food, water, access to electricity, and CO2 – e.g "Just 11% of the global population generate around 50% of global carbon emissions, while 50% of people create only 11%" - with the prospect that in many cases this imbalance is forecast to worsen in the future.[46]

We first of all therefore have to understand that particular areas of consumption - of these basics by 1 or 2 billion people - have to increase.

39. But does it follow that population growth is a secondary factor, and that present and future consumption by developed countries alone has to be subject to constraints? Thus Fred Pearce: 'The idea that growing human numbers will destroy the planet is nonsense. But over-consumption will'; and George Monbiot: 'Population growth is not a problem - it's among those who consume the least. So why isn't anyone targeting the very rich?' [47] The previous Friends of the Earth position statement (FOE Policy on Population, October 2010[48]) came down on the side of 'consumption' - "Friends of the Earth recognises that population growth is one of the drivers of environmental degradation. However, in our view it is not the major driver. Rather, it is consumption issues which present a much greater and more urgent threat to the environment". But it also contained no demographic analysis.[49]

40. It (and Monbiot) drew on the research findings of David Satterthwaite [50] that between 1980-2005 'Most of the nations with the highest population growth rates had low growth rates for CO2 emissions while many of the nations with the lowest population growth rates had high growth rates for CO2 emissions". But this analysis has two problems: that of the 'excluded middle' - its polarising conclusions are only achieved by downplaying a significant middle segment of the data; and secondly because it looks backwards at the emissions of the recent past, rather than forward at emissions to 2030/50. The 'excluded middle' is essentially the population, economic and emissions growth of China, and to a lesser extent India - past and future.

41. A further understanding should therefore be to avoid a false polarity between population and consumption, which is also the conclusion of the Royal Society ***People and the Planet*** report: "Consumption and demography are closely inter-twined. Every person must consume, and each additional person on the planet will add to total consumption levels. … Policies should not treat population and consumption as separate issues." [51] This can be illustrated by a comparison between growth trends affecting China+India, and the US.

42. In the 25 years from 1980 China+India had 37% of global population growth, 52% of global CO2 growth, and 8% of global GDP growth; by contrast the US had 3.4% of world population growth, 10.7% of global CO2 growth, and 28% of global GDP growth. So the global share of CO2 growth for China/India is larger (not smaller) than their population growth share; and when we factor in a comparison of GDP growth then Satterthwaite's original thesis becomes more uncertain still. Although the US was responsible for 28% of total GDP growth over the period, this only required 11% of the CO2 growth; whereas India+China required more than 50% of CO2 growth to obtain a mere 8% of the GDP growth.[51*]

43. Resolving the analysis requires the introduction of a fourth factor: the carbon intensity of production. Currently the US can generate $2300 additional national wealth - for consumption or whatever purposes - per tonne CO2 emitted, and the UK $4300, but India only $580 and China $435; and compare this say to Brazil at $3100 (the differentials are reduced using a PPP analysis). Although China and India have substantially different national profiles for GDP and CO2, both absolute and per capita - so the conclusion that follows relates more to China - their very large 20th century 'legacy' populations and continuing 21st century growth, combined with a very poor carbon intensity ratio, means that their economic engines are leaking carbon at an unsustainable rate as they 'go for growth'.

44. What of the imminent future as the two Asian population giants - with annual GDP growth rates over the last decade of 8-12%, resulting in annual CO2 growth rates of around 6% - attempt to move at least some of their population up the prosperity ladder, as they are entitled to do, and into 'middle-class' consumption patterns? The fact that this will apply to 2.5-3 billion people and 35+% of global population cannot be set aside.

45. On particular economic growth assumptions 40-50% of China's population will be in the middle-class by 2020 and around 75% by 2030. [52] In 2007 McKinsey were forecasting that India's middle class would grow from around 5% to more than 40% of the population in two decades, creating the world's fifth-largest consumer market. [53] The thesis of Chandran Nair that the particular combination of population size and growing consumption in East Asia is not sustainable [54] is supported elsewhere.[55]

46. In terms of global shares, the significance of this now 'included middle' of China+India is apparent: "By 2030 China and India will be the world's largest and 3rd largest economies and energy consumers, jointly accounting for about 35% of global population, GDP and energy demand. … Over the next 20 years China and India combined account for all the net increase in global coal demand, 94% of net oil demand growth, 30% of gas, and 48% of the net growth in non-fossil fuels." [56] In a split between OECC and Non-OECD 2030 emissions, China+India amount to nearly 39%, and although in 2030 some OECD country per capita emissions will still be higher than those of China, new research has claimed that EU and China per capita emissions for energy are already equivalent.[57]

Middle Class in 2030

47. The implications of this interpretation are supported by as yet unpublished research by Professor Tim Jackson included within the Royal Society report, based on modelled scenarios integrating variables for population growth (in three global regions), economic growth and carbon intensity. Whichever of the three economic (in fact 'income') growth scenarios modelled – Sc1 'Current Unequal': $50,000 per capita in high income countries (ICs) at 2050, $40,000 in middle ICs, $5,000 in low ICs; Sc2 Converge to an average $50,000 per capita; and Sc3 Converge to a lower average of $20,000 – it is only a radical and universal reduction in carbon intensity to 20-40g CO2/ $ PPP that renders any of the economic/consumption growth scenarios, combining with the UN population projections, compatible with a sustainable global carbon budget: "A carbon intensity of 40 g/$2005PPP is sufficient to bring world carbon emission down towards the lower end of the emissions range defined by the 50-85% reduction window." [58]

48. So the population and economic growth drivers are complexly intertwined. Both the level, but more particularly the carbon intensity, of consumption are critical factors, but now have to be extended to include a larger segment of global population - developed countries **and** China+India. Whilst future population growth is regionally polarised (so in some regions it does not occur or is even negative) economic growth will also take place everywhere. [59] Both will impact on future environmental limits.

49. The simplified argument that 'consumption is more important than population' needs therefore to be substantially qualified. However one part of the original proposition remains strongly valid. CO2E emissions for Africa are at present marginal[60] and will remain at 3% of the world total despite the rapid increase in the Sub-Sahara African population to 2030.

Population and environmental/ecological impacts

50. The extent to which population growth can contribute to individual or cumulative environmental impacts, and their hierarchy or distribution, needs to be assessed within a single integrating, quantifying and modelled framework. The purpose of this short section is not to describe and assess in detail what those impacts might be – which would be a work on its own - but rather to point to two such frameworks and summarise some of their conclusions relating to population.

    - *OECD Environmental Outlook to 2050* [61] identifies population as a core factor in its analysis, but with primacy given to the consequences of forecast economic growth: "By 2050 the Earth's population is expected to increase from 7 billion to over 9 billion people. Coupled with expected higher living standards across the world, global GDP is projected to almost quadruple …" [62] It judges that the prospects for four key environmental challenges have worsened since its 2008 review which concluded: "In the absence of additional policy interventions and under conservative economic assumptions, the environmental outcomes deteriorate as the expanding and more affluent population exerts increasing pressure on the natural resource stocks." [63] Whilst both report reach Stern-like conclusion on the affordability of tackling these problems, the outcomes they predict in aggregate are stark. [64] The OECD findings are based on complex dynamic modelling [65]

    - *WWF's Living Planet 2012* report deploys the concept of global or ecological footprint to analyse the impact of population on the environment by global regions and development/ income levels. [66] Having

established that 'the per capita Ecological Footprint of high-income nations dwarfs that of low- and middle-income countries' and that 'in contrast, middle- and low-income countries had demanded less than the average per capita biocapacity available globally' it then notes that in 2006 "the middle-income countries [including the BRICs, amongst which are China and India] exceeded this value." Their "population has more than doubled since 1961, while the footprint per person has increased by 65%, largely associated with increased industrialization. Although population growth is slowing in some places, further population increases, together with a rise of middle class consumption patterns in emerging economies, have the potential to increase humanity's global footprint dramatically in the near future."

There is a similar interaction between population and footprint for the low-income countries, which have "a smaller footprint today than they had in 1961 – a reduction of 0.01 gha per person. However, rapid population growth in these countries (4.3 times, since 1961) has led to an overall 323% increase in the total Ecological Footprint of low-income countries since 1961." In terms of ecological impacts WWF conclude: "The Living Planet Index shows that declines in biodiversity are greatest in low-income countries. … The trend in low- income countries is potentially catastrophic, not just for biodiversity but also for the people living there." [67]

51. There are maybe two policy conclusions to draw: that the direct and indirect impacts of population growth are significant, in combination with economic and consumption growth; and that the regional distribution of the more severe environmental impacts aligns with regions of major population growth to 2030 or beyond (S and SE Asia, Africa) - both of which confirm the importance of including the population driver in an overall environmental analysis.

Population Ageing

52. We have already seen how the projected transition in fertility is universal, apparently unstoppable and relentless. But there's an asymmetry in the discussions around population: from other perspectives it's an ageing or declining population which is equally problematical, posing a different set of questions. Median global population age increases from 29 now to 35/41/49 years in 2100 (dependent on growth scenario)[68], with the higher figure (49 years) this time associated with the Low growth scenario, so efforts to reduce future population size also accelerate its ageing and worsen the dependency ratio [69] It's for this reason that some commentators have identified the 'real' global population problem not so much as increase as decline; thus the somewhat alarmist subtitle of Fred Pearce's recent book: 'Peoplequake … ageing nations and the coming population crash'.

53. Again there are very substantial regional differences in terms of demographic and other impacts:

***Europe*:** Over the last decade, confronted by fertility rates below replacement level in every member state, the EU has been considering in policy terms what it has termed its 'demographic challenge' and the opportunities for 'demographic renewal'.[70] The subsequent 2011 study by RAND Europe, despite finding 'some signs of recovering fertility' in the last five years nonetheless has to record no effective change in overall fertility, therefore little ability for policy to intervene because of the impossibility of identifying causal mechanisms.[71] One of their country case studies is of the UK, where it notes 'one of the most dramatic turnarounds in fertility' this decade. In developed countries the concerns extend beyond the demographic to include the major consequences for the public finances of failing to manage longevity risk. [72]

***China and India*:** Here the change and consequences are coming much faster: "Developed countries had around 130 years, with a baby boom in the middle of the period, to adapt to an older population. Developing countries will have to adapt during half that time" *Hania Zlotnik* director, UN Population Division. Nicholas Eberstadt has contrasted the changing future fortunes of China [73] and India [74] in terms of their significantly different pathways affecting demographic composition and ageing, from the perspective of an American think tank. The adverse effects of China's One Child Policy are so damaging to its economy and society that they require its immediate abolition, he believes; nonetheless its "impending depopulation is by now virtually unavoidable".

54. So there is no question that the problems of a possibly reducing and certainly ageing global population are just as important as those created by the preceding huge growth since 1900. However there are, it is suggested, two reasons why this analysis of global population issues should not place as much emphasis on the former: the consequences of population ageing as they unfold will be of a different type, and policy responses are more likely to be largely reactive (e.g by periodically extending the retirement age in developed countries. Of course in developing countries the absence of welfare frameworks will make their response even more challenging); and it's not clear what the environmental impacts, and impacts on environmental limits, of ageing/decline would be, and whether they would be negative. It's environmental limits which are the focal point of our perspective.

Should we encourage a lower population in 2050?

55. We have noted earlier that whilst the UN Low population scenario peaks around 2050, its central projection does not reach its apogee until after 2100 before then also turning downwards. These two population futures are not alternative 'targets', merely statistical forecasts driven largely by different assumptions about the rates at which fertility will continue to decline in every global region. They do however pose an important question - and therefore a choice - for global sustainability: 'If it could be contrived that world population increase was limited to the UN Low variant rather than Medium – so 450 million less than the 8.32 billion projected for 2030; and 1.2 billion less than the 9.55 billion for 2050 - would we wish to encourage that lower growth or not?' Answering such a question involves blending a complex mixture of demographic, social, environmental, political and ethical considerations; and then there would be other more practical ones about the interventions that could be acceptably employed in pursuit of this objective.

56. This is not the equivalent of seeking to define, let alone attain, an optimum population for the Earth. The Royal Society report concludes that "… attempts to quantify the Earth's human carrying capacity or a sustainable human population size face the challenge of understanding environmental constraints, human adaptability, human choices and the interactions among them all. … Because no estimates of human carrying capacity have explicitly addressed the[se] questions, taking into account the diversity of answers, that vary across societies, cultures and times, it must be concluded that no reliable scientific estimates of sustainable human population size exist, and that such estimates would be provisional and technology dependent." [75]

57. Nonetheless research does support the view that "a decrease in the rate of population growth could lead to substantial reductions in global emissions, particularly in the long run" and that "population policies that reduce fertility and slow population growth would probably also have climate-related benefits".[76]

58. In 2009 the Optimum Population Trust (now Population Matters) put forward a proposal researched by LSE, built up from a starting assumption about unmet need for contraception, and proceeding via the comparative cost benefit of reducing emissions resultant from lower global population rather than alternatives.[77] Thus:

> "UN data suggest that meeting unmet need for family planning would reduce unintended births by 72%, reducing projected world population in 2050 by half a billion to 8.64 billion. … The 34 gigatonnes of CO2 saved in this way would cost $220 billion - roughly $7 a tonne. However, the same CO2 saving would cost over $1trillion if low-carbon technologies were used. The $7 cost of abating a tonne of CO2 using family planning compares with $24 for wind power, $51 for solar, $57-83 for coal plants with carbon capture and storage, $92 for plug-in hybrid vehicles and $131 for electric vehicles."

59. Ordinarily means are formally subordinated to ends but in this case, because the complexity of the ends makes it extremely difficult to resolve them to an outcome, it may be appropriate to reverse the usual approach and concentrate instead on the proposed intervention. Millennium Development Goal 5B is to 'Achieve, by 2015, universal access to reproductive health', but at present the UN is reporting that 'Progress in expanding the use of contraceptives by women has slowed' and that 'use of contraception is lowest among the poorest women and those with no education'.[78] Environmental and social justice organisations should support this Goal and the empowerment of women; if the consequences turn out to be reduced fertility and a reduced global population that would be their choice.

60. At the time the OPT apparently found themselves and their proposal subject to criticism, no doubt partly due to its particular expression[79] but in view of the congruence at the level of goals, then a thoughtful and benign neutrality towards proposals like this ought to be considered. In at least its current policy objectives Population Matters appears to have moved away from a prior quest to determine a global 'optimum population'.[80]

Different types of 'transition'

61. Transition is a constant theme in such as Friends of the Earth new 'Planetary Emergency' strategy - about the need to make a transition away from unsustainable global trends and activities, and for a 'fair and planned transition to sustainable development' - but when it was written in 2011 '**demographic** transition' was not understood to be or encompassed as one of the powerful components of the global path towards the sustainable 2050 it called for.[81] And yet as this briefing has demonstrated the full demographic transition - not just population increase but ageing as well - is one of the most powerful drivers that will shape this next century. That surely is therefore the most important reason why discussion and analysis of population and demographic change needs to be brought from the margins and into the environmental mainstream.

62. But paradoxically it is also a 'powerful component' substantially beyond the policy and campaigning reach of environmental organisations: the die for the 21st century global population has already mostly been cast – so in that light clamouring for billions reductions, or indeed substantial increases, are just so many Canute-like protestations against the tide coming in, or going out again - and decisions about the future course of an individual country's demographic transition or the future size of an individual family will and should not be taken in the Global North.

63. So 'powerful yet largely uninfluenceable'. Resolving this apparent paradox maybe requires us to delve deeper into the multiple meanings of this central transition concept, and how it should be deployed. There is Monbiot's final conclusion – that no one appears to be planning 'a consumption transition'[82] - and yet at the same time we also have to recognise that there are global billions of people, individuals with aspirations, capable of participating in markets and consumption narratives, needing to find employment and livelihoods, who will benefit from conventional economic growth - who are aspiring to a quite different type of consumption transition. So whether we're discussing a demographic transition, an upwards transition towards $ wealth, or a transition towards sustainability, we would be better to understand it as one single process, posing questions for us about the nature and direction of that entire long-term transition, and how we seek to promote and influence it. We will need to eschew an analysis of 'false choices' - for example, polarising 'population versus consumption' - and instead have to deal with all of economic growth ***and*** consumption ***and*** population ***and*** carbon reduction.

64. Because the transition we are talking about needs to be of a different and more complex type altogether: towards Sustainable 2050, integrating economic, social and environmental outcomes in the most optimum outcome we can hope for. Whether that is a world of more or less than 9.5 billion is surely a question, with so many ramifications, that should command our attention.

Epilogue

65. It's to be hoped that this inquiry has demonstrated that environmentalists do need to embed an analysis of population into their wider examination of global issues and limits – although in what direction they take that is for them to determine – but that if they are to do that then they must first study the demography, and in some detail. At present there is either a hesitancy to do so that amounts to unnecessary self-censorship, or substitution of another conventional wisdom (around 'consumption') - all seemingly based on a lack of familiarity with the demographic analysis and sources. This briefing should assist in increasing our acquaintance with both, and ability to embark on a new and open conversation.

66. Then readers will have noted that its intention throughout has been emphasise the opportunity for convergence rather than divergence of views, so that environmentalists can now grant themselves a 'permission to discuss' the subject. Only by resisting the siren calls to strike adversarial positions – calling for action to be taken in pursuit of a smaller or larger world population, which their respective advocates however sincere have not noticed are not in their gift to bring about; or by offering the false choice between population or consumption - can those much needed conversations find the space to actually begin. Whilst it's not quite the case that this briefing's position is 'to have no position' - because the logic of achieving 'early peaking' seems necessarily precautionary, when the alternative is only to delay descent but now from a much higher summit – that is the extent of its conclusions; and there are no recommendations.

67. However whilst it is the structure of the analytical narrative itself - the inevitability of the great arc of demographic transition, pushing global population first upwards and then down - that leaches the controversy out of its account, that does not hold for the next level down: the population of individual countries. Essentially for this reason: countries - and also households - are the level at which population and associated policies and programmes (such as reproductive health) come to implemented, and at which responsibility for outcomes has to lie. Looking back to the period when in the space of a few months first China (in October 1949) and then India (January 1950) assumed that responsibility for themselves, with their populations standing at 544m and 376m respectively; and then forward to 2050 when those numbers are projected to be 1385m and 1620m, with both their relative positions and trajectories now reversed; and reflecting on what happened in the century in between, is a telling illustration of the burden of that responsibility. The countries and peoples of sub-Saharan Africa will be faced with those same choices and responsibilities throughout the 21st century.

68. And national and individual choices apply not just to population policy but to immigration, economic, development, planning, housing, health, welfare and environmental policies as well – each freighted with difficulties and opportunities, and all interacting with each other. So the next ARF briefing - on UK Population, at present 63 million and projected to increase by another 10 million in 2050, and then a further 4 million by 2100 [83] – to be published in 2014 is certain to be different in its approach and more likely from the start to be confronting potential controversy: which is the reason again why environmentalists don't want to talk about or engage with the subject despite its obvious significance. But who knows what the outcome of that 'analytical narrative' will be? We won't know until it's completed.

If you're interested in receiving that second briefing in due course, or have some comments or thoughts on either Global or UK Population then please contact: population@anthonyrae.com

This briefing was prepared by Anthony Rae for ARF/Analysis – July 2013. It can be downloaded from www.anthonyrae.com 'Foundation', 'Analysis'

Endnotes

[1]'Sustainable Development in a time of Planetary Emergency' is the title of the Friends of the Earth organisational strategy approved in 2011. The author was at that time on the FOE Board, chair of its Campaigns Committee and participant in the strategy's development.

[2] My thanks to Mike Childs, Head of Policy, Research and Science at Friends of the Earth with whom I worked whilst developing this analysis. The text originally had some language that would have represented a 'position' appropriate to FOE; that has been amended in this published version but the briefing still reflects the sustainable development values of an organisation like FOE. Friends of the Earth's own briefing, prepared on the basis of the ARF research is Global population, consumption and rights August 2013 and Mike's associated blog is here.

[3] See the discussion in Sayre *'Carrying capacity: Genesis, History and Conceptual Flaws'* Berkeley 2007

[4] ***Peoplequake: Mass Migration, Ageing Nations and the Coming Population Crash*** 2011, chapter 1

[5] The Erlichs most recent contribution (January 2013) continues their pessimistic interpretation of global trends: "Environmental problems have contributed to numerous collapses of civilizations in the past. Now, for the first time, a global collapse appears likely. Overpopulation, overconsumption by the rich and poor choices of technologies are major drivers …" http://rspb.royalsocietypublishing.org/content/280/1754/20122845.full.pdf

[6] See http://www.newscientist.com/article/mg21328462.100-boom-and-doom-revisiting-prophecies-of-collapse.html for a 2012 revisiting of ***Limits to Growth***

[7] See Stephen Emmott Humans: the real threat to life on Earth Observer 24th June 2013, and Mark Littlewood Triple the population – we'll all be better off Times same date. And see the review of new books by the 'optimist' Danny Dorling ***Population 10 Billion*** and the 'pessimist' Emmott ***10 Billion***, Guardian 6th July 2013.

[8] Pearce http://www.prospectmagazine.co.uk/2010/03/the-overpopulation-myth/ Monbiot http://www.monbiot.com/2009/09/29/the-population-myth/

[9] scroll down in right-hand box to 'World'

[10] http://esa.un.org/wpp/documentation/pdf/WPP2012_%20KEY%20FINDINGS.pdf 2013 page 8pdf. Just before this briefing went to print in July 2013 the UN Population Division published the 2012 revision of its ***World Population Prospects***; all the numbers cited herein have been updated accordingly. The earlier editions of ***WPP*** for 2006, 2008 and 2010 are also available. Where a quotation from WPP 2010 is still applicable it will referenced instead. For coverage of the 2012 revision see ***World Population Could Be Nearly 11 Billion by 2100*** Science Daily 13th June 2013; ***Global population growth outlook worsens*** Population Matters 14th June 2013; and UN: ***India to be world's most populous country by 2028*** BBC

[11] http://www.unfpa.org/icpd2011/sg_report_demographictrends.pdf

[12] To access Google PDE: use the text link or search for 'GPDE World Development Indicators'. Datasets for 'population' are under Environment; and for 'fertility' under Health. Set ***Compare by*** to 'Country', listed as a subset of Region. ***Region*** underneath should be set to 'All'. Finally select individual countries

[13] http://www.worldpopulationatlas.org/

[14] http://rstb.royalsocietypublishing.org/content/364/1532.toc

[15] http://www.nytimes.com/2011/12/02/opinion/magazine-global-agenda-crowded-out.html?pagewanted=all

[16] http://royalsociety.org/policy/projects/people-planet/report/

[17] UN ***World Population Prospects 2010*** http://esa.un.org/unpd/wpp/Documentation/pdf/WPP2010_Highlights.pdf 2011 para.49

[18] Oxford University Migration Observatory briefing *Global International Migrant Stock* 2011 Net suppliers and receivers or international migration are identified in Key Finding 25 of WPP 2012 (***op cit*** footnote 10)

[19] See fig 3.2 from http://www.worldbank.org/depweb/english/beyond/beyondco/beg_03.pdf

[20] ***WPP 2010*** figure II (***op cit*** footnote 17)

[21] http://www.census.gov/population/international/data/idb/worldpoptotal.php

[22] The source for this information http://esa.un.org/wpp/Other-Information/faq.htm#q3 has recently been removed as a consequence of the 2012 WPP revision. For the decline in the percentage annual growth rate to 2100 by global region see http://10billion.dannydorling.org/Figures.html#27

[23] ***WPP 2012*** table S.13 page 43 (***op cit*** footnote 10)

[24] ***WPP 2010*** (op cit footnote 17) p.17 ***"…*** population growth until 2050 is inevitable even if the decline of fertility accelerates."

[25] http://esa.un.org/unpd/wpp/unpp/panel_population.htm This database provides population forecasts by country and fertility scenario for the period 1950-2100. Scroll down the 'country' list to 'world' and global regions/continent options at the bottom

[26] Royal Society ***People and the Planet*** p.20 **"**Under the UN medium fertility variant the population is expected to reach 9.3 billion by 2050, but an increase or decrease in the total fertility rate by 0.5 will determine whether the world reaches 8.1 or 10.6 billion"

[27] See ***WPP 2012*** page 5pdf (***op cit*** footnote 10) for a graph of the scenario variants to 2100; and ***WPP 2010*** (op cit footnote 17) Table I.1 p.24pdf for a table of population totals by global regions to 2100.

[28] An explanation of the factors involved in the latest upward revision is to be found on page 6pdf of ***WPP 2012*** However we should also note that the first UN 2050 projection produced in 1994 had the Medium scenario at 9.83bn which was then subsequently revised downwards.

[29] ***UN World Demographic Trends*** 2011 (op cit footnote 11) para.37. The numbers in this quotation will be based in the 2010 revision. The UN report ***World Population to 2300*** was produced in 2004, based on the 2002 revision. http://www.un.org/en/development/desa/population/publications/pdf/trends/WorldPop2300final.pdf. In addition to data and analysis it also contains a collection of essays on longterm population futures. See http://www.worldmapper.org/display.php?selected=12 for a global mapping of the 2300 population.

[30] The changing league table is at http://esa.un.org/unpd/wpp/JS-Charts/pop-tot_0.htm; select 'Show all countries by year', the year as '2050' and the order 'Descending'. See also ***Nigeria expected to have larger population than US by 2050*** Guardian 13th June 2013

[31] http://en.wikipedia.org/wiki/Total_fertility_rate#Replacement_rates

[32] ***WPP 2012*** Key Finding 2, page 8pdf

[33] ***WPP 2010*** figure 3 page 37pdf

[34] Search for 'Google public data explorer world development indicators'. Select Health/Fertility Rate, and then 'compare by' Country. You can also prepare comparative charts for population under Environment/Population

[35] http://esa.un.org/unpd/wpp/unpp/panel_indicators.htm Select 'Total Fertility'

[36] See Royal Society ***People and the Planet*** p.26 for more information on forecast changes to fertility rates affecting developed and developing countries to 2050.

[37] See Royal Society ***People and the Planet*** pages 38 for a case study of Niger. "The Republic of Niger provides an extreme example of a country at the early stages of the demographic transition and one that faces severe constraints on development. … A future in which population increase outstrips the production of food and other necessities of life is a real possibility for Niger." A Malthusian prediction for our time!

[38] http://planningcommission.nic.in/data/datatable/0904/tab_137.pdf For a map display of regional fertility variation across adjacent Iran see http://10billion.dannydorling.org/Figures.html#17

[39] P.N. Mari Bhat 'India's changing dates with replacement fertility: a review of recent fertility trends and future prospects' date unknown, page 5; Rahman, DaVanzo, Razzaque 'When will Bangladesh reach replacement –level fertility? The role of education and family planning services' date unknown, page 9

[40] See the discussion in Matthew Lockwood 'Population and environmental change: the case of Africa' in ***An overcrowded world?*** 1995

[41] See http://www.worldpopulationatlas.org/index_map.htm for a novel mapping of individual country population densities

[42] "Of all the countries of the European Union (EU), the UK has had one of most dramatic turnarounds in period total fertility over the last five years, with recent gains more than reversing the slow decline of the previous two decades." ***Low fertility in Europe: Is there still reason to worry?*** 2011 Chapter 8

[43] Chart 8 in http://esa.un.org/unpd/wpp/Documentation/pdf/WPP2010_Wallchart_Plots.pdf depicts this re-ordering coloured onto a world map; sub-Saharan Africa is red … for danger?

[44] http://www.unfpa.org/icpd2011/sg_report_demographictrends.pdf paras. 65 and 68

[45] See Royal Society ***People and the Planet*** pages 32-33 for more information

[46] Imbalances: water - ***People and the Planet***, Royal Society p.49; food - "In 2010 close to one billion people did not receive sufficient calories to meet their minimum dietary energy requirements … Another billion people (estimates vary) are chronically malnourished" ***ibid*** p.52; access to electricity - ***The Consumption Explosion*** NEF 2009 p.17 table 2; CO2 - Kate Raworth ***A Safe and Just Space for Humanity*** Oxfam February 2012 p.19; and see also 'The Consumption Explosion' p.3

[47] See footnote 8 for the Pearce and Monbiot sources, and also the latter's discussion of ***Raworth*** Is protecting the environment incompatible with social justice? February 2012. Andrew Simms repeats this polarising interpretation in We keep moaning about population, but ignore consumption habits Guardian 3rd July 2013

[48] http://www.foe.co.uk/resource/briefings/population_policy.pdf

[49] In an earlier treatment, its 1999 analysis of environmental limits ***Tomorrow's World,*** Friends of the Earth reported current predictions of a 11 billion global population by 2050, and wrote in terms of setting (for the purposes of policy making) world population 'stabilisation targets' for the year 2010. ***Op cit.*** pages 4, 80.

[50] www.iied.org/human-settlements/media/study-shatters-myth-population-growth-major-driver-climate-change

[51] Royal Society ***People and the Planet*** p.62

[51*] Calculations the author's from UN and World Bank population, emissions and GDP databases

[52] Kharas '***China's transition to a high income economy***' Brookings Institute 2009, fig 10 p.30. '***Medium and long-term development and transformation of the Chinese economy***' Cairncross Economic Research Foundation March 2011 p.41-2.

[53] https://www.mckinseyquarterly.com/Tracking_the_growth_of_Indias_middle_class_2032 And see also "Almost a billion people [in S Asia]will join the ranks of the middle class (1.2 billion by 2030 if you believe the ADB and 1.4 billion by 2050)" http://www.eastasiaforum.org/2011/11/28/south-asia-and-asias-middle-class-future/

[54] ***Consumptionomics*** 2011

[55] "The anticipated affluence of some 3 billion additional Asians will put tremendous pressure on the earth's finite natural resources." ***'Asia 2050 Realising the Asian century'*** Asia Development Bank, page 7

[56] BP Energy Outlook 2030 p.45

[57] J.G.J. Olivier et al ***Trends in global CO2 emissions' PBL Netherlands Environmental Assessment Agency 2012***

[58] Royal Society ***People and the Planet*** section 4.6.2.3.1, and figures 4.3-4.4, p.79-81

[59] Every year the world economy grows in size by around 3-4%. Thus by 2050 today's global GDP of around $80 trillion is forecast to increase to $280trn (PPP, constant prices). Although attention is typically on the shifting positions of the top 10 countries - with China now projected to overtake the US as largest economy by 2020 - two more constant factors tend to be overlooked:
- today's unequal hierarchy of country blocs remains constant throughout the period, so whilst BRICS GDP per capita in 2050 will have risen to today's OECD level, the latter will have continued to widen the absolute gap between them; but thatpopulatio0n
- nonetheless, and ignoring short-term volatilities, ***every*** country and population gets absolutely wealthier (as conventionally defined), so the ***impacts*** of economic/consumption growth will be global, if asymmetrically distributed.
See ***The World in 2050-The accelerating shift of global economic power: challenges and opportunities*** PWC January 2011, including figure 8 for OECD/BRICs relative positions

[60] www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=90&pid=45&aid=8&cid=r6,&syid=2005&eyid=2009&unit=MMTCD

[61] 2011 http://www.oecd.org/environment/indicators-modelling-outlooks/oecdenvironmentaloutlookto2050theconsequencesofinaction.htm The Executive Summary can be read online at http://www.keepeek.com/Digital-Asset-Management/oecd/environment/oecd-environmental-outlook-to-2050/executive-summary_env_outlook-2012-3-en

[62] OECD Executive Summary page 4

[63] OECD ***Environmental Outlook to 2030*** 2008 Background report, page 18

[64] See OECD ***Environmental Outlook to 2030*** Background report table 1.2 p.29

[65] "The ENV-Linkages model … is a global dynamic computable general equilibrium model that describes how economic activities are linked between sectors and across regions. It also links economic activity to environmental pressure, specifically to emissions of GHGs. These links between economic activities and emissions are projected several decades into the future, and thus shed light on the impacts of environmental policies for the medium- and long-term future. This model was used to make projections of key socio-economic drivers such as demographic developments, economic growth and developments in economic sectors." http://www.oecd.org/env/indicators-modelling-outlooks/modellingworkbehindtheoecdenvironmentaloutlookto2050.htm

[66] WWF ***LivingPlanet 2012: Biodiversity, biocapacity and better choices***

[67] ***Living Planet*** pages 56-57pdf

[68] http://esa.un.org/unpd/wpp/unpp/panel_indicators.htm 'Median Age'

[69] UN ***World Demographic Trends 2011***, figure VII (***op cit*** footnote 11)

[70] ***Europe's demographic future: Facts and figures on challenges and opportunities*** EU 2007

[71] ***Low Fertility in Europe: Is there still reason to worry?***

[72] See http://www.imf.org/external/pubs/ft/gfsr/2012/01/pdf/c4.pdf

[73] http://www.aei.org/files/2007/09/19/20070919_070918_Eberstadt_g.pdf

[74] http://www.aei.org/article/foreign-and-defense-policy/regional/india-pakistan-afghanistan/indias-demographic-outlook-implications-and-trends/

[75] Royal Society ***People and the Planet p.***69. Note also the Royal Society's judgement about what ought to be the trend … "Beyond 2050 it is difficult to avoid the conclusion that a gradual and equitable decline in numbers will serve humanity best, alleviating pressure on resources and increasing personal opportunities in future generations." p.89

[76] O'Neill et al 'Demographic change and carbon dioxide emissions', Lancet 10th July 2012

[77] http://www.popoffsets.com/pdf/Fewer%20emitters%20lower%20emissions%20report%20Aug%2009.pdf

[78] www.un.org/millenniumgoals/pdf/MDG_FS_5_EN_new.pdf and http://www.un.org/millenniumgoals/maternal.shtml For the connection between the latest WPP revision and access to reproductive health see ***Our Overcrowded Planet: A Failure of Family Planning*** Yale 360 http://bit.ly/11JYj8y

[79] See http://www.populationmatters.org/2009/press/development-lobby-disgrace-population/

[80] http://populationmatters.org/about/policy-goals/

[81] See footnotes 1 and 2 which explain this particular reference to Friends of the Earth, which I have left in place in view of its relevance to these concluding observations

[82] http://www.monbiot.com/2009/09/29/the-population-myth/

[83] The precise figures in ***WPP 2012*** table S.2 (which are cited for consistency) are: 1950: 50.616m; 2013: 63.136m; 2025: 67.210m; 2050: 73.131m; and 2100: 77.175m. The projection for 2050 and 2100 of ***WPP 2002***, just a decade earlier, were 66.166m and then 64.375m. The current ONS principal projection, prepared on a different basis, has the UK 2060 population as 81.5m and 2010 as 97.0m

Statistical Appendix

As referred to in paragraphs 18 and 24, a comparison between successive revisions of the UN's World Population Prospects since 2002 demonstrates a pattern of upward movement in the global projections, and both upward and downward in the individual country ones. An explanation of the factors involved in such revisions is in WPP 2012 page 6; and see endnote 28.

*Change in UN **2050** global population projections in successive WPP revisions*

Scenario	2002 projection	2004	2006	2008	20010	2012	Absolute change	% change
Low	7.41 bn	7.68	7.79	7.96	8.11	8.34	0.93bn	12.6%
Medium	8.92 bn	9.08	9.19	9.15	9.31	9.55	0.63bn	7.1%
High	10.63 bn	10.65	10.76	10.46	10.61	10.85	0.22bn	2.1%

*Change in UN **2100** global population projections in successive WPP revisions*

Scenario	2002 projection	2010	2012	Absolute change	% change
Low	5.49 bn	6.18	6.75	1.26bn	23.0%
Medium	9.06 bn	10.13	10.85	1.79bn	19.8%
High	14.02 bn	15.81	16.65	2.63bn	18.8%

*Change in UN **2100** population projections for individual countries between 2010 and 2012 WPP revisions*

Africa	Population 2013 millions	Population 2100 2010 projection	Population 2100 2012 projection	Change between projections	Change 2013-2100 2012 projection
Malawi	16.4	129.5	85.0	-34%	+418%
Burkina Faso	16.9	96.4	75.3	-22%	+346%
Ghana	25.9	67.2	57.2	-15%	+121%
Rwanda	11.8	42.3	36.2	-14%	+207%
Zambia	14.6	140.3	124.3	-11%	+751%
Benin	10.3	36.8	33.0	-10%	+220%
Kenya	44.4	160.0	160.4	+0%	+261%
Egypt	82.1	123.2	135.2	+10%	+65%
Madagascar	22.9	94.2	105.1	+12%	+359%
S Africa	52.8	54.5	64.1	+18%	+21%
Uganda	37.6	171.2	204.6	+20%	+444%
DR Congo	67.5	212.1	262.1	+24%	+288%
Nigeria	173.6	729.9	913.8	+25%	+426%
Mali	15.3	80.5	100.8	+25%	+559%
Senegal	14.1	44.1	58.2	+32%	+313%
Ivory Coast	20.3	56.4	76.2	+35%	+275%
Chad	12.8	43.7	63.3	+45%	+395%
Mozambique	25.8	77.3	112	+45%	+334%
Niger	17.8	139.2	203.8	+46%	+1045%
Zimbabwe	14.2	21.8	32.6	+50%	+130%
Cameroon	22.3	53.7	82.4	+53%	+270%
Ethiopia	94.1	150.1	243.4	+62%	+159%
Burundi	10.2	14.6	56.3	+286%	+452%

Asia	Population 2013 millions	Population 2100 2010 projection	Population 2100 2012 projection	Change between projections	Change 2013`-2100 2012 projections
Afghanistan	30.6	110.9	59.2	-47%	+93%
India	1252.1	1550.9	1546.8	-0%	+24%
Pakistan	182.1	261.3	263.3	+1%	+45%
Philippines	98.4	177.8	187.7	+6%	+91%
China	1385.6	941	1085.6	+15%	-22%
Bangladesh	156.6	157.1	182.2	+16%	+16%
Indonesia	249.9	254.2	315.3	+24%	+26%

Europe	Population 2013 millions	Population 2100 2010 projection	Population 2100 2012 projection	Change between projections	Change 2013-2100 2012 projections
Germany	82.7	70.4	56.9	-19%	-31%
Spain	46.9	45.0	41.7	-7%	-11%
Italy	61.0	55.6	54.6	-2%	-10%
France	64.3	80.3	79.1	-1%	+23%
UK	63.1	75.7	77.2	+2%	+22%

~ ANTHONY RAE FOUNDATION ~

The Anthony Rae Foundation was founded in 2009 and now has four 'divisions':

Funding – its purpose is to 'to support environmental research and campaigning activity, particularly in the areas of Climate Change and Biodiversity' and aims to distribute about £40,000 per annum. Funding is also provided via the Network for Social Change.

Analysis – providing the Friends of the Earth analysis for its aviation campaign in recent years. ***Global Population*** is the first publication via my Foundation, to be followed by ***UK Population*** in 2014. I've also prepared an unpublished housing analysis for FOE.

Information – the Environmental Aggregator Twitter feed provides a daily compilation of environmental campaigning news and information. Thousands of tweets and no opinions.

Campaigns – my portfolio of local, regional and national environmental issues.