

ROUGH ROAD AHEAD: GLOBAL TRANSFORMATIONS IN THE 21ST CENTURY

by

Barry B. Hughes

As we move towards the 21st century it is appropriate to think broadly, and in an integrated fashion about the possible evolution of key global variables in the next 100 years. This article draws upon historic data from the 20th century to place such an exploration in context, and it uses an integrated global computer simulation to consider how key human systems may interact and evolve. The future is unlikely to unfold as either technological optimists or environmental pessimists generally suggest. There is road ahead of us leading generally where we want to go, but the ride will be sufficiently rough that we cannot be certain about our arrival.

A remarkable portion of global forecasting adopts either apocalyptic or millennial character. The Reverend Thomas Malthus helped define the apocalyptic tradition, which points to the near inevitability of deteriorating conditions, with his *Essay on the Principle of Population*. The Club of Rome's Donella and Dennis Meadows told us that we faced imminent *Limits to Growth*, and argued more recently that we have, in fact, moved *Beyond the Limits* of sustainability. Lester Brown reports annually on the rather distressing *State of the World* and draws our attention especially to problems of food supply. He asks pointedly *Who Will Feed China?* and suggests that we face very *Tough Choices*. Robert Kaplan gave us a vision, focused on Africa, of "The Coming Anarchy." In truly dramatic counterpoint, we can reach back to Sir Francis Bacon for an image of the *New Atlantis*. Or we can read Herman Kahn's more contemporary forecast that *The Next 200 Years* will be ones of overcoming limits, not being overcome by them. John Naisbitt's *Megatrends* even more consistently offer promise rather than identifying problems. And Ronald Bailey tells us that *The True State of the Planet* stands in almost complete contrast to the vision of Lester Brown.¹

Controversy and strong statements of viewpoint obviously sell books and magazines. There is, however, another very important and less commercial logic behind this bimodal futurism, specifically

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the functioning of feedback loops in reinforcing processes. Environmental and political problems can weaken the capacity of societies to adapt, thereby accelerating declines into collapses. In contrast, technological success buttresses the ability of societies to overcome adversity, potentially transforming individual breakthroughs into periods of sustained growth. Thus civilizations historically have exhibited broad periods of growth and material progress, as well as marked episodes of decay and collapse.

What those who translate one or the other of these feedback logics into consistently pessimistic or optimistic portrayals downplay, however, is that both logics are almost always at work and in interaction across space, time, and issue areas. In fact, it is the complexity of the interaction that makes predictions (especially, as is so often said, about the future) untrustworthy. Not unlike the 19th and 20th centuries, the 21st century, upon which increasing numbers of prognosticators now expound, will almost certainly be a Dickensian collage of progress and regression, of hope and despair, of good and bad times. At the end of the coming century, those looking back, like those now reviewing the current century, will see technological and material progress, but will also detail great costs of that progress.

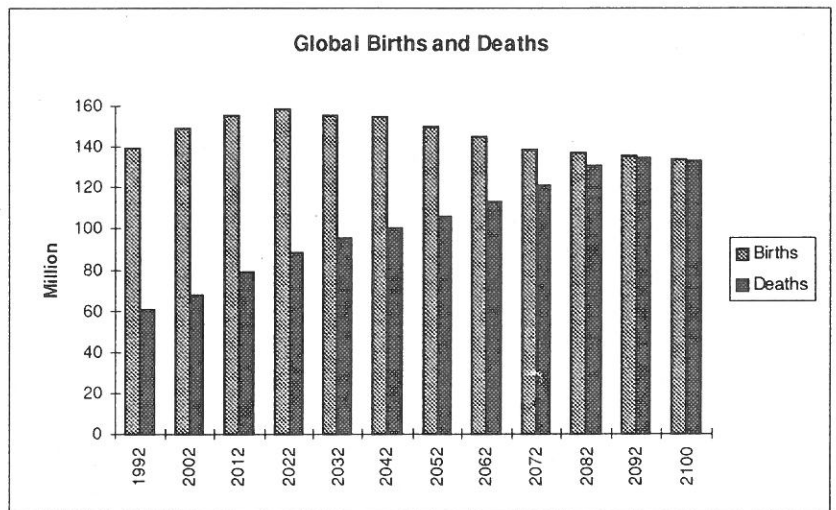
The next century will, of course, also have its unique themes. Among the most important will be a serious grappling with (but not attainment of) environmental sustainability. The tension inherent in the simultaneous pursuit of economic growth and environmental quality will almost certainly increase, as economic transformation accelerates in much of the developing world. Another theme to which we can attach high probability will be an equally serious grappling with socio-political organization, because there is a second growing tension, the one between the sociopolitical transformations of global liberalism and the need to maintain and strengthen civil society. This article argues that the in coming century humanity will make progress toward sustainability and toward stable liberal societies. That argument may appear to place it within the general camp of optimistic forecasting. The road through both transformations will, however, be a rough one, and we can be certain about successful navigation of neither.

This article relies on both extensive historic data and on forecasts from an integrated global model, International Futures (IFs), for its tables and analysis.² The base case of the IFs modeling system has been tested against, and produces long run forecasts generally consistent with, various analyses of the United Nations, World Bank, Food and Agricultural Organization, International Energy Agency, Organization for Economic Cooperation and Development, Intergov-

ernmental Panel on Climate Change, and other organizations, as noted in the following discussion. In looking across the issue areas of those forecasts, however, and in examining their interaction, we learn a great deal.

The Big Picture: Demographic and Economic Transformations

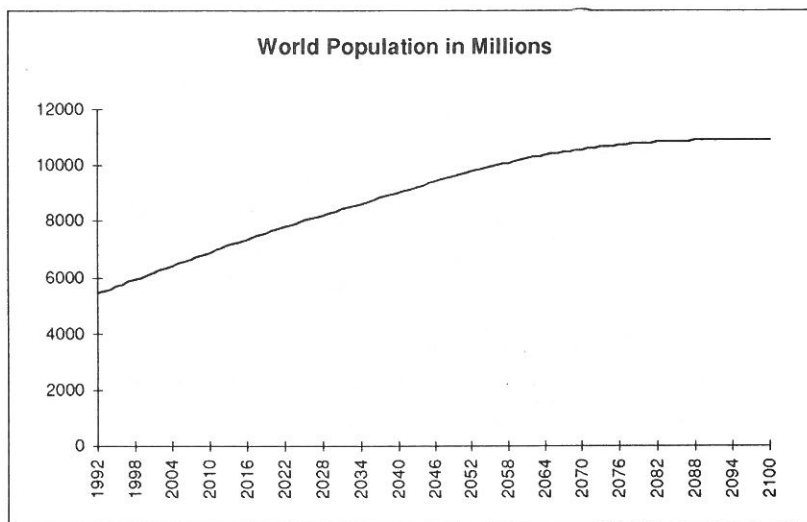
In the 20th century world population has grown from 1.6 billion people to about 6 billion, with growth rates that accelerated from 0.5% in 1990 to more than 2.0% in the early 1960s³. At that time global demographics passed a critically important, but surprisingly little-celebrated turning point: global population growth rates began to fall. They have fallen to 1.5% as total fertility rates continue a dramatic decline that has taken them from 5 children per woman globally in the early 1950s to just under 3 children today.



As we close the century, global demographics is passing a second critical turning point. Even as global population growth rates fell in the last three decades, the net number of people added to the global total continued to grow and now surpasses 80 million annually. Very early in the 21st century, however, as birth rates continue to fall and as deaths in an aging global population continue to rise, the net number added annually will begin to decrease noticeably. Moreover, we will likely reach a third critical milestone in the second decade of the next century: global births will begin to decline.

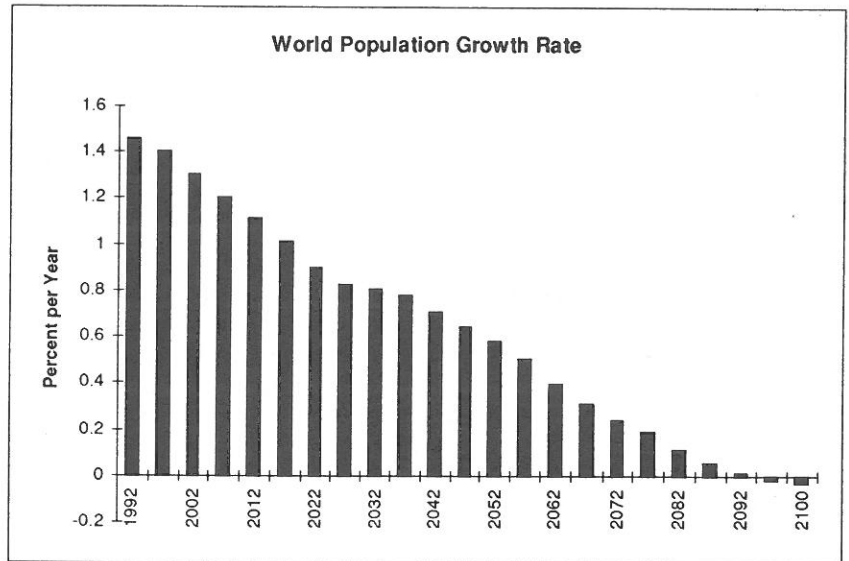
Our level of confidence in such forecasts can be moderately high, because fertility and mortality rates tend to change relatively slowly and quite steadily, imparting a great deal of momentum to demographic trends. Although it is much less certain, many forecasters, including those of the United Nations and the World Bank, anticipate still another global demographic milestone near the end of the next century, namely the attainment of zero population growth. Most commonly, forecasters anticipate a global population of around 10 billion at that time, but some forecasts are as low as 8 billion.

Although mortality rates generally change even more slowly than fertility rates, and changes in mortality affect total population less than changes in fertility, those rates are also uncertain in the longer run. Some analysts foresee greatly increased life spans, while others suggest we are approaching relatively hard biological limits to extension. At least as important is real uncertainty about disease incidence, especially in the face of growing resistance to antibiotics.



The milestone of zero population growth is sometimes discussed as if it would be the end of population history, but it will, of course, precede still other important changes. Global population could well then decline, in much the same way that populations in many European countries, where fertility rates that average 1.5 across the continent, are now declining. And even were the global aggregate population to attain something approximating stability, underlying national and regional patterns could be highly varied. Nonetheless,

this demographic transformation to and perhaps through zero population growth will be one of the most fundamentally important aspects of the 21st century. It will contribute both to the broader transformation towards sustainability and to the liberal sociopolitical transformation (not least through the aging of global population).



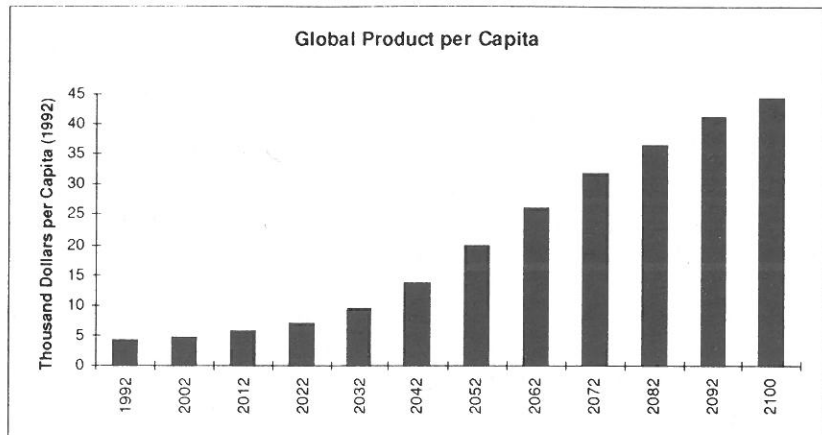
The other "big picture" transformations of the 21st century will be in economics. In the 20th century the global Gross Domestic Product (GDP) has grown from about \$2 trillion to nearly \$30 trillion (each in 1990 dollars), an annual average growth rate of about 2.7%.⁴ In per capita terms global GDP has grown from a bit over \$1,000 to more than \$5,000. In spite of the Great Depression and in the absence of much growth in most of Africa, this century has seen by far the most rapid economic growth in history. To put this century's change in perspective, consider that in 1820 the global GDP per capita was about \$650 and the value for 1500 has been estimated at \$565.

We should recognize the great importance of having reached a global per capita GDP level of \$5,000. Dramatic transformations occur in almost all societies as GDP per capita grows from \$1,000 to \$5,000. Primary school attendance becomes near universal and literacy rises well above 50%. Life expectancy jumps sharply towards that in the richest countries and fertility rates fall very rapidly. Changes in such "quality of life" variables is much less marked above \$5,000 per capita than below it. Thus it is very significant to

be able to say that the world on average (unfortunately nowhere near 50% of the world's people) has reached that level.⁵ The most dramatic element of economic transformation in the 21st century will be the movement of a large majority of humans above \$5,000 per capita.

We all know, however, that the economic change of the last century has been extremely uneven and that income inequalities among and within countries have increased markedly. In 1900 the richest countries of the global economy, like the United Kingdom, the United States, Australia and New Zealand, had Gross Domestic Products per capita in the \$4,000-5,000 range (in 1990 dollars), while the poorest were at levels below \$1,000. At the end of the century the richest have reached per capita levels of around \$20,000 and the poorest are still at or below \$1,000.

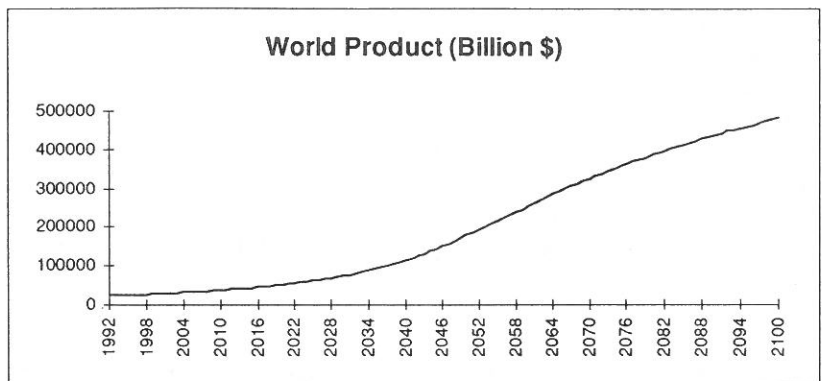
It is less well recognized that, on average, Latin America and Asia have progressed in this century from GDP per capita levels a bit above and a bit below \$1,000, respectively, to levels *above* those attained by the richest countries at the beginning of this century. In recent decades a number of less-developed countries, particularly the tigers of Asia, but also a number of Southern European countries have demonstrated that it is possible for countries, even with few obvious natural advantages, to rapidly adapt technologies from more-developed countries and to advance quickly in economic well-



being. Given the possibility and great desirability of doing so, it would be surprising if many additional countries did not follow that lead in the early 21st century. Although it is still another important turning point that has been little noted, growth in the ratio of GDP per capita in rich countries to that in poor countries, a ratio that has increased sharply in this century, has ceased growing in the 1990s. It will most likely narrow markedly in next 100 years.⁶

Although few souls are so bold as to forecast global economic growth into, much less through the 21st century, the prestigious Intergovernmental Panel on Climate Change (IPCC) did just that as a basis for studying the continuing build-up of carbon dioxide. They suggest a possible 24-fold increase in the global economy between 1990 and 2100 (13-fold in more and 69-fold in less developed economies, respectively), an acceleration relative to the 15-fold increase of the 20th century.⁷

That forecast might seem outrageous to many who view the slowing growth of the period since the early 1970s to be a precursor to greatly reduced global economic growth. There are, however, good reasons to believe that global economic growth in the 21st century will exceed that of the current century. First, global economic growth has been on a generally accelerating path for more than 200 years. Maddison (1995) points out that the period of most rapid economic growth in human history, the "Golden Age," was 1950-73. Although the second most rapid growth was in 1870-1913, the third most rapid was the much maligned 1973-1992 period. Second, the very large differentials that have appeared globally in GDP per capita have created the possibility for countries at lower levels of GDP per capita to dramatically increase their growth rates



through adoption of existing technology from richer countries. The IPCC forecast is reasonable.

Other aspects of probable economic transformation in the 21st century are less easily quantified, but no less important. Most significantly, the transformations from agricultural to industrial economies and from industrial to informational economies will diffuse around the globe. Among the indirect consequences of this will be a continued transformation in the nature of global transactions. Merchandise trade is now about 13.5% of the global economy, well above the earlier peak of 9% preceding the collapse of trade after 1929⁸. Although current data track it poorly, service trade has expanded even more rapidly, and in recent years financial transactions across state borders have exploded. For instance, *The Economist* of March 16, 1996, reports daily global foreign-exchange trading was \$10 billion in 1973 and \$1.3 trillion in 1995. Although we still focus much of our public attention and public policy in international economics on global trade, it is obvious that issues surrounding global finance will dominate the 21st century.

Rough Patches: Food, Energy, and Environmental Quality

Although these "big-picture" transformations suggest an increasingly stable world demographically and an increasingly rich one economically, things look less comforting when we move down a level of abstraction and view the future through a more "physical" lens. Specifically, we must ask ourselves three questions concerning consequences of growing populations and economies: Will we have enough food for nearly twice as many humans? Will we have enough energy to power our burgeoning economies? In our efforts to feed ourselves and our economies, will we greatly damage our physical and biological environments, thereby undercutting rosy economic forecasts? The quick answer to each of those questions is "probably yes." That is, in the 21st century we will probably feed ourselves, extract and produce the energy we need, and significantly and very often negatively affect our environment.

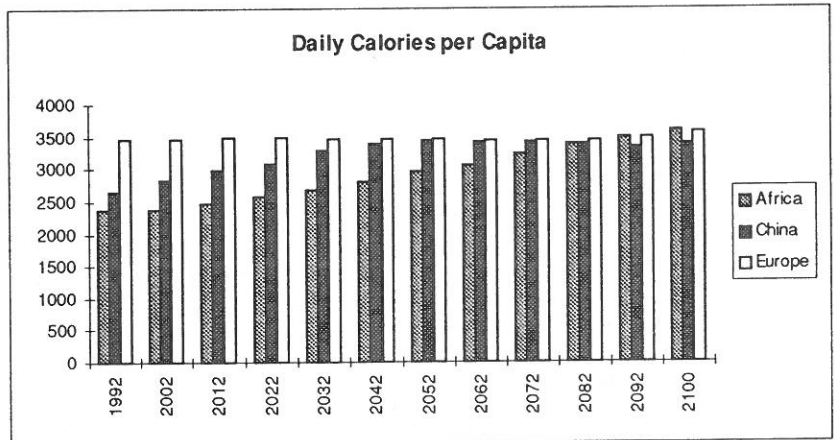
Food. Although we do not have historic data on global food supplies in the first half of the 20th century, we do have them for most of the second half. They trace a pattern of growing availability and sufficiency, but one that has left significant numbers of people behind.

Between the early 1960s and 1990s, global per capita calorie consumption increased by about 15%.⁹ Levels in less-developed countries increased even more rapidly from 1,990 calories in 1962 to 2,500 in 1991. On a global basis, the population estimated to be

malnourished decreased from 900 million (35% of the total in LDCs) in 1969-71 to 800 million (20% of LDC population) in 1988-90. Over that period calories consumed globally per person each day rose from 2,440 to 2,720.

In spite of this progress, there is an ongoing debate about our ability to feed ourselves that tends to swing between optimism and pessimism in correlation with cycles in world food prices and episodes of surplus and scarcity. Concern was thus very high in the early and mid-1970s and has risen again in the early 1990s.

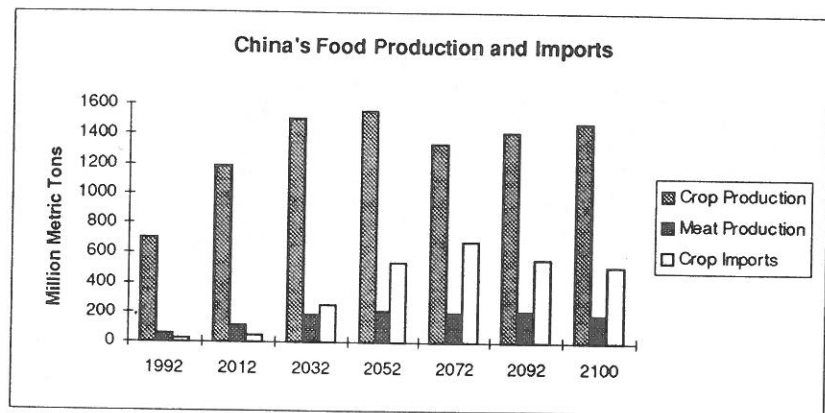
To put the problem in perspective, an increase in the global population from 6 billion to 10 billion means that we will need to increase global food supplies by a factor of 1.67 just to maintain current dietary levels. To bring global average calorie availability from 2,720 to 3,500, approximately the level in the richest countries today, we would need a further factor of 1.29. To do both, we would seem to need food supply increases of about 2.14 (1.67 times 1.29). That would ignore, however, the fact that the increased calories will, if consumers have their preference, come in large part through the addition of more grain-fed meat to diets. Even assuming that we were to eliminate much of the agricultural waste that is prevalent in the food harvesting and distribution systems of less developed countries, we need to multiply basic crop production by about 3.5 times to satisfy consumption demand of 10 billion wealthy eaters.



Those who look with anxiety to the future of agriculture can marshal an important array of arguments that include: there is very little new land coming into cultivation and, in fact, agricultural land per capita is declining; land that is entering production often comes at the expense of tropical forest and produces land of marginal quality for agriculture; aquifers around the world are being drawn down and sites for placement of new irrigation reservoirs are dwindling; fertilizer and other chemical use has reached levels that often bring few marginal returns and that contribute greatly to pollution; ocean fishing is so intense that fish stocks are falling.

Those who look more optimistically to the future rely on one major argument: agricultural technology continues to advance, especially as we move into an era of genetic engineering. Moreover, a substantial portion of the world has not yet adopted even current state-of-the-art technology. This argument is buttressed by the reality that food production has grown so much in recent decades (more than doubling since 1960), in the face of previous pessimistic forecasts.

One of the focal points of the debate currently is the prospect for meeting food demand in China. Lester Brown has concluded that rapid industrialization will lead to a substantial withdrawal of land from agriculture and a major growth in dependence on food imports.¹⁰ He forecasts Chinese imports by 2030 of 300-640 million metric tons of grain. To put that in context, all of Asia imported only about 80 million metric tons in 1990, and North America exported only 110 million metric tons.



In part because of the difficulty of obtaining data from China, FAO analysts have often not developed agricultural forecasts for that country with the same detail as for other countries in the world and have therefore not seriously challenged Brown's analysis.¹¹ Brown's argument, based on both available data and on analogy with patterns in other densely populated Asian countries like Taiwan and South Korea, carries considerable weight. Moreover, the argument can be extended beyond 2030, because neither the dietary nor the industrial transition in China will be complete by then. There appears a high probability that Chinese food imports will place heavy pressure on the global system.

In and of itself, this conclusion is clearly alarming. It is alarming *not* because of agricultural implications for China: the demand emanating from China is a result of higher incomes and a resulting shift in diet towards grain-fed meat. In addition, it might actually be comforting for the rest of the world to anticipate that China's food import needs will require recycling of a significant portion of the foreign exchange that its manufactures will earn and that such a trade pattern will integrate China tightly into the global economy. It is alarming instead because it suggests the possibility that Chinese imports will lead to increases in global food prices and to further pressure on marginally fed populations like those in Africa (and because of environmental implications for China). Even if the global agricultural system absorbs that pressure in the long run, and FAO analysis suggests that it will¹², the rapidity of the rise in demand for imports may well present problems during the transition.

Energy. During the 20th century, the global energy system has undergone two notable transformations. First, global energy consumption per capita has increased by a factor of about six. It now exceeds one ton of oil equivalent per person each year. Second, the dominant primary sources of energy changed from wood and coal at the beginning of the century to oil and gas by the 1970s.

Obviously, there has been much variability with respect to both transformations. Per capita energy consumption in profligate North America is about double that of Western Europe which, in turn, is more than two times the global average.¹³

Although there is also much variation across countries in the mix of fossil fuels, there is relatively little variation in the dependence on them (except in the poorest countries, where wood still constitutes a major source of energy). Globally, oil, coal, and gas collectively provide about 90 percent of global commercial energy, in descending order of importance (they provide more than 80% of total global energy, including wood and other non-commercial biomass use).

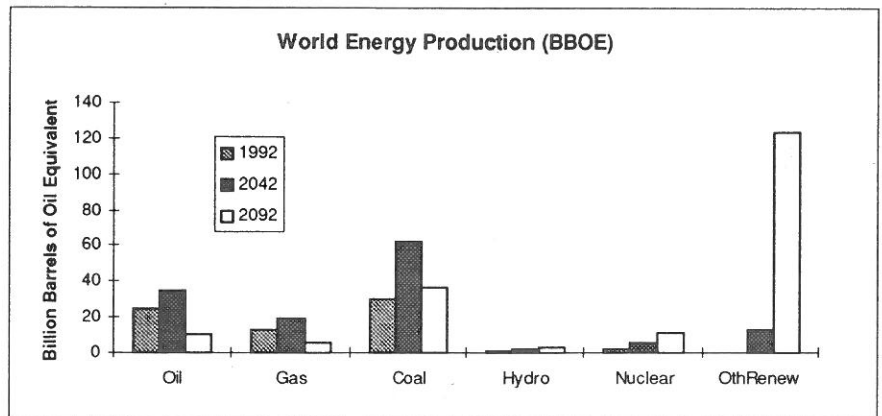
The two "energy shocks" of the 1970s, a decade in which oil prices

jumped by a factor of about 10, led many to the mistaken conclusion that fossil fuel shortages were imminent and that a transition to renewable energy was necessary. In fact, known reserves of oil, gas, and coal, would satisfy current levels of global demand for 43, 66, and 230 years, respectively. These numbers have all grown since 1973 as discoveries and ability to extract from known reserves have outpaced production. There is still considerable potential for reserve expansion. Although oil and gas resource constraints will almost certainly become significant sometime in the next century, and will be seen in the form of rising costs of production and therefore rising prices, coal will remain abundant.

The real energy issue for the 21st century is environmental impact, not resource availability. Therefore the important questions for the 21st century are the probable growth in total energy demand and the portion of that which renewable and relatively less polluting energy forms may provide. Perhaps the most important insight to which the energy price increases of the 1970s gave rise is the degree to which energy consumption increases can be decoupled from economic growth. Prior to 1970 conventional wisdom was that energy use rose in lock-step with GNP. Although U.S. energy consumption per unit of GNP had fallen 2.5 times in the preceding century, there was much less change in that ratio for most other countries.

Given the IPCC forecast for 24-fold growth in GDP during the coming century, as reported above, what is a reasonable assumption for growth in energy demand? The IPCC itself builds two scenarios, a doubling and a quadrupling of global energy demand. The World Energy Council (1993) similarly suggests growth in global energy demand by factors between 2.2 and 4.4 by 2100. The lower of these scenarios seems unrealistically conservative in the face of historic patterns of energy growth (more than 2% annually over a long period). Consider that even in the face of dramatic increases in energy prices, and in the context of slowing economic growth, global energy demand grew by nearly 45% between 1973 and 1994. The coupling between economic growth and energy demand growth has been weakened, but by no means destroyed. Thus the forecast by authors from the International Energy Agency (IEA) and the International Institute of Applied Systems Analysis (IIASA) of a 2.6-fold increase in global energy usage by 2050 appears considerably more reasonable¹⁴, and even the 4-fold demand increase foreseen at the high end of other forecasts for 2100 seems optimistically low.

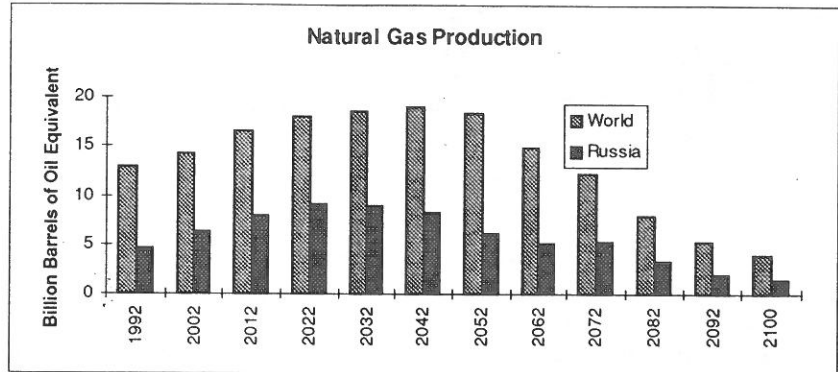
How might the world satisfy energy demands at four-times or more those of today? Or, to focus more clearly on the important question, how much of the supply over time is likely to come from renewable energy forms and from nuclear energy? The answer to



that question depends primarily on the relative prices of fossil, nuclear and renewable energy forms. Nuclear energy has actually become more expensive, as the full costs of the nuclear fuel cycle, including long-term disposal of nuclear wastes, increasingly and appropriately become part of costing. Although renewable energy costs continue to fall, those costs remain relatively high, especially in industrial and transportation applications, where more concentrated energy is needed than in residential/commercial heating and cooling. Additionally, most "new renewable" forms are dependent on direct sunlight and thus are intermittent in the absence of expensive storage or extensively interconnected power grids. Fossil fuels remain relatively plentiful and therefore not particularly expensive. Wonderful declarations in Rio and elsewhere aside, there is an extreme global scarcity of political will to tax and discourage fossil fuel use. Thus the share of energy supplied by renewable or nuclear forms is unlikely to grow rapidly before the middle of the next century.

Leaving aside the contributions that wood and hydroelectric power make, what contributions might the other solar or "new renewable" forms make in the first half of the next century? The World Energy Council suggests that the new renewables are unlikely to provide more than 5-10% of global energy by 2025, and the IPCC, which seeks to develop low-carbon scenarios, is barely more optimistic for those forms in that period.¹⁵ The IPCC does foresee contributions

by renewables growing to satisfy half of global energy needs by 2050, two-thirds in 2075, and three-fourths in 2100, led by biomass and not by intermittent solar renewables. These IPCC forecasts for renewables are, however, keyed to their demand scenario of 2-fold increase. Their scenario for 4-fold increase in demand requires that fossil fuels, overwhelmingly coal, satisfy more than half of the total requirements through the century. (Interestingly, those making very long term forecasts seldom look to nuclear energy, including fusion, for significant contributions.)



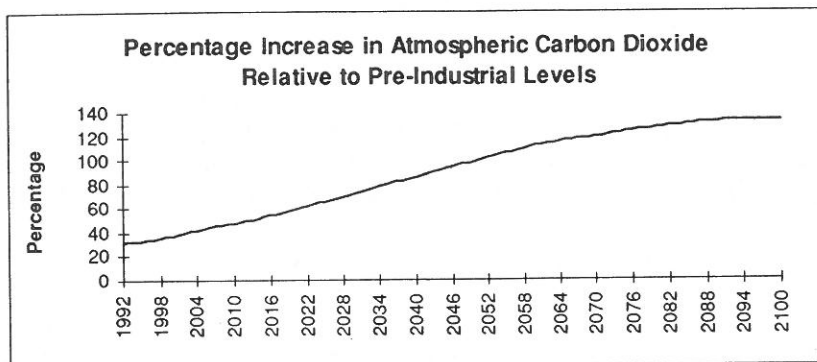
This glance at energy forecasts for the 21st century suggests significant difficulties and great uncertainties ahead. The transformations required to provide energy for the burgeoning global economy seem almost unimaginable. Energy demand and supply forecasts seldom have as much surface validity as do those in agriculture.

The road to our energy future is almost certain to be rough. Oil reserves have become even more concentrated in recent years and future oil shocks, delivered by developments in the Middle East are nearly certain. The growing dependence of the U.S. on imported oil, as its production continues a long decline, reinforces that conclusion. Natural gas is the environmentally most desirable of our fossil fuels and is relatively plentiful. In the first half of the next century, its use could double. Russia alone controls more than one-third of known global reserves. Given these parameters, it is highly probable that in the early 21st century Russia will suffer from the "Dutch disease." That is, it will significantly increase its production and export of gas (a single holding company, Gazprom, controls much of that resource

and is moving aggressively to increase production). The foreign exchange earnings from truly substantial exports will support the value of the ruble and undercut Russian exports of other goods and services. This pattern will have the same distressing implications for the Russian economy that it has had for other countries that at some point became highly dependent on exports of oil and gas (Mexico, Venezuela, the Middle Eastern countries, and even the Netherlands and Great Britain).

Environment. To say it again, the real issue for the future of energy is not resources, but environmental impact. Although those who have breathed the air of almost any major city of the Third World, or wanted to swim in the oceans near those cities, will know much of that impact to be local, the issues that we must most worry about are larger scale. And of those, the most troublesome is build-up of atmospheric carbon dioxide (CO_2) and consequent global warming.¹⁶

Little debate continues around the reality of CO_2 increases or of attendant global warming and sea-level increases. The Intergovernmental Panel on Climate Change (IPCC), drawing on the collective research and insight of hundreds of scientists around the world, tells us that even were we able to hold emissions to current levels through the end of the next century, atmospheric carbon dioxide would rise to about 500 parts per million by volume (ppmv), compared to 280 ppmv prior to global industrialization and 350 ppmv today.



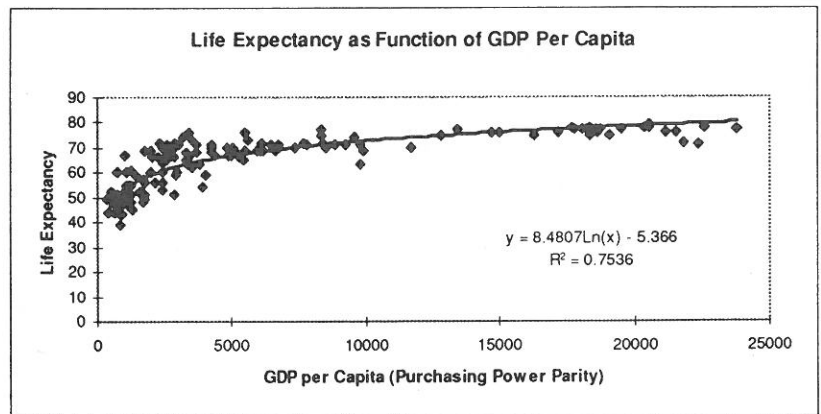
That presumption of constant emissions is, of course, not a reasonable forecast. The medium forecast of the IPCC, using energy forecasts that we have already argued to be very conservative, is that atmospheric CO₂ will reach 650 ppmv by 2100. Their calculations suggest that this will mean a 2 degree Centigrade increase in global temperature and about a half-meter rise in ocean level. Unless carbon emissions levels were returned to 1990 values within 140 years, even those levels of temperature and sea-level change would not be equilibrium values.

Again, we face a future with tremendous uncertainty. The ability of the oceans and other sinks to absorb and retain increased atmospheric carbon dioxide, the contributions that other gases will make to the greenhouse effect, the degree to which changes will be continuous and smooth or will leading to "tipping" behavior of carbon and temperature systems, the rate of fossil fuel use, the change of disease patterns with temperature rise, and the net costs of global change to human settlements and ecosystems near oceans, to agricultural systems, and to forests are all uncertain. Some estimates of the portion of GDP that would be required to mitigate the impact of a 2 degree temperature increase are only a few percent, perhaps only 1 percent for more developed countries and several times that for less developed countries. Although we have made progress in estimating the magnitude of such changes and costs, the uncertainty remains extremely high and the upside risk in costs appears substantial.¹⁷

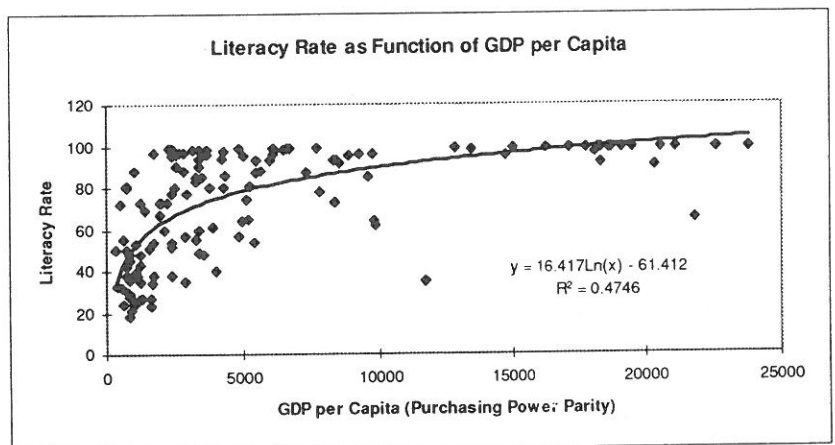
Domestic Social and Political Change

The overarching demographic and economic transformations of the next century are likely to be dramatic. The efforts to deal with food sufficiency, energy availability and environmental quality will probably be complicated and difficult. Social and political change in the coming century could prove comparably dramatic and complicated.

We noted in passing earlier the significance of reaching GDP per capita levels of about \$5,000. Actually, we should amend that somewhat. Much of the most dramatic social change occurs as GDP per capita measured *in purchasing power* rises towards \$5,000, a transition that normally occurs as GDP per capita measured *in exchange rates* climbs to about \$3,000. Because most of the world's population lives in countries with GDP per capita below these levels, a large portion of the social change associated with the transition to such income levels has yet to occur. It is highly probable that by the end of the 21st century, most of that transition will be complete.

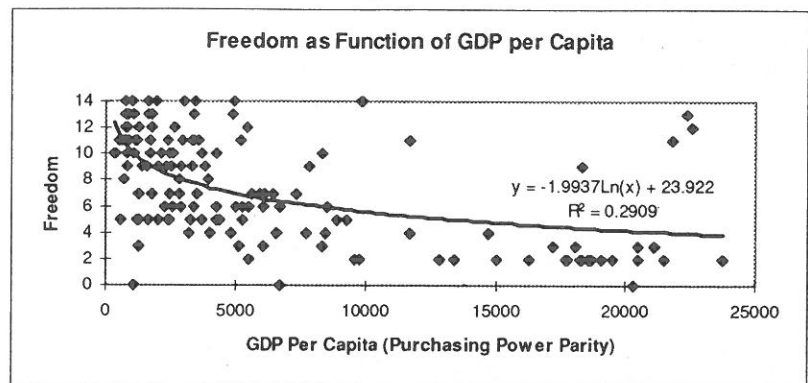


What are the implications of that forecast? As GDP per capita in purchasing power parity rises to \$5,000, life expectancy rises to the high 60s, within a few years of the longevity that those in the richest countries now expect. To put this in context, even with modern medical technology life expectancy for those in the poorest countries is today in the mid 40s.

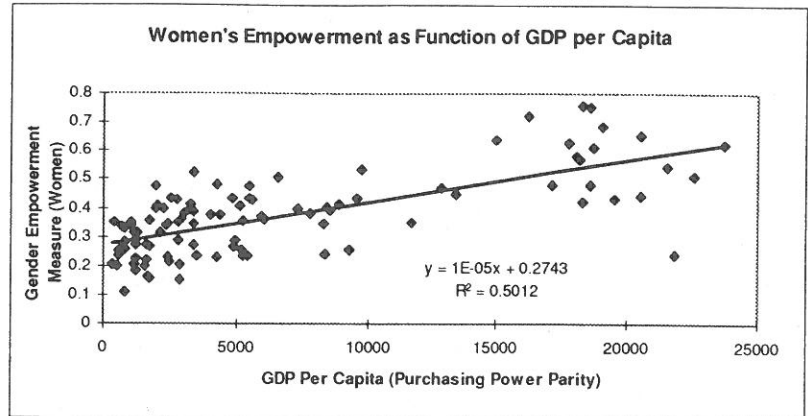


Similarly, in transition to \$5,000 per capita (PPP) the total fertility rate or number of children borne by each woman in a population falls from 6.0-7.0 to about 3.0, not far above the 1.5-2.0 rates of the richest countries. And literacy rates rise from well below 50% to nearly 80%, well along the path towards universal literacy. These transitions are fundamentally important, and because they have a strong start globally, the 21st century should see their completion in all but isolated geographic and class pockets.

Moreover, the impact of these social transitions extends beyond individual quality of life to social organization. The Freedom House assesses democracy in countries with two 7-point scales on which lower numbers mean greater democracy. The sum of those scales drops from very high levels to about 7 at \$5,000 per capita (PPP) and then drops much more gradually at higher levels of GDP per capita.



The status of women in society presents one significant exception to the pattern of concentration of social change below \$5,000 per capita (PPP). The United Nations Development Program's Gender Empowerment Measure (GEM) tracks the economic, political, and professional participation of women in society (for instance, women hold about 10 percent of parliamentary seats globally). A value of 1.0 on the GEM would indicate equality of participation, but there are no countries in which the aggregate GEM exceeds 0.8. The measure increases rather steadily and linearly with GDP per capita. In short, the struggle for equal treatment of women will likely be won more slowly over the next century than the battles for high literacy, long life expectancy, and even the political forms of democracy.



Although it may seem almost cavalier to say it, these social transformations will also have a greatly ameliorating impact on the nationalist and intercultural struggles which many observers today predict will worsen in the future.¹⁸ Higher income and attendant increases in literacy, life expectancy, and democratic governance will not eliminate such conflicts. They will, however, channel much of the battle into open and relatively more peaceful political processes. Contrast the devolution of autonomy in Catalonia, Brittany, or Quebec (and even the intensity of conflict in Northern Ireland)¹⁹ with the level of violence of national conflicts in Bosnia, Chechnya, Kashmir, or Sri Lanka. This argument should, of course, not diminish the urgency of attention to nationalist and religious struggles, which claim thousands of lives annually.

Nevertheless, the more intransigent social problems of the 21st century are likely to be anomie and individual-based disorder rather than organized social conflict. With movements into service and information economies, richer societies have greatly reduced class-based tensions, largely by increasing the heterogeneity of social condition far beyond that typical of industrial society. The same forces will affect cultural or national conflicts within and between societies.

Yet that differentiation and disconnection of individuals and small groups within society undercuts society itself. Hence Bell wrote of *The Cultural Contradictions of Capitalism*, a communitarian movement draws attention ever more insistently to the disintegration of civil society, and signs of social stress, such as drug addiction, an intractable underclass, and growing prison population, proliferate.²⁰ Authoritarian Asian capitalism may believe that it can avoid such

problems, but current social transformations in Japan raise serious doubt.

Global System Change

Overall, we can anticipate significant social and political change in the next century across a wide range of countries, much of it constituting "progress." There is thus considerable potential for expansion of the grouping of rich, democratic countries that also boast relative demographic stability and high standards for human rights. That grouping now includes only Europe, North America, and a few other countries around the world. The complex layering of regional, domestic, and international governance structures that now characterizes Western Europe and to a lesser extent North America will likely also expand to additional countries. To the degree that the linkage between democracy and peace continues to hold, these changes also hold out the promise of a larger interstate zone of democratic peace.

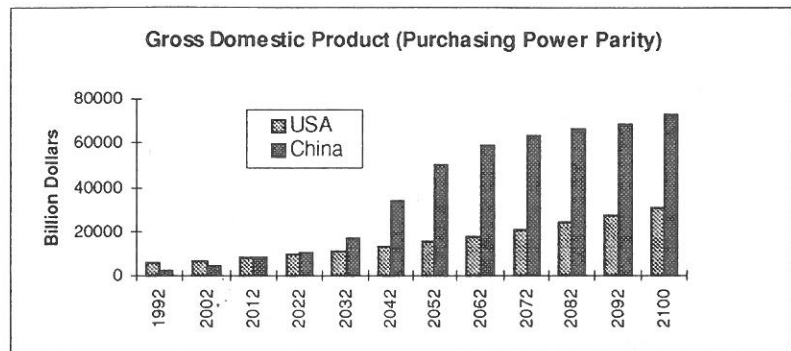
It would be foolish, however, to anticipate that the traditional rules of interstate politics will be repealed. And among the most important of those rules is that changes in power position at the top of the interstate power hierarchy hold great significance and danger of conflict. Seldom does the hegemonic or leading state of the system turn over its dominant systemic position without struggle (although, interestingly, the U.S. has seemed unconcerned as the European Union has aggregated a now comparable economic capability and appears poised to widen and deepen European integration still further).

It is probable that the most significant power transitions of the 21st century will involve Asia. Two merit special attention. First, China will climb above Japan in power. That will probably occur very early in the next century. Already China is reaching the level of Japan in terms of GDP at purchasing power parity. Given current growth rate differentials, it could surpass the GDP of Japan in exchange rate terms by about 2020. It is also likely to attain conventional military power parity with Japan between now and 2020 and already has a nuclear capability that the Japanese have forsworn. In short, this critical power transition appears likely in the first two decades of the 21st century. China's recent flexing of regional military muscle signals potential difficulties in the transition, and the presence in the region of the United States appears very important as it proceeds.

The second transition will be China's overtaking of the United States itself. If China were to maintain economic growth rates of 10

percent each year, and the U.S. continues to struggle for rates of only 3 percent annually, Chinese overtaking of the U.S. would follow its passing of Japan by only about 10 years. Even if Chinese economic growth falls by 2-3 percent annually, both power transitions are probable before the middle of the next century.

Interestingly, in 1820 China and India had by far the largest GDPs in the world, although they lacked significant internal coherence and external strength. China's GDP was more than five times larger than those of France or the United Kingdom. By 2100, China's GDP will likely be more than twice the size of the United States, and again more than five times the GDP of either France or Great Britain.



At the time of the transitions with Japan and the U.S., Chinese GDP per capita at exchange rates will probably be little more than \$3,000-\$4,000. Although this means that it will likely have completed a significant portion of the major social transformations we discussed earlier, these levels would not give China a high probability of having moved solidly to democracy. That is, Japan and the United States will be dealing with a country in the middle of its transition to democracy at the same time that it becomes the economically, and perhaps militarily most powerful country in the world.

Conclusions

We sometimes view our era as one of change so rapid that it sets us apart from both past and future. We recognize the pace of that change to be a major source of the domestic and international conflicts that have made the 20th century bloodier than any in the

past,²¹ one reason that we may prefer to look forward in hope to a quieter 21st century.

Demographic, economic, and social change in the 20th century has, in fact, been faster on a global scale than ever before. And we have passed the turning point of demographic growth, so that even probable addition to world population in the 21st century of as many people as were added in this century will be a proportionately much smaller change.

We would be mistaken, however, to anticipate less rapid economic (including agricultural and energy), environmental, or sociopolitical change in the coming century. Global economic growth will probably be more rapid. Agricultural and energy transitions will be difficult and the most significant single environmental problem of the fossil-fuel era, global carbon emissions, will worsen. Most of the world will pass through a stage of economic development characterized by highly turbulent sociopolitical transformation. In addition, the country poised to move into global economic leadership, after a century of U.S. leadership, will almost certainly have a much less stable democracy than did the U.S. when it took the global reins from Great Britain.

Nonetheless, those who subsequently review the 21st century may well be able to conclude with pride that, in *their* century, humanity attained demographic stability with long life expectancy and literacy for almost all, freed nearly everyone from malnutrition, converted much of the energy system to a sustainable one with the promise to stabilize and then reduce atmospheric carbon dioxide, and created strong democratic institutions in most of the world. Important sustainability and sociopolitical transformations will be very far advanced. In short, the 21st century may ultimately prove itself a good one, but younger generations should hold on for a rough ride.

NOTES

1. Thomas Malthus, *An Essay on the Principle of Population as It Affects the Future Improvement of Society* (London, 1798); Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, and William K. Behrens, III, *Limits to Growth* (New York: Universe Books, 1972); Donella H. Meadows, Dennis L. Meadows, and Jorgen Randers, *Beyond the Limits* (Post Mills, Vermont: Chelsea Green Publishing Company, 1992); Lester R. Brown, *Who Will Feed China?* (New York: W.W. Norton, 1995); Lester R. Brown, *Tough Choices: Facing the Challenge of Food Scarcity* (New York: W.W. Norton, 1996); Robert Kaplan, "The Coming Anarchy," *The Atlantic Monthly* 273 (February, 1994); Sir

Francis Bacon, *New Atlantis*; Herman Kahn, William Brown, and Leon Martel, *The Next 200 Years* (New York: William Morrow, 1976); Julian Simon, *The Ultimate Resource* (Princeton, NJ: Princeton University Press, 1981); John Naisbitt, *Megatrends* (New York: Warner Books, 1982); Ronald Bailey, ed., *The True State of the Planet* (New York: The Free Press, 1995). My thanks to David Horan for research assistance throughout this article.

2. The forecasts presented in this article were produced with version 3.05 of the International Futures (IFs) global computer simulation; see Barry B. Hughes, *International Futures* (Boulder, CO: Westview Press, 1996) for version 2.21. For information on IFs see <http://www.du.edu/~bhughes/ifs.html>. To download version 2.21 see the site maintained by William Dixon at <http://w3.arizona.edu/~polisci/ifs/>. The base case of the IFs modeling system has been tested against, and produces long run forecasts generally consistent with, the analyses of the United Nations, World Bank, Food and Agricultural Organization, Organization for Economic Cooperation and Development, and others.

3. Historic estimates from John D. Durand, "The Modern Expansion of World Population," *Proceedings of the American Philosophical Society* 111 (1967) and the United Nations, *Demographic Yearbook* (New York: UN, 1961).

4. Angus Maddison, *Monitoring the World Economy 1820-1992* (Paris: OECD, 1995), pp. 19, 226-227. Maddison's measures use purchasing power parity calculations. Although he is very careful about comparing approaches and selection of measures, historic (and even contemporary) GDP estimation remains an art with considerable uncertainty attached.

5. Because the global income distribution is so skewed, median GDP per capita (the level where an equal number of people have incomes above and below it) is still solidly below \$2,000. See Barry Hughes, *Continuity and Change in World Politics* (Englewood Cliffs: Prentice-Hall, 1997), p. 390.

6. The absolute gap in per capita GDP between rich and poor countries will likely continue to increase throughout the 21st century. Just as slowing population growth rates applied to growing population bases have added increasing numbers of people to the global population over the last several decades, the bases of GDP per capita in rich countries are so much higher than those in poor countries that even much slower growth rates in the former will add relatively more incremental per capita dollars for many decades.

7. Intergovernmental Panel on Climate Change (IPCC). See three volumes by three working groups (New York: Cambridge University Press, 1995). See also the IPCC web page at <http://www.unep.ch/>

ipcc/ipcc-0.html.

8. Maddison (1995), 38.

9. The Food and Agricultural Organization (FAO) has placed much of the text of recent publications concerning world food conditions and forecasts on the World Wide Web. See <http://www.fao.org/>.

10. Lester R. Brown, *Who Will Feed China?* (New York: W.W. Norton, 1995). See also Lester R. Brown, *Tough Choices* (New York: W.W. Norton, 1996).

11. See, for example, Nikos Alexandratos, *World Agriculture: Towards 2010*. (New York: FAO, 1995), p. 151. In sharp contrast to Brown, however, the International Food Policy Research Institute (IFPRI) believes that China will obtain sufficient increases in production and efficiency of production so that grain imports will increase only to 22 million tons in 2020. See Mark W. Rosegrant, Mercedita Agcaoili-Sombilla, and Nicostrato D. Perez, "Global Food Projections to 2020: Implications for Investment," Food, Agriculture, and the Environment Discussion Paper 5. (Washington, D.C.: International Food Policy Research Institute, 1995). That appears very optimistic.

12. The 3.5-fold increase that we need in global production (calculated earlier) would require an annual average increase in production of about 1.3% over a century. The FAO points out that the rate of increase in global production has declined from 3.0% in the 1960s to 2.3 percent in the 1970s and 2.0 percent between 1980-92. They foresee a further decrease to 1.8 percent through 2010 (Alexandratos, 1995: 5).

13. British Petroleum produces an annual statistical review that is invaluable for understanding global energy patterns. See also World Energy Council (WEC) Commission, *Energy for Tomorrow's World* (New York: St. Martin's Press, 1993) and the International Energy Agency (IEA), *World Energy Outlook* (Paris: International Energy Agency, 1996).

14. International Energy Agency (IEA), *The Strategic Value of Fossil Fuels: Challenges and Responses*. (Paris: International Energy Agency, 1996).

15. Intergovernmental Panel on Climate Change (IPCC), *Climate Change 1995: Impacts, Adaptations and Mitigation of Climate Change*, Volume of Working Group II. (New York: Cambridge University Press, 1995), pp. 15-18.

16. It may seem cavalier to skip over deforestation here. We are likely to lose at least another 10 percent of global forest area in the next century. Nonetheless, global warming is a more substantial problem.

17. The IPCC notes that published estimates of the damage from carbon emissions range from \$5 to \$125 per ton, but that uncertainties prevent confidence in even this wide range. (For context, current annual emissions of about 6 billion tons of carbon, with an environmental damage estimate of \$50 per ton, would mean that energy systems had an unrecognized cost of \$300 billion, about 1 percent of the global product.)
18. Samuel P. Huntington, "The Clash of Civilizations," *Foreign Affairs* 72, no. 3 (Summer, 1993); 22-49.
19. About 3,000 people have been killed in the civil strife of Northern Ireland (*International Herald Tribune*, July 21, 1997, page 6).
20. Daniel Bell, *The Cultural Contradictions of Capitalism* (New York: Basic Books, 1976); Amitai Etzioni, ed., *New Communitarian Thinking* (Charlottesville: University Press of Virginia, 1995).
21. War casualties per capita in the 20th century have been more than twice those of the unusually nasty 17th and 18th centuries.