Ecological Sustainability and Human Population Growth: Today's Challenges for the Future of Civilization

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Abstract. As humans across the world strive to increase the quality of life, natural resources are being increasingly strained. If all of humanity enjoyed a standard of living equivalent to the average US citizen, it would require 5.3 earths to sustain us. Compounding this is exponential world population growth, projected to reach 9 billion by 2050. The intersection of rapidly increased numbers of people seeking higher standards of living, and the unprecedented rate of depletion and deterioration of natural resources represents the tipping point for the earth's ability to sustain human life. This paper probes into the key challenges of human population increases, over-consumption of resources, and the role of Jesuit Universities to educate, transform, and lead by example.

The Central Problems

Technological advances and transhumanism

Technological advances over the past 250 years have allowed humans to transcend themselves, to live beyond their natural means, or in ecological terms, to exceed nature's carrying capacity for our species. This phenomenon, called transhumanism, springs from native human intellect with its enormous capacity to solve complex problems, its innate curiosity and drive to understand our universe and to attain more control over nature, expand the frontiers of our knowledge, and a drive to achieve an ever higher quality of life. Technological advances stimulate enormous historical advances in civilization. For example, in more recent history, developing artificial ammonium fertilizers (the 1909 Haber-Bosch process), herbicides, pesticides, and irrigation systems allowed for the increase in crop yields of up to 200x more per acre than nature alone can produce (Friedman, 2008). The Green Revolution has fed orders of magnitude more people on earth than nature can provide for, far exceeding our carrying capacity. The paradox of transhumanism is that while these advances were developed in the spirit of stopping worldwide hunger, the environmental destruction to soil, air and water systems that

ensued, and our runaway human population increases have been largely ignored. Likewise, the Industrial Revolution has led to our ability to live comfortably and even luxuriously at a relatively low price with the advent of mining natural resources, mass industrial production and cheap labor. These advances brought us textiles, electricity, automobiles, telephones and the world wide web; all relatively inexpensive, and highly accessible, especially in developed countries. Historically, humans have significantly transformed the natural landscape in areas of high population density through agricultural conversion, water diversion and extraction, urbanization and industrialization. Today human dominance on earth has physically changed the earth's surface (with expansive networks of highways, railways, cities, electrical lines, waterways, deforestation, agricultural landscapes, mountain top removal coal mining, etc.) to such a degree that there is increasingly less justification for linking pre- and post-industrialized Earth within the same epoch. Many geologists argue that we are living in a new geological era called the Anthropocene, an artificial ecology of our own making (Dalby, 2009).

In our quest to transcend nature's limits on life, human technological ingenuity offers both benefits and consequences. For example, we have developed clean, nuclear power but suffer from the radioactive waste it produces and the devastating use of this technology to make nuclear warheads. Modern medical developments are always racing to keep up with new emerging diseases like Lyme disease, SARS, HIV AIDS, as well as higher rates of ADHD, cancer, obesity and diabetes, and many of these health conditions are correlated with side effects of technological applications like industrial toxic pollutants, pesticides and herbicides, and ecosystem alterations induced by land use changes. Genetically modified corn designed to be resistant to specific herbicides produce impressively massive quantities of inedible corn, while the high fructose corn syrup it yields increases the rates of obesity and diabetes in Americans.

While frequent application of fertilizers enhance crop yields throughout the world, this practice comes at the cost of increasing numbers of near-shore dead zones in oceans due to fertilizers in the run-off, which are evidence of the negative repercussions to society, nature, and the earth. More over, recent advances in nanotechnology have enabled us to synthesize completely new chemical particles that have never existed on earth. The prospects for new technological advances with these new uncharted nanoparticles are enormous, even thrilling, yet, the environmental and biological side-effects are also completely untested, and could be disastrous. The ethical considerations of both biotechnology and nanotechnology are just now being considered, and even though every day more and more new genetically modified organisms and new nanoparticles are being released into the environment in the spirit of research and development, there is no governmental regulation on these infant branches of science.

An Ethical Conundrum

A deep ethical conflict lies within these "competing goods"; take, for example, the desire to cure diseases like malaria, and the consequences of developing new biotechnological techniques for the cure that can easily be abused for the production of bioterrorist weapons. Or the desire to stop world hunger by using industrialized agriculture techniques, versus the desire to stop agriculture-induced environmental degradation by greatly modifying agriculture to be more environmentally sustainable with a smaller yield. There is a moral conflict in the desire to extend the lives of people beyond the age of their natural death. As people age, they continue to consume common resources, and if their life is sustained on life supporting machines, the resources they consume each day are disproportionately high. Since these life-extending measures are only available to the wealthy, an additional wrinkle in the debate emerges. The

poor, whose share of common resources is being used by the wealthy, and those who will live in the future, whose share of common resources is rapidly dwindling, have a stake in this debate.

Transhumanism, then, is tied to the human desire for comfort, goods, pleasures and luxury, and has led to greater and greater demand for plentiful and cheap food, products, and energy, especially in developed countries. Industrial agriculture, factory animal farms, mass manufacturing of products, and cheap energy have been possible through the use of fossil fuels; and this coal and oil-based economic model has led to wealth in the west, and has begun to significantly increase GDP and quality of life in developing countries over the past few decades. Europeans and North Americans have been using coal, petroleum and natural gas to stimulate their growing economies for over 160 years, emitting billions of tons of greenhouse gases into our atmosphere, with no knowledge, until the last several decades, of the devastating environmental consequences (Gore, 2006). Because of the mounting evidence that burning fossil fuels leads to global climate change, the continue high level of 'use' of fossil fuels in developed countries, many feel, has become an 'abuse' or 'exploitation' with disproportionately high impacts on the poor.

Developing countries like China, India, and Vietnam are now taking their turn at growing their economies with fossil fuels, which points to another ethical conflict of competing goods. How can developing countries be denied the right to raise the quality of life by using fossil fuels to fuel their economies when the wealthy western world has become wealthy and continues to benefit from producing the vast majority of fossil-fuel based global climate change pollution?

International treaties, such as those attempted in Kyoto and more recently in Copenhagen, are efforts to avoid a contradiction of ethical demands through collective and comprehensive attempts at curbing the exploitation of fossil fuels to address global climate change. These

international mediations have not been as successful as hoped, in part, due to the sheer magnitude of complexity of the problem.

Global Climate Change

As a result of our ever growing technological advances and life style demands which require high quantities of energy, annual global emissions of CO_2 into the atmosphere from the burning of fossil fuels have been steadily rising since 1750, and have quadrupled since 1950. An estimated 265 billion tons of carbon have been released into the atmosphere since the Industrial Revolution. The United States has the highest per capita CO_2 emissions, Europe's being less than one half that of the U.S. To date, international climate change summits have tried to develop voluntary reductions in greenhouse gas emissions. To be fair, while the regulatory outcomes from international summits like the Copenhagen Conference have been minimal, this meeting marked the first time that all world leaders openly acknowledged that anthropogenic greenhouse gas (GHG) emissions are the major cause of Global Climate Change (GCC), and that life on earth will be extremely threatened if global warming surpasses a $2^{o}F$ temperature increase. The Intergovernmental Panel on Climate Change (IPCC), the multinational group of the worlds' leading climate experts has concluded that global atmospheric concentrations of GHG such as carbon dioxide, methane and nitrous oxide have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years. The global increases in carbon dioxide concentration are due primarily to fossil fuel use and land use change, while those of methane and nitrous oxide are primarily due to agriculture (IPCC, 2007). GCC will lead to an overall warming of the earth, an increase in frequency and intensity of catastrophic storm events, melting of polar caps and mountain glaciers, severe droughts in certain regions leading to desertification and wildfires, a

dramatic loss in crop production, shortages of freshwater, the spread of vector-borne diseases, and a loss of biodiversity and ecosystem functions. Collapsing ecosystem functions and loss of biodiversity produce a positive feedback to GHG emissions and GCC, by causing an imbalance in the biogeochemical cycling of water, carbon, nitrogen, sulfur and other elements critical for life on earth (IPCC, 2007). GCC will affect all creatures, humans and cultures, but the most vulnerable biomes are deserts, savannahs, and grasslands, and coastal areas, and the most vulnerable humans are the poor in developing nations living in dry habitats. These people will be affected first, and their resources for resistance and resilience will be the smallest.

Two Key Challenges:

Scientists who study these complex issues are concerned with two key challenges that arise from the aforementioned stresses and strains on our ecological and social systems. These two issues will increasingly and inevitably command our attention and require a response from world leaders and concerned citizens.

Growing world populations

Compounding the problem of worldwide increases in the use of natural resources and fossil fuels to power rapidly growing economies and support quality-of-life improvements, is the exponential rise in world population. The twentieth century witnessed an extraordinary growth of world population from 1.6 billion in 1900 to 6.8 billion today (U.S. Census Bureau, 2010). Eighty per cent of that increase occurred in the last 50 years, with the world's population currently growing at 1.2 per cent annually. Ninety-five per cent of current population growth is taking place in the less developed countries, where population growth is 2.5 per cent per year, or a population doubling time of 29 years (United Nations, 2000). At this rate, the present world population of 6.8 billion is projected to rise to over 9 billion by 2050 (United Nations, 2000).

From an ecological perspective, world populations can be expressed as density (number of people · km^{-2}) and density can be related to environmental carrying capacity. Between 1900 and 1950, world population density increased from 13 to19 people · km^{-2}, and today is 45 people · km^{-2} (0.18 people · $acre^{-1}$). The distribution of human densities today differs markedly between the more developed regions (average 23 people · km^{-2}) and the less developed regions (60 people · km^{-2}). The Earth has148 million km^2 of land (36.48 billion acres), however only 31 million km^2 (7.68 billion acres) of the total land on Earth is arable. The average density of humans on earth today is around 1 person per 1.13 arable acre. The majority of these people live at or near the poverty level, and consume very few resources. If every person on Earth today enjoyed a quality of life equivalent to the average American, for example, it would require the equivalent of 5.3 planet Earths to sustain the human species.

Most of the world population growth in the next 40 years will occur in developing countries like India, China and many African countries. The demographic age pyramid in these countries is very large at the base (most people are 25 years of age or younger), and diminished at the top, very few people over 75 years of age. In contrast, developed countries such as Japan, Russia, and most of Europe are now experiencing decreasing population densities, and aging demographics (Holt, 2004). Like Europe, the United States also has a declining rate of fertility, however, the immigration stream into the US is great enough to keep the country's overall population increasing at a low rate. Japan's demographic age pyramid is upside down, like a triangle standing on it's apex, with most people being over 25 years of age, and an ever dwindling recruitment of young into the population. One third of the citizens of Japan will be

over the age of 65 by the middle of this century, adding enormous burden on the shrinking working class to support them (Holt, 2004).

India will soon surpass China as the world's most populous nation with over 1.5 billion people. In the northern part of India, where there are high levels of illiteracy, birth rates average 6 births per woman. In the northern Indian culture, having sons assures protection in old age, so people continue to have more and more children to increase their chances of having more boys. Today, half the country is under 25 years old and reaching reproductive age (Holt, 2004).

Many countries in Africa have very similar trends in their population demographics. In Sub Saharan Africa for example, HIV AIDS has exacerbated the imbalance having too few adults and elders in relation to orphaned children. The global socio-political effect of reduced numbers of young in the developed countries compared with youth population explosions in developing countries is a huge generation gap among countries, which translates into a more polarized world society. Social scientists note that such disparities are potentially very destabilizing.

World population growth poses a complex and messy problem of competing "goods". The addition of another one third as many people to the planet in the next few decades is central to the environmental crisis, yet how can it be stopped? How can one set of cultures impose on others population control measures? Is the right to have several children sacred and desirable? Is the right to one's share of the common resources on the planet sacred and undeniable?

Rising conflicts over water and food

The demand for clean, fresh water has steadily risen with increasing population and socio-economic development. Consequently, the per capita availability of fresh water on a global basis has fallen to nearly one third of its 1950 level. At present, agriculture accounts for some 70

per cent of freshwater consumption worldwide (United Nations, 2000). Chronic water shortages exist in many areas where precipitation is low or unreliable and/or where withdrawals have significantly increased to meet additional demand from expanding irrigation, industry or urban populations. Assessments of the world's water resources are commonly measured in terms of the ratio of water withdrawals to water supply. A ratio of less than 10 per cent indicates few water resource management problems; a ratio of between 10 and 19 per cent points to water availability's becoming a limiting factor. When water withdrawals are in the range of 20 to 40 per cent, management of both supply and demand will be needed to guarantee sustainability. Use in excess of 40 per cent of available water indicates serious scarcity and usually an increasing dependence on desalination and a situation where groundwater is being used faster than it is being replenished. Water use has been growing at more than twice the rate of the population increase during the twentieth century. About one third of the world's population lives in countries experiencing medium-high to high levels of water stress (United Nations, 2000).

With increasing population densities the demands for fresh water resources is heightened. Water shortages are emerging everywhere, including Punjab which is the bread basket of India, and this results in a decline in food production (Holt, 2004). In the Western United States there have long been conflicts over which states have rights to how much water from the Colorado River. In the last several years, mountain top ice fields have diminished in the Western US, and meltwater which for centuries irrigated rich agricultural land, is severely reduced. Increased pressure on the Colorado River has decreased its water levels so that it now dries up in the Sonoran Desert long before it ever reaches Mexico. Desert and dry savannah biomes around the world are experiencing similar issues. In the Gaza Strip, Israel owns the water rights and has not allowed Palestinian farmers living in Gaza to dig deeper to obtain fresh water for crop irrigation

and to water their cattle. Similarly, in Yemen, 1 out of 3 people do not have access to fresh drinking water, and this number is expected to rise to 2 out of 3 by 2025. Mount Kilimanjaro is a classic example of a "fountain in the desert". The glaciers atop the mountain have supported human civilization and a lush biodiversity of plants and wildlife on the mountain and for miles around the base of the mountain for thousands of years. Today, no water reaches the foot of the mountain, and people are moving further and further toward to top in to obtain fresh water (Gore, 2006). In Afghanistan and Pakistan there are struggles over water rights of rivers that cross the border. India is involved in the Afghan/Pakistani conflict; it has invested heavily into Pakistani reservoirs, damming their rivers, which can regulate the volume of flow to Afghanistan.

There are several large multinational companies in the business of water privatization. Among them Suez and Bechtel are increasing their control over the world's freshwater resources at an alarming rate. Conflicts and street riots have occurred in response to water privatization, for example, Bechtel obtained a contract from the city of Cochabamba, Bolivia to privatize their water (including the city's rain water). Soon after the contract was signed, the citizen's water bills increased by over 60% and people were forced to forego food and education in order to pay for their meager 5 gallons of water per day. Older retired people were forced to work on the street to get enough money to pay for their water, and in 200-2001 violent street riots took place (http://www.youtube.com/watch?v=86N20IOigKE).

Scholars project that as GCC causes large areas of once fertile land to become desertified, people will be displaced and will seek fresh water and fertile soil for sustenance elsewhere. There will be conflicts at borders and water and food will become dominant national security concerns (Dalby, 2009). Traditionally security was about maintaining sovereignty against outside threats. Those issues have not gone away, but at the end of the cold war, the real focus

was on environmental issues throughout the world, like the ozone hole, burning of rain forests, and species extinction. Today, with the issues of water and food shortages causing displacement of people, the military is thinking about environmental security in a new way (Dalby, 2009).

It is true that increased GDP (reduced poverty) and education tends to lead to smaller family sizes. Moreover, smaller family sizes and reduced overall population densities will lower the demand on natural resources like water, soil, crop production, and fuel. However, we also know that higher standards of living require more fuel, more consumption of natural resources, and higher rates of consumption of goods. Even if world population density remained constant (6.8 billion), with no additional growth, our increasing demand for the earth's resources is unsustainable. A strong conservation ethic is required along with a near-complete transformation to clean energy technology, in order to steer the future of humanity toward a peaceful, prosperous and sustainable existence.

What should Jesuit Universities do to educate, transform, and lead by example?

Jesuit education has been known historically for several of its most important features, which speak directly to the aforementioned challenges. Since its founding, Jesuit education has attempted to offer relevant curricula to eager minds and hearts and has prepared young people to take their places in leadership positions within their community and world. Jesuit schools have sought to address ethical and social issues within a community of faith, hope and charity. The following examples of what Jesuit schools might do to address issues of sustainability are meant as a starting point, a beginning reflection for further study and analysis:

1. The curriculum. Those who work in universities, and indeed along the continuum of educational attainment, from elementary to secondary education, will recognize that young people are very interested in the issue of sustainability. Increasingly, there is evidence that they

are aware of and sensitive to the implications of a stressed planet, and to the social, ethical and moral issues which continue to emerge from such things as pollution, depletion of food supplies, global warming, deforestation, desertification, and others. Educators should ask if the curriculum has been constructed to address these issues through the basic sciences, the technological sciences, the social sciences and the humanities. The list of issues and topics for inclusion in the curriculum would include, at a minimum, land and water use and quality, food production and sustainability, food stock depletions, climate change and its impact on human habitats, genetic manipulation of plants and animals, human reproduction and family size. Each of these has social, political, environmental, economic and ethical dimensions for studies at any level.

2. Leadership building. Collectively, universities across the world educate nearly all of the K-12 teachers, community leaders, religious leaders, cultural leaders, policy makers and national government leaders. Leaders educated with a sensitivity to global issues will be able to apply their talent and expertise to create a culture of sustainability and sensitivity to the impact of lifestyle on the environment, which applies to the wealthiest and the poorest of societies. Institutes, centers, student-led organizations, and research projects where faculty and students collaborate are training grounds for leadership skills as they help young people articulate their knowledge, share their passion, and act on their beliefs.

3. Degree Programs. There is a call for new degree programs in sustainability. In particular, those Jesuit universities that have schools of engineering, business, architecture, economics, environmental science, and law, could consider developing environmental sustainability degree programs in these areas to promote the development of new professionals in clean energy technology, green building design, and ambitious environmental policy

development. These areas represent the social and technology needs of the present and future; hiring the best faculty to develop competitive programs in these emerging disciplines is critical.

4. Leading by example. Jesuit university buildings and churches should be structures that are highly energy efficient, and carbon neutral, whenever possible. New buildings that are being designed and planned should always consider following the most environmentally sustainable building codes, using recycled, local materials and capitalizing on the local environmental conditions, as with, for example, the model that inspired the plans for the new Colegio San Jose Barranquilla campus (http://www.colsanjose.edu.co/es/). Buildings utilize over 40% of all energy consumed in developed countries, exceeding that used in transportation (Krupp, 2008), making Capital Planning an area where our campuses can lead by example, and make a significant contribution to environmental sustainability.

In addition, Jesuit universities and communities should be communities that develop an *ethic of conservation*. This means developing a culture of ethically responsible stewardship which includes embracing habits of restraint, and forming a spirit of trusteeship for nature for the benefit of future generations (Friedman, 2008). The Jesuits are famous for teaching and for turning words into deeds. Managing global climate change and rising human populations is arguably the greatest challenge humankind has ever faced (Berry, 1999), and it will require action from all of civilization.

An example of a successful project, among many from a variety of Jesuit institutions, might be Loyola University Chicago's new sustainability program. Designed to create and reinforce a conservation ethic, or culture, Loyola University Chicago (LUC), an urban university of 15,000 students, involves students in identifying and quantifying the amount of resources and goods that are brought onto campus (e.g. food, water, electricity, gas, paper, printers, computers,

etc.), and similarly identifying and quantifying the waste stream. They have designed a course called Solutions To Environmental Problems (STEP) whereby students from multiple disciplines come together to tackle an issue of environmental sustainability on campus. In the first iteration of the course, students decided to use the waste vegetable oil from cafeteria deep fat fryers to make into biodiesel, and to use that fuel in the shuttle buses that travel daily between Loyola's two campuses. Loyola now has a complete biodiesel lab which produces over 300 gallons per month. This fuel is used in each of the 5 shuttle buses that ferry students between campuses to reduce the campus carbon emissions by 1,200 tons of carbon dioxide per semester. In the process of making biodiesel from waste vegetable oil, a by-product, called glycerin, is produced. Instead of having the glycerin transported to the land fill, students perfected a recipe for making liquid soap which they now bottle and sell in the campus convenience stores and bookstores.

Presently, the STEP course has evolved to address the broken food system in the US, and students are building an urban rooftop organic garden for producing crops, flowers and honey bees. They are developing business plans for distributing and selling the products. In addition, the class is designing a biogas system where all of the waste food and kitchen scraps from campus dining halls, are digested anaerobically to make methane (natural gas) to offset energy consumption, and a rich fertilizer for the organic gardens and landscaping. These types of projects empower students to see how they can affect change in their own lives, as well as the lives of their families and friends. Students that experience the STEP program think more intentionally about what they purchase, how they can be resourceful by using and reusing goods before recycling them, and what kind of transportation they choose to use.

5. Educating girls. Another important strategy which Jesuit schools can advance is supporting and emphasizing the education of girls and young women. Mortenson (2006)

suggests that educating the girls in developing nations where having large families is common, is the best way to approach world peace, and population control. His experience working in small villages in Afghanistan has led him to believe that educating girls gives them opportunities to have a higher standard of living, with more meaning to their lives including jobs and careers, which draws them toward understanding, tolerance, and a desire for a smaller family. This approach, is clearly effective in the communities that Mortenson's Central Asia Institute have touched, and perhaps is the key to decreases in rural poverty and family size. Is it possible to successfully "export" this model to Africa, China, India and beyond?

If educating girls in developing countries is important, as Mortenson (2006) suggests, then perhaps we should challenge ourselves to develop practical and effective ways to deliver such educations. Exchange programs where graduate students in Education from developed world Jesuit Colleges and Universities could complete a 1-2 year practicum in developing world situations to teach and help build peace, prosperity, and environmental sustainability. There is a degree of urgency that we need to pay attention to. If 50% of the people in poverty stricken India and Sub Saharan Africa are either at or rapidly approaching reproductive age, we should be thinking of ways to address this problem immediately.

Conclusion:

Jesuit Universities are uniquely poised for delivering a transformative education through the curriculum and through experiences like those mentioned above. Fr. Kolvenbach has described Jesuit Higher Education as unique and important, and one that contrasts with those approaches that stress academic rigor alone. Jesuit universities deliver an education which attempts to foster growth in the whole person, addressing the social, physical, moral, and spiritual, as well as the intellectual dimension. He argues that a person's moral, religious and

social beliefs are integrated in real life, and should also be integrated in education. Father Locatelli, S.J. expressed how the standard U.S. academic model fails to provide moral guidance to students, and that Jesuit institutions have an obligation to guide students toward moral living.

If incorporating environmental issues into the curriculum and developing degree programs in environmental sustainability can help produce a transformative Jesuit education toward a conservation ethic goal, how can our institutions directly facilitate change in developing nations, with fewer resources?

Summary

New technological advances have enabled human populations to exceed the natural ecological carrying capacity of the earth. These advances can present us with a moral dilemma of "competing goods", as they often come with negative consequences that are not anticipated, discovered or acknowledged until we reach a crisis state, such as with global climate change, air and water pollution, the loss of biodiversity, and human population increases. As humans across the world strive to increase the quality of life, natural resources are being increasingly taxed. The intersection of rapidly increased numbers of people seeking higher standards of living, and the unprecedented rate of depletion and deterioration of natural resources represents the tipping point for the earth's ability to sustain human life. By virtue of their approach to educating the whole person, Jesuit Institutions of Higher Education around the world are poised to facilitate the development of an environmental ethic, a broad cultural change toward greater stewardship of natural resources for future generations. In addition, our institutions can build highly energy efficient buildings, and develop programs that better serve the critical need to educate girls in developing countries, providing them with employable skills, which often results in their choice to have smaller families. These tactics, combined with a surge of clean energy technology innovations would provide the systematic approach required to change our world's course of action and avoid wide-scale global destabilization (Brown, 2008; Gore, 2008; Friedman, 2008; Krupp and Horn, 2008).

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