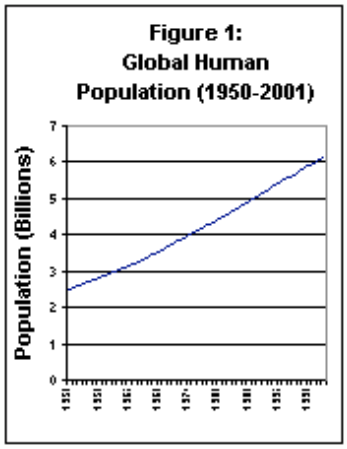
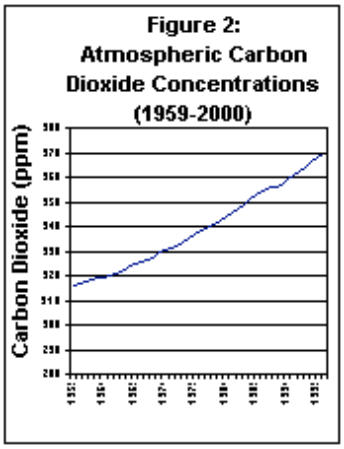
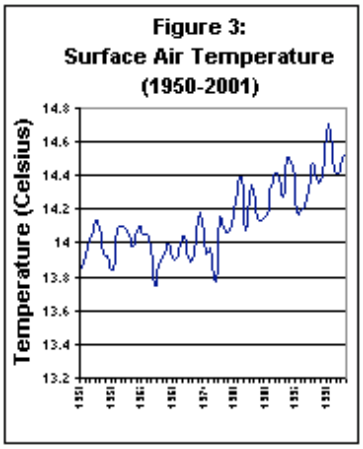
Executive Summary:
Population Dynamics and Global Climate Change







Population and Global Warming: Science and Policy Issues

- The dramatic increase in human population since 1950 has been paralleled by two other significant trends: the rapid rise of both atmospheric carbon dioxide levels and average global temperatures. (FIGURES 1, 2 and 3) While the relationships among these three rising trends are complex, the underlying facts are simple. As the population has increased from 2.5 billion in 1950 to 6.2 billion in 2002, people have progressively consumed greater amounts of fossil fuel and engaged in more activities, such as deforestation and the production of certain chemicals, all of which produce carbon dioxide and other greenhouse gases.

- There is broad agreement in the international scientific community that these greenhouse gases have increased the temperature of the earth and will continue to do so at an accelerating rate in the coming decades if current trends persist. In 2001, the Intergovernmental Panel on Climate Change (IPCC), an international, UN-sponsored panel of several thousand scientists, concluded that "most of the warming over the past 50 years is likely to have been due to the increase in greenhouse gas concentrations" (Intergovernmental Panel on Climate Change 2001). The 1990s were the warmest decade in the 20th century, and 1998 and 2001 were the hottest years ever recorded.

- The IPCC scientists now estimate that if emission trends continue, CO_2 levels will double by the middle of this century from their pre-industrial levels, and the global mean surface temperature will rise from 1.4 to 5.8 degrees Celsius (2.5 to 10.4 degrees Fahrenheit) between 1990 and 2100 (Intergovernmental Panel on Climate Change 2001). Due to the persistence of greenhouse gases in the atmosphere, warming will continue for at least several decades after greenhouse gas concentrations reach a peak.

- Because of the predicted serious negative impacts of global warming, these findings illuminate the critical link between population and climate change. The size of the human population and its activities in the 21st century will be a major factor driving the extent of warming. Likewise, the impact of warming on humanity will be greatly affected by population size; greater human numbers may reduce the options for mitigating or adapting to sea level rise, changes in precipitation patterns, and other by-products of warming.

The Effect of Population on Climate Change

- Beyond the parallel rising global trends of population and greenhouse gas emissions, the situation is somewhat more complicated. On a per capita basis, global carbon dioxide emissions from the combustion of fossil fuels rose from 0.3 metric tons (mt) per person in 1900 to 1.1mt in 1970 and have remained relatively flat since then (Carbon Dioxide Information Analysis Center 2002). On a global scale, the substantial increases in total emissions over the last three decades correlate closely with population growth (Meyerson 1998a, Meyerson 2002). (FIGURE 4)

- Global per capita emission figures, however, obscure huge disparities in per capita emissions by country. The average person in the United States contributed 5.4 tons of CO_2 to the atmosphere in 1998, five times as much as the average Mexican, and 19 times as much as the average Indian (Carbon Dioxide Information Analysis Center 2002). In 1995, the 20 percent of the world's population living in countries with the highest per capita emissions contributed 63 percent of the world's fossil-fuel CO2 emissions. The low emitters - the 20 percent of world population at the opposite end of the spectrum - contributed just two percent of global fossil fuel CO2 (Engelman 1998).

- Furthermore, a rapid increase in the population of a country with small when per capita emissions can contribute to high national emissions later, when population growth may have slowed or stopped altogether and per capita emissions continue to rise (Engelman 1998). Inequality in distribution of wealth may also mean that a small percentage of the population of a country may be responsible for a large share of greenhouse gas emissions.

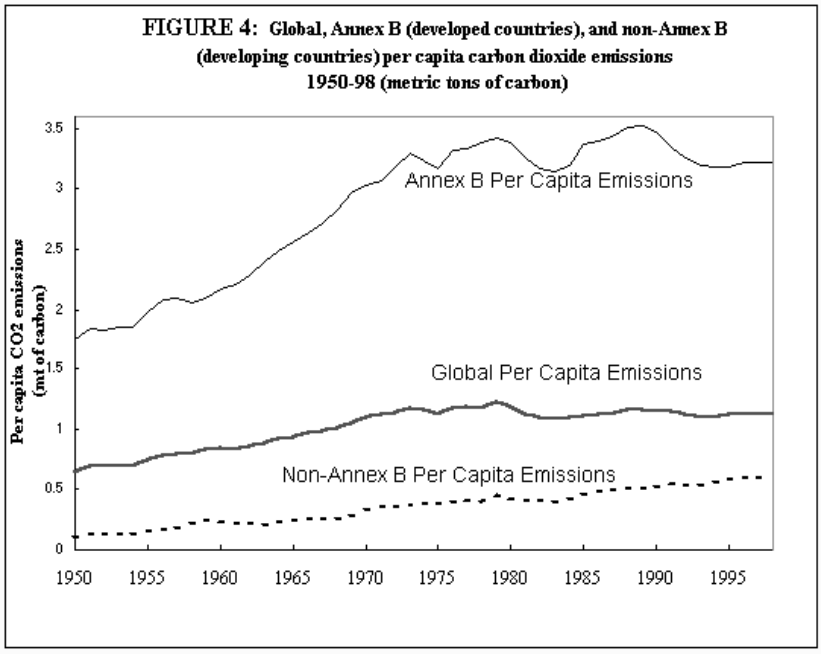
Population, the Kyoto Protocol and Per Capita Emissions Trends

- The 1997 Kyoto Protocol to the Framework Convention on Climate Change, if ratified, would commit the 38 developed (Annex 1) countries to cut their national emissions of greenhouse gases by an average of 5.2 percent between 1990 and 2010. Developing nations face no specific emissions limitation obligations in the Protocol, on the principle that industrialized nations have contributed the most to the problem and thus have an obligation to take the first steps (United Nations 1997).

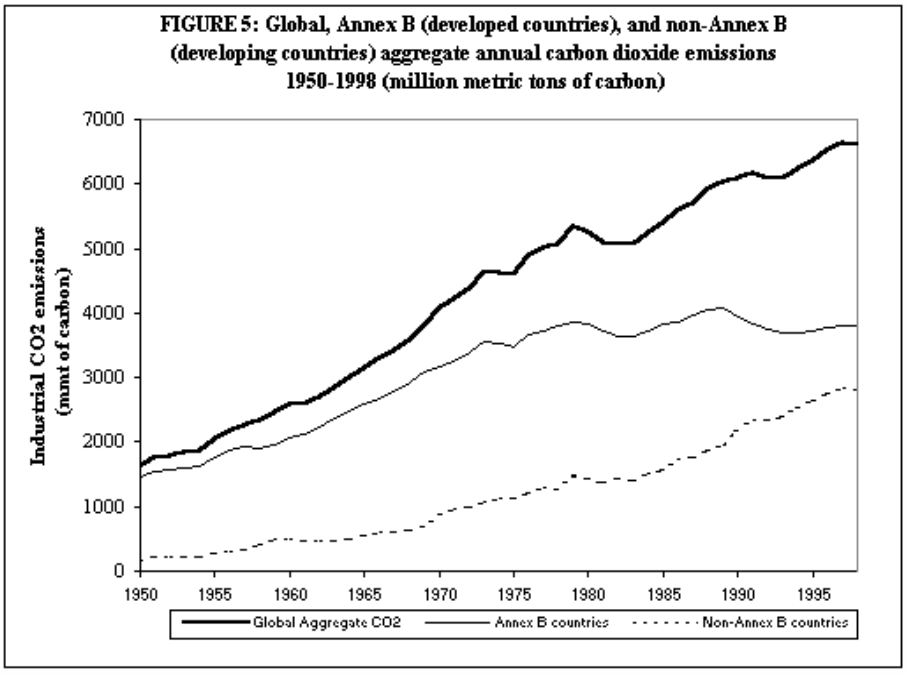
- Population is not specifically referenced in the Kyoto Protocol, but it is factor that will play a major role both in terms of compliance with the Protocol and with respect to future climate policy negotiations. The Protocol is based on national caps that will not be adjusted for increases or decreases in population due to either fertility or migration. Thus, for example, while the United States' population is projected to rise by 24% from 1990-2010, and Italy's population is projected to decline by 1%, both countries must make approximately the same level of emissions reduction (Meyerson 2002). Since population increases result in more houses, cars, and therefore, emissions, countries with rising populations are at a comparative disadvantage under the national

cap formula used in Kyoto (Meyerson 1997).

- This effect is particularly relevant because of recent trends in per capita emissions. For the developed countries as a whole, per capita emissions have been relatively flat since 1970, fluctuating between 3 and 3.5 mt per person. Developing country emissions are far lower on a per capita basis, but the gap is narrowing, in both per capita and absolute terms. In 1950, the developing country per capita average emission was only 0.1 mt, but it rose to 0.58 mt by 1998 (Carbon Dioxide Information Analysis Center 2002, Meyerson 2002). (FIGURE 4) The aggregate emissions of the developing countries are also increasingly rapidly and are expected to surpass those of the developed countries within the first few decades of the next century, as a result of both rising population and per capita emissions in the developing world. (FIGURE 5)



- On an individual basis, some developing (non-Annex 1) countries, such as South Korea and South Africa, already produce per capita emissions that exceed those of some developed (Annex 1) countries, such as Portugal, Switzerland and Romania. China, with its enormous population and rising per capita emissions, is projected to surpass the United States as the largest contributor to greenhouse gases within the next few decades.



- Whether or not the Kyoto Protocol is ratified, it is evident that a future global climate change agreement will need to incorporate the concepts of population growth and decline, international migration, and changing relative levels of per capita emissions (Meyerson 1998b). While developed countries have been the dominant source of greenhouse gas emissions in the past, developing country emissions will be the major factor in the twenty-first century, and a future treaty will need to respond to this coming demographic reality.

The Effect of Climate Change on Population

- The projected impacts of global warming on the human species are a serious concern. For instance, the IPCC's "best estimate" scenario projects a sea-level rise of about half a meter by 2100, with a range of 9 to 88 centimeters, substantially greater than the increase over the last century. The ecological and human impacts of rising oceans would be substantial, including increased flooding, coastal erosion, salination of aquifers, and loss of coastal cropland and living space (Intergovernmental Panel on Climate Change 2001). The frequency and intensity of hazardous weather, such as cyclones and droughts, would likely increase.

- A warming climate also poses a significant public health threat. Higher average temperatures mean longer and more intense heat waves, with a corresponding potential for more cases of severe heat stress. The redistribution of precipitation patterns would markedly increase the number of people living in regions under extreme water stress (Hadley Centre for Climate Prediction and Research 1998), a problem that would be compounded by increasing population. The geographical range of temperature-sensitive tropical diseases, such as malaria and dengue fever, would also expand (Epstein et al. 1998).
- The combined effects of population growth and climate change are likely to produce shortages that result in the exploitation of environmentally sensitive areas such as hillsides, flood plains, coastal areas, and wetlands. Biodiversity and fragile ecosystems could be at great risk. These conditions may also increase environmental refugees and produce large number of international migrants and related socio-political challenges.

Conclusions

- In the 20th century, the near quadrupling of human population and more than tripling of per capita carbon

dioxide emissions created a situation in which the human species now has a significant impact on the earth's climate. Future demographic trends will likewise affect the climate. There is a substantial difference between the U.N. low projection, in which the population would peak at around 7.9 billion in 2050, and the U.N. high projection, in which the world population would increase to 10.9 billion in 2050 and continue to grow rapidly (United Nations Department for Economic and Social Information and Policy Analysis Population Division 2000). The actual outcome will depend on fertility and mortality trends and access to reproductive health services and education, particularly in the developing world where most of the growth will occur. Which path the population takes over the next fifty years will have a major impact on the extent of global warming and its economic, social and environmental consequences.

- A world which has 8 rather than 10 or 11 billion people in the 21st century is likely to result in milder impacts from climate change, such as sea-level rise and changes in agriculture, storm frequency and precipitation, and more opportunities for migration, adaptation, and the protection of human welfare.

This executive summary was produced in February 2002 by Dr. Frederick A. B. Meyerson of Brown University in cooperation with the Population Resource Center. Resources cited: (1) Carbon Dioxide Information Analysis Center, 2002. Global, Regional, and National Fossil CO_2 Emissions. http://cdiac.esd.ornl.gov/ (2) Engelman, R., 1998. Profiles in Carbon: An Update on Population, Consumption and Carbon Dioxide Emissions. Population Action International, Washington, D.C. (3) Epstein, P. R., H. F. Diaz, S. Elias, G. Gradherr, N. E. Graham, W. J. M. Martens, E. Mosley-Thompson, and J. Susskind, 1998. Biological and Physical Signs of Climate Change: Focus on Mosquito-Borne Diseases, *Bulletin of the American Meteorological Society* 79: 409-417. (4) Hadley Centre for Climate Prediction and Research, 1998. Climate Change and its Impacts. The U.K. Meteorological Office and DETR, London. (5) Intergovernmental Panel on Climate Change, 2001. http://www.ipcc.ch. (6) Meyerson, F., 1997. Pollution and Our People Problem, Page A21. *The Washington Post*, Washington, D.C. (7) Meyerson, F. A. B., 1998a. Population, Carbon Emissions, and Global Warming: The Forgotten Relationship at Kyoto. *Population and Development Review* 24: 115-130. (8) Meyerson, F. A. B. 1998b. Toward a Per Capita-Based Climate Treaty: A Reply. *Population and Development Review* 24: 804-810. (9) Meyerson, F.A.B., 2002. "Population and Climate Change Policy". Chapter 9 in Schneider, S., et al. (ed.s), *Climate Change Policy*. Island Press, Washington, D.C. (10) United Nations, 1997. Conference of the Parties, Third Session. *Kyoto Protocol to the United Nations Framework Convention on Climate Change*, United Nations, Kyoto, Japan. (11) United Nations Department for Economic and Social Information and Policy Analysis, Population Division, 2000. World Population Prospects: The 2000 Revision. United Nations, New York. Data Sources: Figure 1: United Nations (see [11] above for full citation), Figure 2: Scripps Institution of Oceanography, Figure 3: Goddard Institute for Space Studies. Figures 4 and 5 were modified and updated with the permission of the Population Council, from Frederick A. B. Meyerson, Population, Carbon Emissions, and Global Warming: The Forgotten Relationship at Kyoto. *Population and Development Review* 24: 115-130 (March 1998).