THE ENVIRONMENT-POPULATION NEXUS[1]

Amulya Reddy

1. I would like to stress at the outset that I am neither a population nor an environment expert. My preoccupation for two decades has been with energy. Energy, however, is intimately connected with environment and population, and as a result, I have considered some environment-related and population-related energy issues. In the matter of population and environment, I have had occasion to consider:

   - how specific energy measures can influence desired family size[2]
   - how different sections of the population in developing countries have different CO_2 emissions[3].

2. With this very limited background, I have read the papers of Holdren and Martine on the environment-population nexus. While my analytical approach is much more in tune with that of Holdren, I am moved by some of the concerns of Martine. I believe, however, that the differences are perhaps reconcilable to a great extent with a *multi-world model* that I have developed on the back of an envelope for this *ad hoc* discussion.

3. The IPAT approach to the environment-population nexus is based on an equation:

   Impact = Population x (Consumption/Population) x (Impact/Consumption)
   = Population x Per Capita Consumption x Impact Intensity

   which, since Per Capita Consumption is a measure of Affluence, and Impact Intensity (Environmental Impact per Unit Consumption) is determined by Technology, can be written in a generalized form as IPAT or

   Impact = Population x Affluence x Technology

4. In the special case of energy and CO_2 Emissions, the IPAT equation reduces to

   Emissions = Population x (Energy Consumption/Population) x (Emissions/Consumption)
   = Population x Per Capita Energy Consumption x Emissions Intensity

---

1. This note was prepared for an invited informal presentation at the MacArthur Foundation, Chicago, on July 1, 1994, at 10 am at which Dan Martin and Carmen Barroso of the MacArthur Foundat ion and Lincoln Chen of Harvard University were present.

2. Batliwala, Srilatha and Reddy, Amulya K.N., Energy Consumption and Population , Session on Linkages between Population, Natural Resources and the Environment at the POPULATION SUMMIT OF THE WORLD'S SCIENTIFIC ACADEMIES, New Delhi, October 24 -27, 1993 (in press).

3. Reddy, Amulya K.N., A Development-focused Approach to the Environmental Problems of Developing Countries presented at the Conference on GLOBAL ENVIRONMENT, ENERGY AND ECONOMIC DEVELOPMENT, October 25-27, 1993, United Nations University, Tokyo (in press).

Impact $I = P . e . i$

5. The IPAT equation in general, and the above emissions equation in particular, is self-evident; in fact, it is a matter of definition. It assumes, however, that the world to which it applies has a homogeneous un-stratified population, i.e., the whole population has the same affluence and uses the same technology, or in the case of energy, has the same per capita energy consumption and uses the same energy technology. If, however, the world is not homogeneous and the population is stratified, then there has to be a different IPAT or $I = P e i$ equation for each of the homogeneous population strata into which the total population is stratified.

6. **Two-world Model**: If, for instance, a two-world model is considered in which there is a stratification into two populations, and *it can be assumed that the emissions of the two populations are additive*, then

$$\text{Total Impact } I = I_1 + I_2$$
$$= [P_1 . e_1 . i_1] + [P_2 . e_2 . i_2]$$

If, for instance, 1 and 2 represent the imperial countries and the colonies respectively in the last century, it is believed that $I_1 >> I_2$ which implies that $[P_1 . e_1 . i_1] >> [P_2 . e_2 . i_2]$. The confirmation of such a view requires substantiation with empirical time-series data on P_1, e_1, i_1, P_2, e_2 and i_2. The assignment of historical responsibility for degradation of the global atmosphere -- if at all necessary for policy purposes -- must be based on such hard statistical analysis.

7. **Three-world Model**: If, on the other hand, a three-world model is considered in which there is a stratification into three populations, and once again, it can be assumed that the emissions of the three populations are additive, then

$$\text{Total Impact } I = I_1 + I_2 + I_3$$
$$= [P_1 . e_1 . i_1] + [P_2 . e_2 . i_2] + [P_3 . e_3 . i_3]$$

Here, the subscript 1 can be used to represent the population in the industrialized countries, 2, the elites of developing countries and 3, the masses of the developing countries.

In terms of this formulation, the conclusion $I_1 >> I_2 >> I_3$ is valid if $[P_1 . e_1 . i_1] >> [P_2 . e_2 . i_2] >> [P_3 . e_3 . i_3]$ in which case

$$\text{Total Impact } I = \bullet\ I_1 + I_2$$
$$\bullet\ [P_1 . e_1 . i_1] + [P_2 . e_2 . i_2]$$

and firstly, the environmental impact is an overwhelmingly *urban* phenomenon, and secondly, population is a relatively less important factor because P_1 and P_2 are much less than P_3.

8. But, all these conclusions and implications cannot be made in an *ex cathedra* manner; they require a great deal of patient and rigorous empirical analysis. For instance, there has been very little work in disaggregating the total carbon emissions according to even this over-simplified partitioning of the global population. The problem is that it is necessary to determine the usage of net-carbon-emitting end-use devices by these population groups.

9. Unfortunately, there are many glib generalizations in vogue. For instance, it is a fact that rural poor in developing countries use fuelwood for cooking, but to assert that this leads to net carbon emissions, it is necessary to prove that they get their fuelwood non-renewably by the felling of trees. But, in many regions of the Third World (for example, Southern Karnataka), empirical studies have shown that women and children are the fuelwood-gatherers and they gather fallen twigs and branches which means that their cooking practices do not harm the global atmosphere to any significant extent.

10. Notwithstanding the difficulties of research, there are many advantages to be derived from patient and rigorous empirical analysis. In particular, there would a far better understanding of the environment-population nexus in all its rich complexity. And what may be of greater importance is the possibility of developing a richer variety of interventions to reduce population growth rates. It may even be possible to evolve a least-cost mix of population-reduction interventions to guide foundations interested in making an impact on the problem.

FILENAME:JH073094.DOC July 30, 1994