Global environmental resources versus world population growth

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ABSTRACT

To secure a quality life for current and future generations, sufficient land, water, and energy must be available. Worldwide today there is evidence that food production and distribution processes are problematic; more than 3.7 billion humans are now malnourished. With the imbalance growing between population numbers and vital life sustaining resources, humans must actively conserve cropland, freshwater, energy, and biological resources. There is a need to develop renewable energy resources. Humans everywhere must understand that rapid population growth damages the earth's resources and diminishes human well being.

What will be required of us to secure a quality life for future generations in the world? Will there be sufficient land, water, energy and biological resources, to provide adequate food and other essential human needs? Threatening to overwhelm the availability of these basic world resources are the fundamental needs for food and other human resources required by the expanding human population.

1. Trends in food production

Clear evidence suggests that worldwide problems with food availability already have emerged. According to the World Health Organization (Indian Express, 2003) more than 3.7 billion people now are malnourished – the largest number and proportion ever reported. Concurrent, many serious diseases, like malaria, HIV/AIDS and tuberculosis, are increasing not only because of worldwide malnutrition but also because the increasing density and movement of human populations facilitate the spread of diseases (McMichael, 2001).

Cereal grains comprise about 80% of world's human food intake making their sustained availability vital to human survival (Pimentel et al., in press). Disturbing reports from the United Nations Food and Agriculture Organization (FAO, 2002a) indicate per capita availability of basic cereal grains has been decreasing for the past 20 years. Thus far, despite all the advances in biotechnology and agricultural technologies, per capita grain production has continued a slow decline since 1984 (FAO, 2002a).

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2. Impacts on global resources

2.1. *Cropland status*

More than 99.9% of the human food supply (calories) comes from the land, and less than 0.01% from oceans and other aquatic ecosystems (FAO, 2002b). Now, when food production should be increasing to meet human nutrition needs, the per capita availability of world cropland has declined 20% during the past decade (Worldwatch Institute, 2001). Yearly, more than 10 million ha of valuable cropland are degraded and lost because of wind and water erosion of soil (Preiser, 2005). In addition, each year an added 10 million ha of cropland are being lost because of salinization caused by irrigation (Thomas and Middleton, 1993).

Combined, world soil erosion and salinization are responsible for causing major losses of productive cropland. Per capita irrigation in arid regions is declining and this diminishes suitable cropland for food-crop production (Pimentel and Wilson, 2004).

Along with the loss of cropland and irrigated land, per capita fertilizer use worldwide is declining and these changes are suppressing food-crop production, especially in developing countries (Pimentel and Wilson, 2004). Furthermore, valuable forest areas are being permanently destroyed to replace lost cropland (Pimentel et al., in press).

Globally, an average of only 0.23 ha of cropland per capita now is available for crop production. In contrast, 0.5 ha per capita is available to support the diverse food system of the U.S. and Europe (Pimentel and Wilson, 2004). At present, cropland in the U.S. now occupies 17% of the total land area, and relatively little additional cropland is available to support the future expansion of U.S. agriculture (USDA, 2003).

2.2. *Freshwater availability*

Adequate quantities of freshwater, which support the very survival of every plant and animal on earth, are in short supply in many regions of the world. A human requires slightly more than 1 l of drinking water each day. In contrast, to produce the food to feed a human each day requires more than 1600 l of water (Pimentel et al., 2004).

More than 70% of all available freshwater is used in world agriculture (UNESCO, 2001). For example, to produce 1 ha of corn requires 5 million l of water/ha (more than 500,000 gal per acre) (Pimentel et al., 2004). As populations continue to increase, more freshwater will be consumed and water conflicts within and between countries will escalate (Pimentel et al., 2004).

2.3. *Energy*

Human, animal, and fossil energy power diverse human activities, and are essential for food production and industry, as well as for the delivery of fresh, clean water where needed. Agriculture in industrialized nations uses enormous quantities of fossil energy for such inputs as fertilizers, pesticides, the manufacture and operation of farm machinery, and the powering of irrigation systems. For example, to produce 1 ha of corn or rice requires approximately 1000 l of oil equivalents (Pimentel et al., 2002a). In developing countries, expensive fossil energy is replaced by human and animal power to provide the needed energy for crop production.

Americans lead the world in fossil energy use. An average American consumes about 11,000 l of gasoline energy-equivalents each year (USCB, 2004). Because of this high-fossil energy use, plus the lack of adequate domestic sources, the U.S. now imports 62% of its oil. Given the population expansion, the importation of oil will have to increase.

Fossil fuels are finite energy resources! Reliable projections are that oil and natural gas reserves of the world will last another 40 years (Salameh, 2005). U.S. coal is expected to last 50 to 100 years, depending on how fast it is substituted for oil and gas. However, the processing of coal into oil and gas will contribute to air pollution and global climate change. Hydrogen can be converted into a fuel. To do this requires the input of 3.7 kcal of fossil energy to produce 1 kcal of hydrogen energy, plus use of considerable water (Pimentel et al., 2002b).

2.4. *Prospects for renewable energy*

Currently the U.S. population uses about 100 quads of energy each year and this will continue to increase as the population continues to grow (USCB, 2004–2005). Therefore as fossil energy sources are being depleted, all renewable energy sources must be investigated and priority given to their use. Depending on the geographic region, the most reliable of the potential renewable sources are wind power, photovoltaics, solar thermal, and biomass energy. Even when all of these solar-based technologies are perfected and fully operational, they are expected to provide only about half, or nearly 50 quads of energy of the current U.S. consumption of fossil energy. Furthermore, the renewable energy sources will occupy about 17% of additional land area required to collect the solar energy (Pimentel et al., 2002b). Some of this land requirement would compete with cropland, pasture and forest land.

2.5. *Roles of biodiversity*

Millions of plant, animal, and microbe species in our global environment carry out essential functions especially for agriculture, forestry, and aquatic systems. These include pollination of crops, soil formation, biological pest-control, and recycling wastes. Maintaining the health and integrity of the global environment enhances the quality of human life.

2.6. *Climate*

Escalating global-climate change due to the burning of fossil fuels is predicted to have negative impacts on agriculture, public health and the environment (Patz et al., 2000). Some atmospheric changes already are apparent and these influence rainfall patterns and the availability of water resources, temperatures and the length of cropping seasons, and ultimately food production. Along with climate change are increases in crop pests, as well as insect vectors of diseases, like malaria.

2.7. *Chemical pollution*

The pervasive use of chemicals throughout the world impact human health, other animals and plants and present a serious constraint to ensuring sustainability. Chemical exposures are documented to contribute to a variety of serious human diseases. These include cancer, birth defects, immune system defects, reduced intelligence, behavioral abnormalities, decreased fertility, altered sex hormones, altered metabolism, and specific organ dysfunctions (Carpenter et al., 2002).

3. Population impacts on natural resources

Will the future survival of the largest human population ever inhabiting the earth be further threatened by insufficient natural resources? Obviously more people will require and indeed use the basic resources. Unless resources can be conserved, the shortages will have negative impacts on human life.

The present world population of 6.5 billion is projected by the United Nations to increase to 9 billion and may eventually reach as many as 11 billion by 2050 (UN, 2004). Even if a worldwide policy of 2 children per couple, instead of the current 2.8 children, were agreed on tomorrow, the world population will continue to expand for about 70 years before stabilizing at about 13 billion people (Pimentel and Wilson, 2004). China, with a policy of 1 child per couple, will add about 8 million to its population this year because of its young-age structure (PRB, 2004). Furthermore, population momentum depends on the young age structure of the current world population, which propels the speed of growth (Why Population Matters, 2005). Note, 40% of the world population is under the age of 20 years (PRB, 2004).

Recent studies of environmental refugees throughout the world reveal that their numbers are increasing at an alarming rate and such movements of human populations contribute to global insecurity (Myers and Kent, 2005). These refugees are fleeing income disparity and shortages of food, cropland, freshwater, biomass fuel, and other essential resources needed for survival. Furthermore, the rapid growth in world population, according to the United Nations, provides a potential breeding ground for terrorists and threatens global security (UN, 2005).

4. Implications of free immigration

The U.S. population of 300 million is increasing rapidly, not only because of the 1 million legal immigrants, but also because of the more than 400,000 illegal immigrants, who enter the United States each year (USCB, 2004). The U.S. has one of the fastest growing populations in the world. In fact, the U.S. population growth rate is nearly twice that of China (PRB, 2004). At the current growth rate, the U.S. population could easily double to about 600 million in about 70 years (PRB, 2004).

The U.S. population problem is two-fold, and centers on both the legal and illegal immigration policies. Concerning the legal immigration regulations, the Bureau of Census data suggests that the U.S. population could stabilize in about 70 years if an immigration rate of 200,000 per year were established (Bouvier et al., 1995). This 200,000 immigration figure is about the level that was traditional for the United States from 1776 to 1945. If adopted, it would again be an ideal level of immigration for the United States.

Halting the influx of illegal immigrants into the U.S. is paramount! Their easy entrance into the U.S. is imposing enormous economic burdens on all Americans, and especially on those living in the border states. Illegals are a special financial burden on our educational and health systems. Securing the U.S. borders over vast areas is a difficult task, but urgent. There are numerous traffickers who regularly transport illegals, including terrorists across the border. Certainly, the U.S. businesses hiring illegals perpetuate the illegal system and should be prosecuted.

The present high rate of legal and illegal immigration and the current U.S. birthrate, result in the yearly addition of 3.3 million people to the U.S. population of 300 million. If this growth continues, more food will need to be produced and this further stresses cropland availability. In addition to food, each person added to the U.S. population requires an additional 0.4 ha (1 acre) of land just for highways and urbanization. California, with one of the highest rates of immigration, is losing 100,000 ha each year of its valuable farmland needed for urbanization and highways (USCB, 2004). For many decades, California has been one the highest producing agricultural states, but it is fast losing this distinction. Under stress of population needs, California already has a serious shortage of water and is mining their aquifers dry.

Neither restricting nor maintaining a high rate of legal immigration in the U.S. will solve the world population or the global environment problem. With the U.S. accepting 1 million legal immigrants, this is only about 1% of the total number of people added to the world population each year. Globally, there are 85 million people being added to the world population each year (PRB, 2004). Clearly, overpopulation is a global problem and is most notable in China and India, plus many developing countries.

Each nation, including the U.S., must learn to live within the carrying capacity of its population and natural resources. This is not to suggest that there should be no global trading, but that each nation must determine how it will pay for its global imports. Of course, this depends on the population numbers and the availability of its natural resources. Hopefully, globalization and free markets will be supported by all world governments.

5. Global standard of living

We suggest that a reasonable standard of living would be to reduce U.S. consumption of goods and energy by one-half. For instance, It has been documented that when the U.S. runs out of oil, natural gas, and coal and has to rely only on renewable energy, renewable energy sources will be able to provide only about half or slightly more than 5000 l of oil equivalents instead of the current 11,000 l of oil equivalents now used each year (Pimentel et al., 2002b).

Clearly this will mean drastic changes in energy use and changes in the American lifestyle. Overall energy conservation and efficiency of energy use is paramount. Some other major changes would include: smaller automobile size with double the gasoline efficiency; significant reductions in the living space; reducing heating, cooling, and light energy expenses; improving the movement of goods by energy efficient methods; and reducing the recreational energy costs.

6. Population reductions

Concerning population numbers, each nation will determine its own family planning and environmental protection programs, because each nation knows best its population and environmental resource issues. In particular, AIDS is a devastating disease in most nations of the world. For any nation to dictate whether condoms should or should not be used is an insult to the people of all nations and affects the health of adults and children in that nation. Scientific evidence has proven that condoms, when properly used, are 95% to 99% effective in preventing AIDS and other serious sexually transmitted diseases as well as unwanted pregnancies (Avert, 2005).

To halt the imbalance escalating between expanding population numbers and the earth's essential natural resources, humans must control their numbers while they make efforts to conserve cropland, freshwater, energy, biodiversity and the other life-supporting environmental resources. Certainly people in developed countries could contribute by reducing their high consumption of all natural resources, especially fossil fuels.

7. Future outlooks

Serious efforts must be made to improve our basic food crops, such as developing perennial grains and pest resistant crops, and improving the nutritional makeup of major crops. Concurrently, the transition to reliable renewable energy resources must be a focus.

Americans and humans everywhere must understand how damaging rapid human population growth is for individuals, for their continued well being and personal freedom. Each individual added to the global population not only diminishes the quality of human life and the availability of natural resources for all, but the share each individual can expect to receive.

Basically all the earth's resources are **finite** and are essential for the survival of human life. These resources must be valued and conserved for present and future generations.

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