North America 2030: An Environmental Outlook

Discussion Paper

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The issues presented in this discussion paper will inform the agenda of the Commission for Environmental Cooperation's (CEC) Joint Public Advisory Committee's (JPAC) environmental outlook conference to be held on 25 June 2008. In addition to the JPAC's consideration of these topics, the CEC Council has asked the Secretariat to summarize and assess the existing research concerning the major forces and underlying trends that are likely to impact the environment in North America to 2030. This research is expected to be published later in 2008. These initiatives are intended to assist the CEC in the consideration and development of its 2010-2015 Strategic Plan by highlighting possible areas for cooperative action to support environmental mitigation, adaptation and innovation strategies across all three countries.

1 Introduction

North America's environmental future is not pre-ordained. Indeed, experts posit a range of possible scenarios for the continent's environment in 2030 (see Box on page 3). While many factors account for these differences, government policy decisions, at all levels—including in the area of international cooperation—and on matters as diverse as climate change and urban landform, will have a determining impact in influencing which environmental future comes to pass.

Overall, the picture that these experts paint of the North American environment in 2030 is similar to today's except that the pressures are greater and the environment is therefore under more stress: North Americans continue to lead similar lifestyles, consume the same fossil fuels (in slightly different proportions), and exploit the same mineral and renewable resources. Because the economy is bigger, the population larger, and material consumption greater, experts expect that North Americans will require more energy, use more land, and generate more wastes, in spite of expected technological progress. These pressures, in turn, will have a detrimental effect on environmental quality. The exception is air quality, which is expected to improve as a result of increasingly stringent standards and regulations.

This broad picture, of course, hides significant differences across the continent and among various scenarios. North America's economic, social and environmental diversity implies that the same events and trends (e.g., oil price spike, climate change), as well as their impacts, will manifest themselves differently depending on the region. This diversity makes the development of coordinated environmental policies more complex.

In addition, the scenarios explored here are subject to the usual uncertainties associated with the possibility of dramatic, albeit imaginable, surprises that would alter this outlook significantly. These include:

- An oil price shock or the interruption of international oil supplies leading to economic disruption and a greater policy emphasis on energy efficiency and the

more rapid development of North American energy sources, including renewable energy technologies;
- An "albedo flip" accelerating the melting of arctic ice, opening up the Northwest Passage to summer navigation and encouraging the migration of species north to the possible detriment of existing ecosystems;
- A disease pandemic, disrupting trade, economic prosperity and population growth;
- Technological breakthroughs leading to the rapid adoption of more environmentally-benign products and processes.

Thus, while 2030 is close enough in time that North Americans will be using much of the capital stock and many of the technologies they are using today, it would be a mistake to assume either that our choices today will not or cannot influence environmental quality in this period or that development will follow a simple linear path.

The rest of this paper is organized in three sections:
- Section 2 summarizes the main trends driving the environmental agenda;
- Section 3 describes five key environmental issues; and
- Section 4 proposes questions for discussion.

Key Sources of Expert Projections

This discussion paper draws primarily on the Organization for Economic Cooperation and Development's (OECD) *Environmental Outlook to 2030* (2008) and the United Nations Environment Program's *Global Environmental Outlook* (2007) for the projections presented. These are supplemented by other sources, for example, the most recent projections of the UN Population Division population projections (UNPD 2007, 2008).

The OECD Environmental Outlook is built around a baseline reference scenario (OECD Baseline), in which currently existing policies are maintained but no new policies are introduced, particularly none to protect the environment. Various policy 'variants' are explored related to, for example, local and regional air pollution, greenhouse gas emissions, and agricultural support. Two that are considered at various points in this report are their more stringent variants—one being a global policy package (OECD pp Global) and the other reflecting policies needed to stabilize atmospheric concentration at 450 parts per million by volume of carbon dioxide equivalents (OECD 450 ppm).

In contrast, the four GEO-4 scenarios have fundamentally different assumptions about changes in individual behavior and public policies. Briefly, in:
- ***Markets First*** (GEO4 MF) – maximum economic growth is pursued; this emphasizes technological solutions to environmental problems. "Lip service" (sic) is paid to sustainable development policies.
- ***Policy First*** (GEO4 PF) – strong policies to improve human and environmental well-being are implemented, primarily in a top-down fashion. Social and economic considerations are biased in favour of environmental considerations.
- ***Security First*** (GEO4 SeF) – or 'Me First'; the focus is on power and wealth generation for select groups.
- ***Sustainability First*** (GEO4 SuF) – there is a persistent push for the implementation of sustainable development policies from all sectors of society. There is a strong emphasis on equity; and equal weight given to environmental and socio-economic policies.

Further details on each of these scenarios are provided throughout this paper.

2 Trends Driving the Environmental Agenda

Three broad sets of trends are expected to drive North America's environmental outlook over the next quarter century. These are:

1. The Continued Growth of North American Societies
2. Global Environmental Change and
3. The Security Agenda

2.1 Continued Growth and Integration of North American Societies

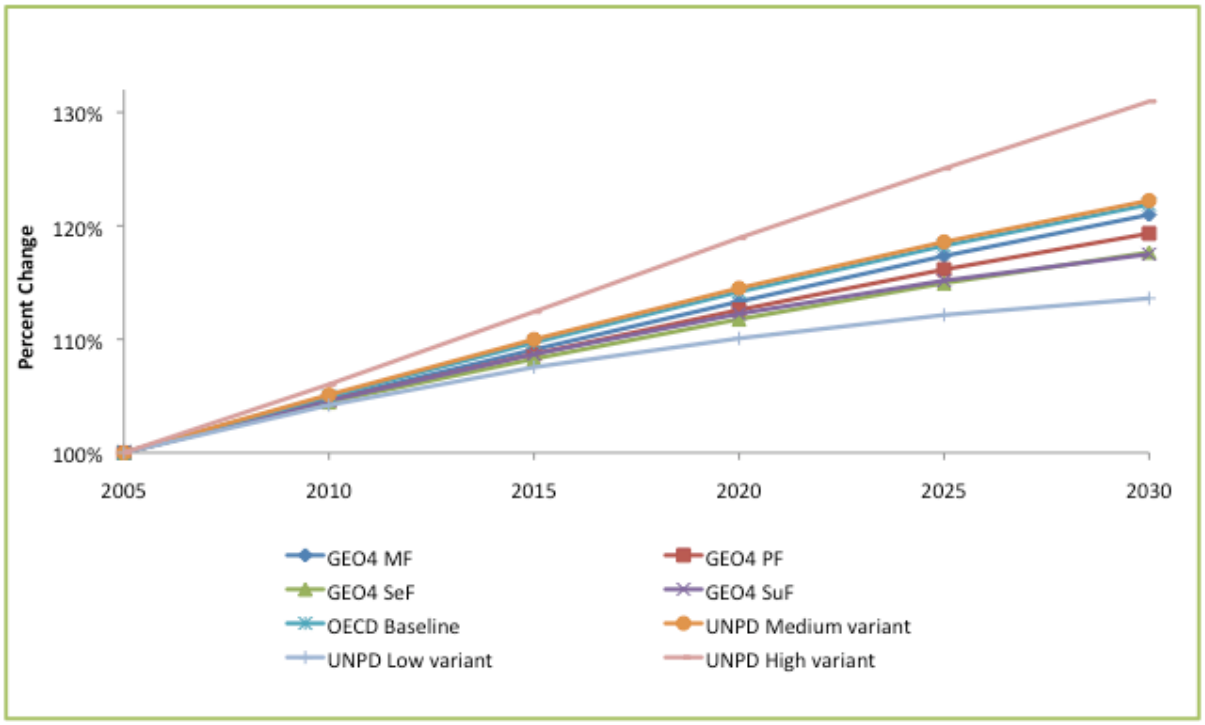
Over the next few decades, the population of North America is expected to grow, both in size and in wealth (Figure 1). The UN Population Division presents estimates of total growth ranging from 60 to 135 million people between 2005 and 2030 or by 14 to 31 percent from 2005 levels (UN 2007). The GEO4 and OECD estimates all fall within this range, clustering around a 20 percent increase, or approximately 100 million people.[1] Even the low number represents the addition of almost three times Canada's current population in only a quarter century.

Somewhat surprisingly, the expected growth rates over this period are slightly lower in Mexico than either the United States or Canada, reflecting its continued rapid decline in birth rates. A further reason for this is that Mexico is noted as one of the countries with the highest levels of net emigration at the present time, and this situation is not expected to change in the near future (UN 2007).

Importantly, much of this population growth will occur in urban areas. In its Medium Variant, the only one for which it provides estimates, the UN projects the percentage of persons living in urban areas in North America rising to over 85 percent in 2030 compared to under 80 percent in 2005. New York and Mexico City also maintain their status as two of the world's largest urban agglomerations (UN 2008, p. 10). These trends actually imply greater absolute growth in urban areas than in the population as a whole and an absolute decrease in the rural populations. This trend is evident in all three countries. In the UNEP GEO4 scenarios, the same pattern is seen at the North American level and in Canada and the United States; only in Mexico is an increase in the rural population expected.

[1] Note that the OECD policy variants assumed no changes in the population estimates.

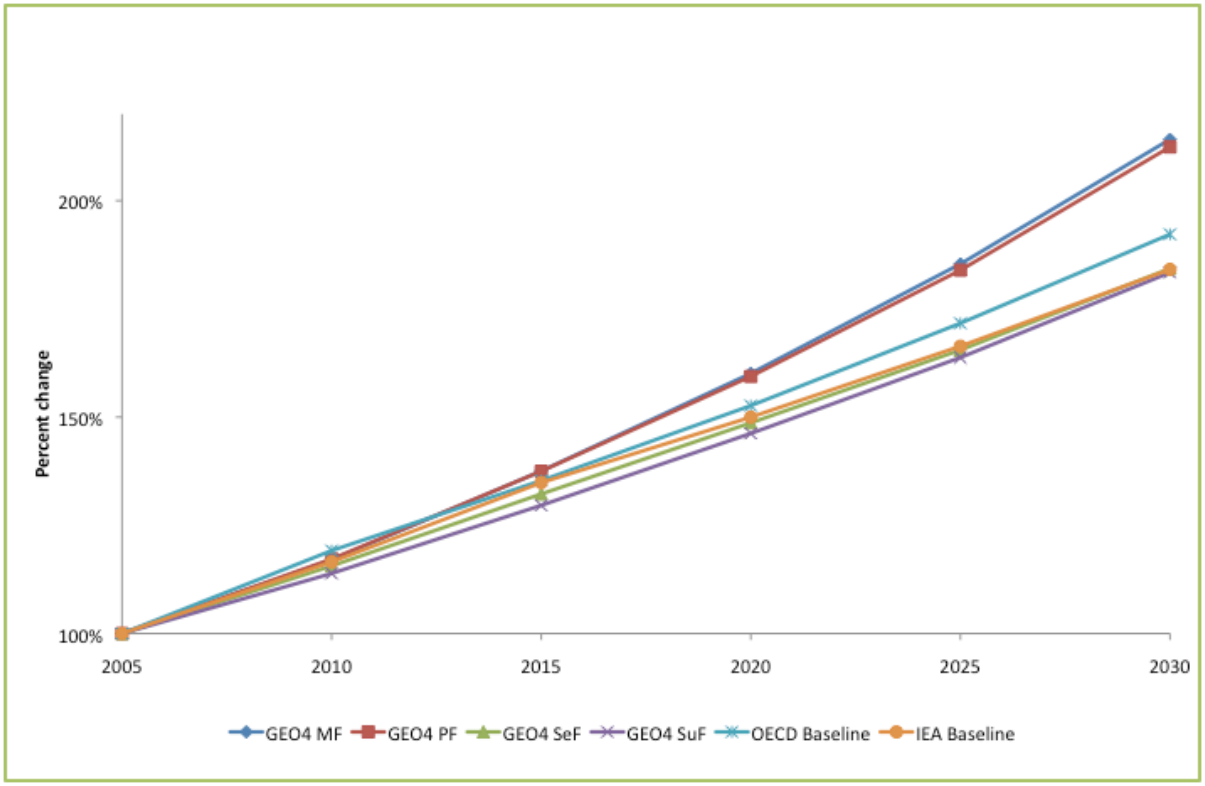
Figure 1: Total Population



Finally, a significant ageing of the population is expected throughout the region, with the percentage of the population 65 years or older significantly increasing in all countries. By contrast, a decrease is expected in the share of population under the age of 15 (more slowly in Mexico).

North America's economic growth is expected to remain robust to 2030, in part because the same factors that have contributed to this growth in the past remain present (increase in the size of the labour force, increased labour productivity, stable political climate, etc.). Projections of the average rate of annual growth for North America range from 3.4 to 4.7 percent, resulting in an 80 to 115 percent increase in total economic activity from 2005 to 2030 (Figure 2). In terms of GDP per capita, the increases are on the order of 55 to 80 percent over this period. Average incomes will rise in all three countries, but Mexico's will continue to lag behind that of the United States and Canada.

Figure 2: Total Gross Domestic Product



Population size and disposable income are the main drivers influencing consumption levels. The expected increase in population and continued rise in average per capita incomes in North America imply a steady increase in material consumption levels over the next 25 years (OECD 2008):

- Studies have shown that there is a positive relationship between per capita income and growth in demand for energy, food and the generation of wastes.
- The number of cars owned by households increases with incomes, as well as car use and total travel.
- Changing lifestyles, such as smaller households, will impact the environment because smaller households tend to use more resources (e.g., water and energy) per person.
- Whereas the previous factors would increase environmental stresses, the ageing of the population may reduce them. Older people tend to consume fewer goods and more services, which in general reduces their environmental footprint.

This growth in population and economic activity is almost certain to increase the demand for environmental goods and services in the form of material inputs from the environment and the amount of byproducts that are discharged to it. Even if the environmental impacts per dollar of GDP decline over time, reflecting a decoupling of economic growth from environmental impacts due to continued productivity increases driven by the application of new technologies and structural changes in the economy

(i.e., away from those sectors that affect the environment most directly—agriculture, forestry, mining), the continued growth in population and economic activity implies that the total level of impact is likely to continue to rise. A key factor influencing the scale of this impact will be the policy choices made which will influence, among other things, the nature and rate of technological advances.

While the North American Free Trade Agreement (NAFTA) provided an impetus to increased trade among Canada, the United States and Mexico, the economies of these three countries were already highly integrated even before the Agreement was signed. North America today is considerably different than when the NAFTA was first implemented, having moved with full implementation to a stage of deeper integration. This integration is the result of powerful geographic, economic and demographic factors and is expected to remain in the foreseeable future, albeit not necessarily in its current form. With closer economic ties and tighter supply and market linkages spanning the continent, trade and commercial relations are certain to play an increasing role in both the emergence and resolution of environmental issues.

2.2 Global Environmental Change: the North American Challenge

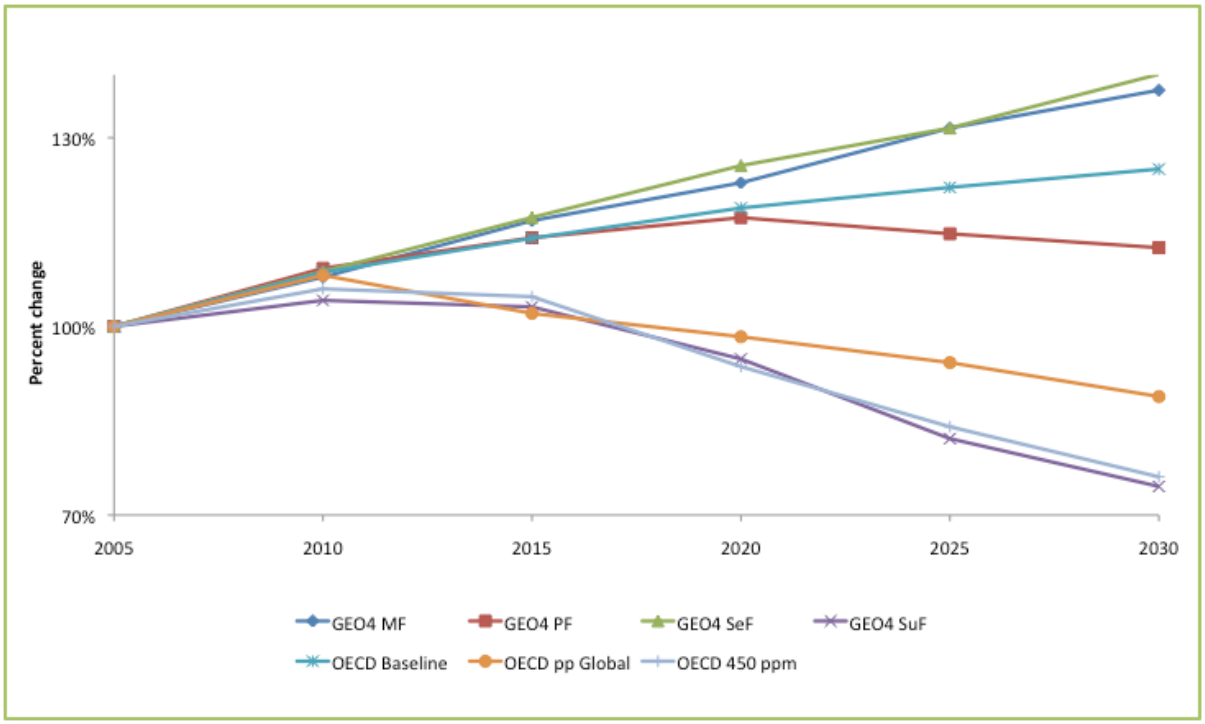
North America's continued development will increasingly take place against a backdrop of global environmental change. The strongest manifestation of this change will be global mean temperatures, expected to rise at an increasing rate, reaching around 0.3°C per decade by 2030.[2] Furthermore, the Intergovernmental Panel on Climate Change (IPCC) indicates in its 2007 report that annual mean warming is likely to exceed the global mean warming in many parts of North America, particularly the Arctic.[3]

This rate is one to which the world is essentially already committed to as a result of greenhouse gases already in the atmosphere. As such, there is little difference across the scenarios in this regard over the period to 2030. The scenarios, however, do differ in their estimates of atmospheric concentrations of greenhouse gases and, more significantly, the underlying emissions that will drive longer-term warming. Demonstrating the importance of policy for environmental outcomes, total GHG emissions in North America are projected to rise by as much as 40 percent or decline by as much as 25 percent between 2005 and 2030 (Figure 3). The lower level of emissions in the OECD and GEO scenarios reflect increasingly stringent policies, particularly the imposition of a price on GHGs, either in the form of a carbon tax or a cap and trade system. GEO4 SuF goes further to include specific efforts to reduce net emissions from land use changes while the OECD scenarios include policies to bring forward the introduction and uptake of second generation biofuels (OECD 2008, p. 438).

[2] Note that OECD and GEO4 scenarios both likely underestimate the increases in global mean temperature. This is because both relied on the same model, IMAGE, which was still using a median estimate for climate sensitivity from the IPCC's Third Assessment Report, 2.5°C for double the atmospheric GHG concentration of pre-industrial levels; this estimate was raised to 3.0°C in the IPCC's Fourth Assessment Report.

[3] Intergovernmental Panel on Climate Change (2007), Fourth Assessment Report.

Figure 3: Total GHG Emissions



On balance, the socio-economic impacts of climate change are expected to be negative (Ruth et al. 2007). Climate change is projected to affect human health through:

- More intense and prolonged heat waves (UNEP 2007). There is likely to be a substantial increase in health risks from heat waves in the Midwestern states because of demographic shifts to more vulnerable populations and an infrastructure no longer adequate to withstand severe heat extremes. (Ebi and Meehl 2007).
- Increased smog episodes in some locations (UNEP 2007). In the eastern United States, ozone related deaths from climate change could increase by approximately 4.5 percent from the 1990s to the 2050s (Field et al. 2007). Health problems would be exacerbated in cities subject to air inversions, such as Mexico City (Magrin et al. 2007).
- An increase in water- and food-borne contamination, and diseases transmitted by insects (such as Lyme disease, West Nile Virus and Hantavirus pulmonary syndrome) in some locations (UNEP 2007). This would include an increase in the population at risk from malaria and dengue fever in Mexico (Magrin et al. 2007).

Some populations will be more affected by climate change than others (e.g., the very young and the very old, low income people, Aboriginal populations in the Arctic).

Other expected impacts of climate change include:

- An increase in the frequency and intensity of extreme weather hazards such as floods, droughts, and hurricanes as well as increased forest fire activity (Hirsch,

2004; Government of Canada, 2004). Experts expect that public disaster management and response will require increased resources to address more frequent and bigger fires, floods, and heat waves (Ebi and Meehl 2007).

- A drop in water levels in the Great Lakes and the St Lawrence, requiring additional dredging to some existing shipping lanes (Field et al. 2007), reducing hydroelectric production and adversely affecting tourism. Already dry areas (e.g., the southwestern US) are expected to be particularly vulnerable to increased droughts, the continued mining of underground aquifers and the melting of the snowpack feeding rivers.
- Increased damages from coastal storm events (aggravated by slowly-rising sea levels), causing widespread problems for transportation along the Gulf and Atlantic coasts (Field et al. 2007).
- A mixed impact on agriculture. Several crops may see increased yields (e.g., corn, rice, sorghum, soybean, wheat, common forages, cotton and some fruits) (Field et al., 2007) while others (e.g., Mexican coffee (Magrin et al. 2007) and California grapes (Ruth et al. 2007) could be adversely affected. The negative impact of strained water resources on agricultural production is expected to be in the billions of dollars (Ruth et al. 2007).
- An extended season for forest fires (Field et al. 2007) while warmer temperatures overall facilitate the spread of forest pests such as the pine beetle.
- A mixed impact on fisheries with cold-water fisheries likely to be negatively affected (with gains in the northern and losses in the southern portions of ranges) while warm-water fisheries may gain (Field et al. 2007).

Global environmental change may also affect North America indirectly by increasing resource competition, reducing global bio-diversity, exacerbating regional political and economic tensions and creating new refugees in different continents. In an increasingly interdependent world, North America cannot insulate itself against the spread of infectious diseases or pollution from abroad. Already, Arctic residents and wildlife are subject to persistent organic pollutants and heavy metals originating outside North America while air pollution from Asia (including toxic substances such as mercury) is now being recorded on the West coast of the continent.

If North America will absorb environmental pressures from the rest of the world, it also will continue to impose such pressures outside its borders, not only through its own GHG emissions (Canada, the United States and Mexico currently rank among the top 11 emitters of fossil–fuel-based CO_2 emissions) but also through its higher than world-average material standard of living, which requires the importation of a wide range of products and resources whose environmental costs are concentrated at the point of production.

2.3 Environmental Security

The concept of security long outgrew its traditional roots in military defence to embrace domains as diverse as energy and food. Over the next 25 years, the concept may broaden further to encompass environmental security.

Energy security, for example, has long guided American policy. US energy demand has contributed largely to the growth of the oil and gas industry in North America and is one of the main factors behind the current rapid expansion of the Alberta oil sands.

The possibility that the world may be running out of cheap, easily-accessible sources of oil ("peak oil") may accentuate pressures to develop North American energy sources (e.g., oil shales, oil sands, biofuels, offshore oil, coal, Arctic oil and gas, including perhaps seabed methane hydrates) for the benefit of North American consumers. Several of these sources are environmentally riskier than conventional supplies and in some cases large contributors of greenhouse gases.

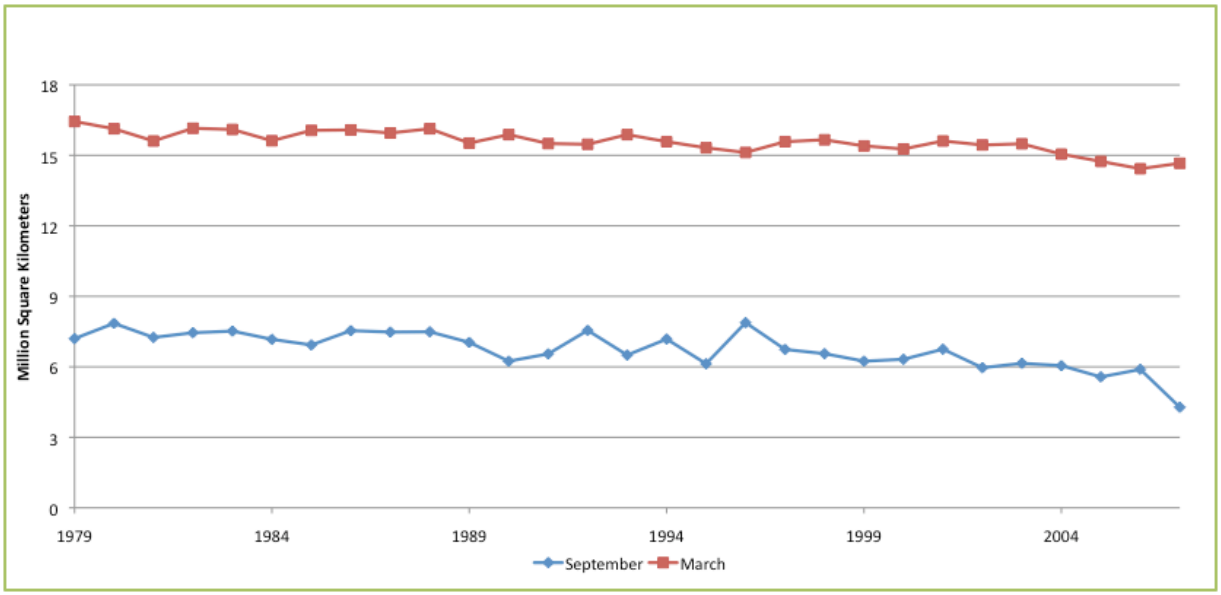
Food security may emerge as a more important issue over the next two decades, partly driven by rising consumer demand in North America and internationally, the growing use of food crops for fuel and the impact of climate change on worldwide agricultural production. The pursuit of North American food security policies is likely to require the more intensive use of agricultural land as well as greater production inputs.

The application of the term security to public policy is likely to continue evolving as new threats are recognized. The impending opening up of the Northwest Passage to commercial navigation (Figure 4) has already led Canada to step up its military and regulatory presence in the Arctic. Melting Arctic ice could have major implications not only for commercial navigation (the Northwest Passage offers a much shorter route between Asia and Europe or the eastern Seaboard) but also for the development of oil, gas and other minerals (significant oil reserves are thought to exist in the Arctic), fish and wildlife (some species are expected to be particularly vulnerable to rising temperatures), and the growth of human settlements. In addition to these environmental implications, increased Arctic development could lead both to conflict over maritime boundaries (several competing claims already exist) and also to increased smuggling. Thus, while security concerns may lead to environmental implications (e.g., arising from accelerated domestic oil development), environmental change (the opening up of the Northwest Passage) may also lead to security concerns.

The pursuit of North American security policies in the face of perceived external economic or environmental threats has the potential of intensifying the development of continental resources, with significant local and regional environmental consequences.

Figure 4: Changes in Arctic ice cover, 1979–2007

(data from National Snow and Ice Data Center - http://nsidc.org/data/seaice_index/archives/index.html)



3 Resulting Issues

We have clustered expected changes in environmental quality over the next twenty-five years around five broad issues:

1 Energy use and production
2 The built environment
3 Competition for water
4 Human health, and
5 Biodiversity

3.1 Energy Use and Production

Energy use and production are key determinants of environmental trends. They are primary contributors to GHG emissions and air pollutants as well as a major influence on landscapes. At the same time, trends in energy use are amenable to policy action. As a result, there is a greater range of possible scenarios here than elsewhere, with sharply different environmental and economic implications.

Projections of energy use in North America show that increases in the near-term on the order of 10 to 20 percent between 2005 and 2015 are all but inevitable (Figure 5). By 2030, however, the range broadens significantly from no growth to a nearly 50 percent increase. In every case, fossil fuels continue to dominate energy use. Even in the more aggressive scenarios, fossil fuels still account for over 75 percent of fuel use in 2030, albeit with a shift from coal to natural gas (Figure 6). Modern biofuels also play an increasing role in these scenarios, reaching levels of 7 to 10 percent by 2030. Finally, the sectoral breakdown of energy use is not expected to shift significantly between now and 2030 (Figure 7). Transport continues to dominate, rising to as high as 48 percent in 2030 from a present level of around 41 percent. Industry's share is expected to fall slightly, from 25 percent today to over 20 percent in 2030 in all of the scenarios considered. Small increases are also expected in the service sector in most scenarios.

What lies behind the differences seen in the scenarios? Certainly the differences in population and economic activity, and to a lesser extent differences in lifestyle choices, play a role. Some scenarios (Figure 5) also posit a greater role for nuclear power. More important, however, are differences in policy, especially those related to GHG emissions as discussed earlier, i.e., the imposition of carbon pricing and investments in renewable energy technologies. Even so, energy production and use contribute greater than 75 percent of all GHG emissions and 85 percent of all CO_2 emissions in the scenarios with the strictest policies. It is important to note, though, that certain policies, e.g., an explicit effort to sequester carbon, were not explicitly considered in the scenarios presented here.

Figure 5: Total Primary Energy Use

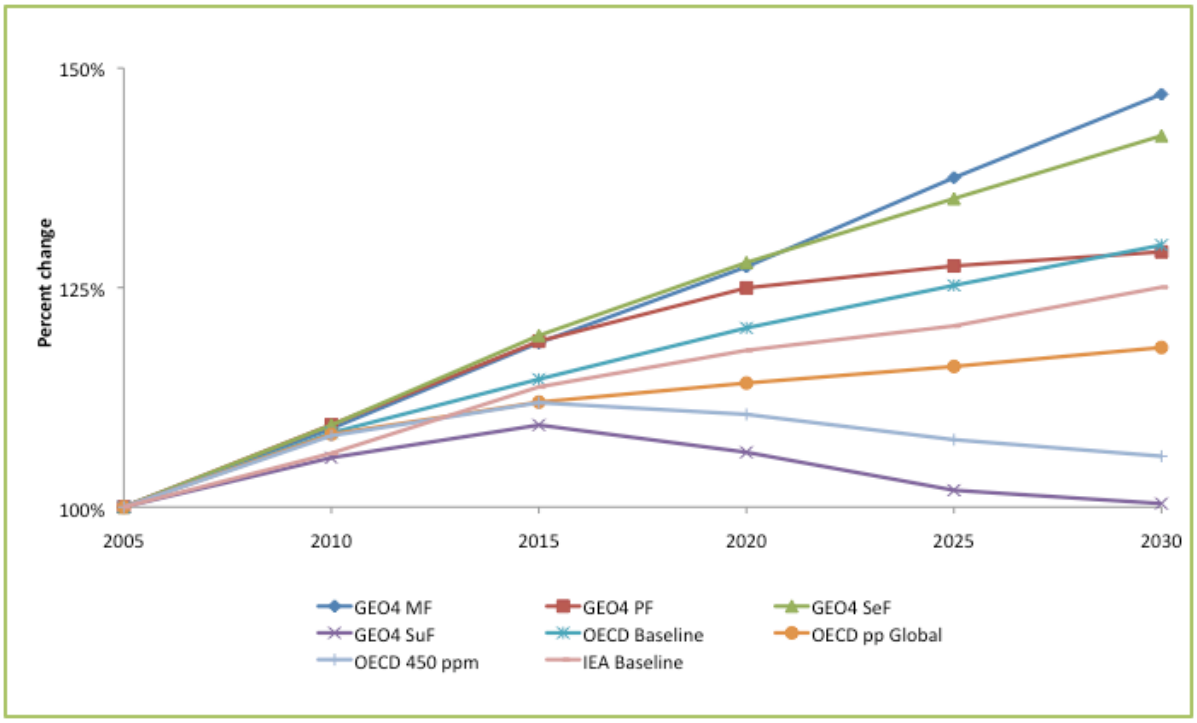


Figure 6: Primary Energy Use by Fuel

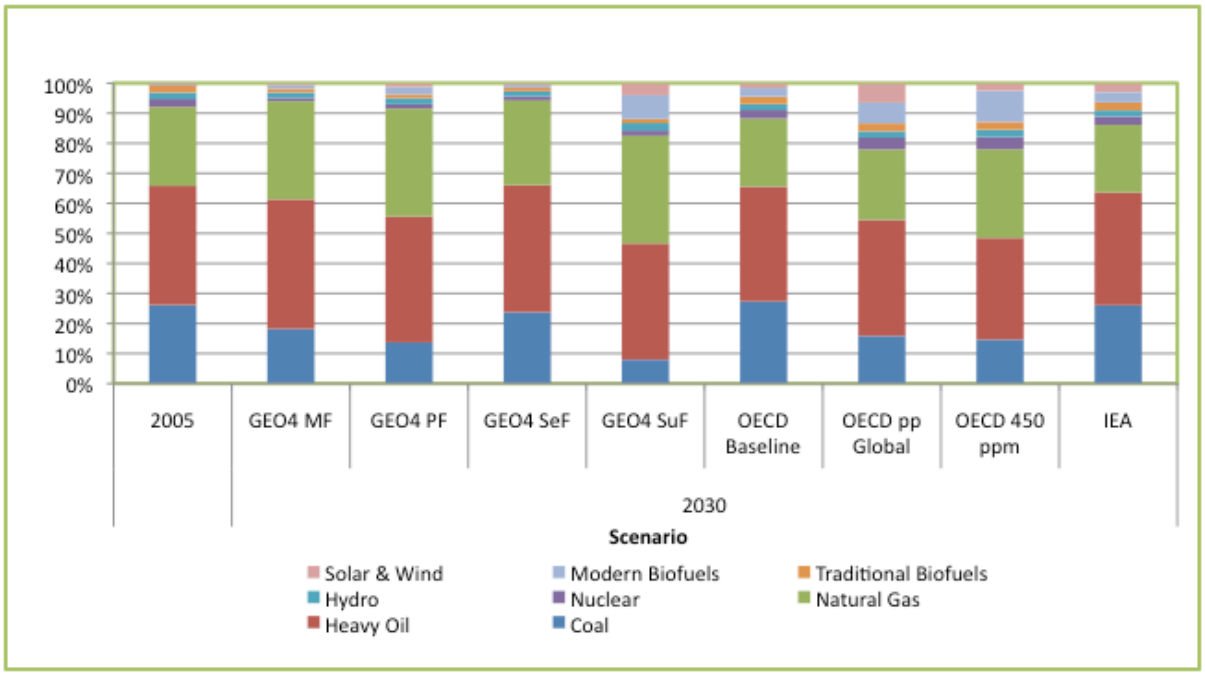
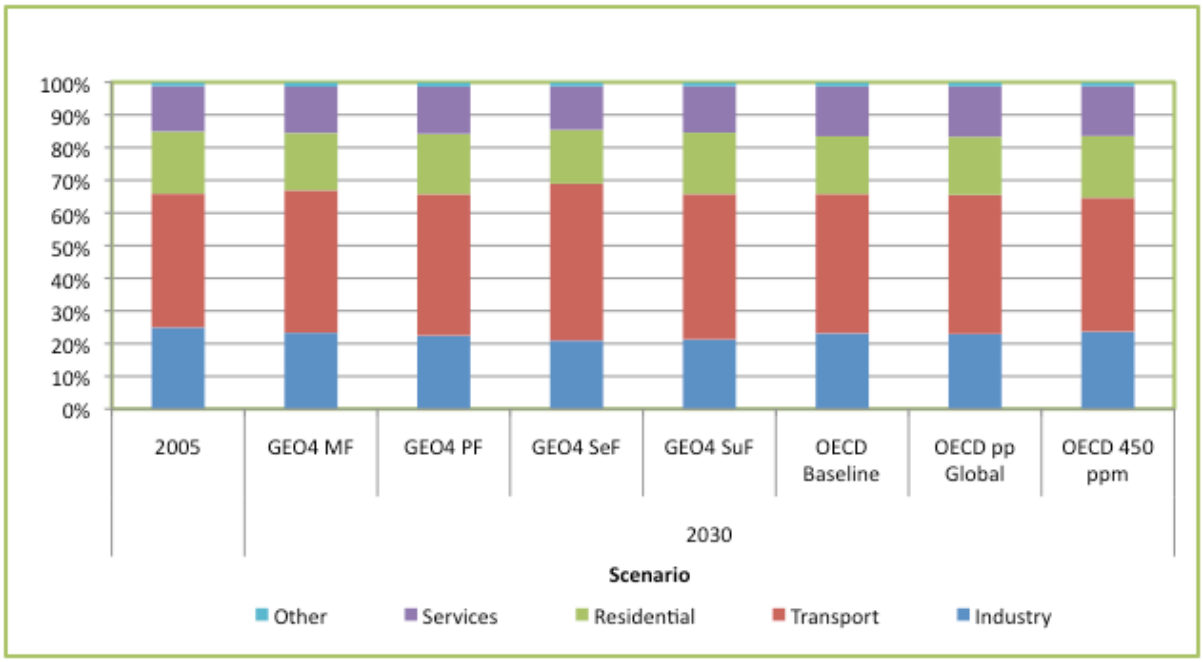


Figure 7: Final Energy Use by Sector



All three countries in North America have historically been significant producers of energy in the form of oil, natural gas, and, particularly in the United States, coal. North American oil and gas production is projected to increase slightly between now and 2030, but not as fast as demand, so imports will continue to increase, mostly in the US. This production will increasingly depend on unconventional sources, however, such as off-shore deposits and the oil sands of western Canada. Coal production will rise steadily (US EIA 2007; NEB 2007). The production of energy from these sources is more expensive and thus relies on continued high prices. More significantly, production from the oil sands disturbs large areas, uses large amounts of energy and water, and has potentially significant impacts on air and water quality (Woynillowicz et al. 2005). Therefore, how these resources are developed will have a strong impact on the environment of the continent.

3.2 The Built Environment

Although ultimately dependent on the natural environment, most human activity occurs in heavily modified spaces. The most modified spaces—urban areas, highways, and other large pieces of infrastructure—can be referred to as the built environment. How the built environment evolves over time, both its individual components and the pattern in which they are placed on the landscape, will have a significant impact on the environment of North America as a whole.

A key aspect of the components of the built environment is resource use. As noted earlier, the OECD and UNEP expect the shares of final energy use to remain about the

same in the residential sector and increase slightly in the service sector; given the overall growth in energy use, these imply net increases in consumption and attendant environmental effects. This increase is due to both to a larger population and a higher per capita consumption, particularly in Mexico. Other studies, however (e.g., Adelaar et al. 2007), point to the significant potential for improvements in energy efficiency, and by analogy, greater resource efficiency overall, in these sectors in North America. Their Deep Green scenario posits an aggressive but technically achievable goal of significantly reduced energy use and zero net carbon emissions in the commercial and residential building stock of North America by 2030. Making this happen, though, will require strong efforts in research and development and capacity building, as well as the implementation of policies that ensure that the market reflects the full societal costs of energy use.

Perhaps the most significant issue is that of how urban areas develop in the future. As noted earlier, between intrinsic growth and continued rural to urban migration, the population of urban areas is expected to grow faster than the total population in North America. Median estimates put this at a 30 percent increase in urban population between 2005 and 2030 versus 20 percent for the total population. In conjunction with other factors, notably increasing incomes, this is expected to lead to an even larger increase in the extent of urban sprawl. One estimate is that the extent of built-up area in North America will more than double by 2030 (Angel 2006; Angel et al. 2005).

The implications of this level of urban sprawl go well beyond the mere conversion of other types of land, oftentimes rich agricultural land, to built-up areas. In the absence of explicit policies, reduced density is associated with increased transportation and related environmental impacts in the form of increased energy use and air and water pollution. The increase in infrastructure that comes with larger urban areas is also a key factor affecting local biodiversity. On a broader scale, the resources required to build this new infrastructure will create environmental impacts elsewhere on the continent and around the world.

3.3 Competition for Water

Growing populations and economic activity will lead to increasing demands, and competition, for resources. At the regional scale, perhaps the most important of these resources is water.

Freshwater use in North America currently exceeds 600 billion cubic meters per year, dominated by agriculture (approximately half of all withdrawals) and electricity production (up to 40 percent of withdrawals) (Figure 8). The OECD Baseline scenario projects an increase of approximately 10 percent between 2000 and 2030, with the fastest growth occurring in the domestic and manufacturing sectors; agriculture is

actually expected to see a slight decline.[4] The GEO-4 scenarios show a range of possibilities for this period, however, from a decrease of almost 30 percent to an increase of 40 percent. Accounting for these differences are assumptions related to population growth, economic activity and the rate of change of water use efficiency. Such an increase in efficiency could be driven in part by more consistent and comprehensive pricing of water, including the reduction of water use subsidies.

One of the major implications of increasing water use is an increase in water stress.[5] Currently, approximately 40 percent of North Americans, or 170 million people, live in river basins facing severe water stress. This includes more than 50 percent of the Mexican population and much of the southwest of the United States. In the OECD Baseline, the percentage is projected to stay roughly the same in 2030, but this still implies an additional 30 million people facing severe water stress at that date (Figure 9). The reduced demands, even when combined with slower population growth, in the GEO4 PF and GEO4 SuF scenarios are not able to fully counteract the expected negative impacts of climate change[6]. An additional 15–20 million persons will face severe water stress by 2030 according to these scenarios. Faster population growth and increased demands in GEO4 SeF lead to projections of closer to 50 percent of the population of North America—more than 240 million persons, or 70 million more than at present—living in river basins facing severe water stress.

[4] Whereas the OECD (p. 229) notes that some of the policies explored in its alternative scenarios, in particular the reduction of agricultural subsidies, would affect the projections of water use and water stress, no specific results are presented.

[5] The concept of "water stress" is used in many water assessments to obtain a first estimate of the extent of society's pressure on water resources. Severe water stress is defined as a situation where withdrawals exceed 40 percent of renewable resources. It is assumed here that the higher the levels of water stress the more likely that chronic or acute water shortages will occur.

[6] Since the differences between scenarios in climate to the year 2030 are minimal, however, this cannot explain the differences between the scenarios.

Figure 8: Total Water Use by Sector

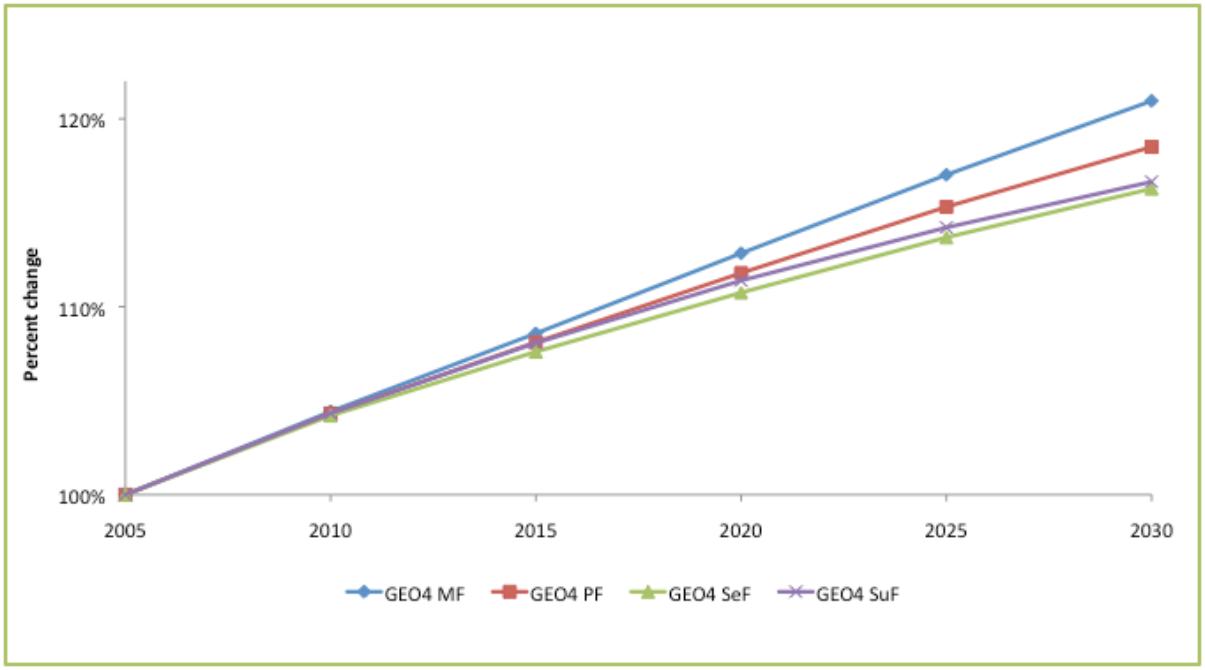
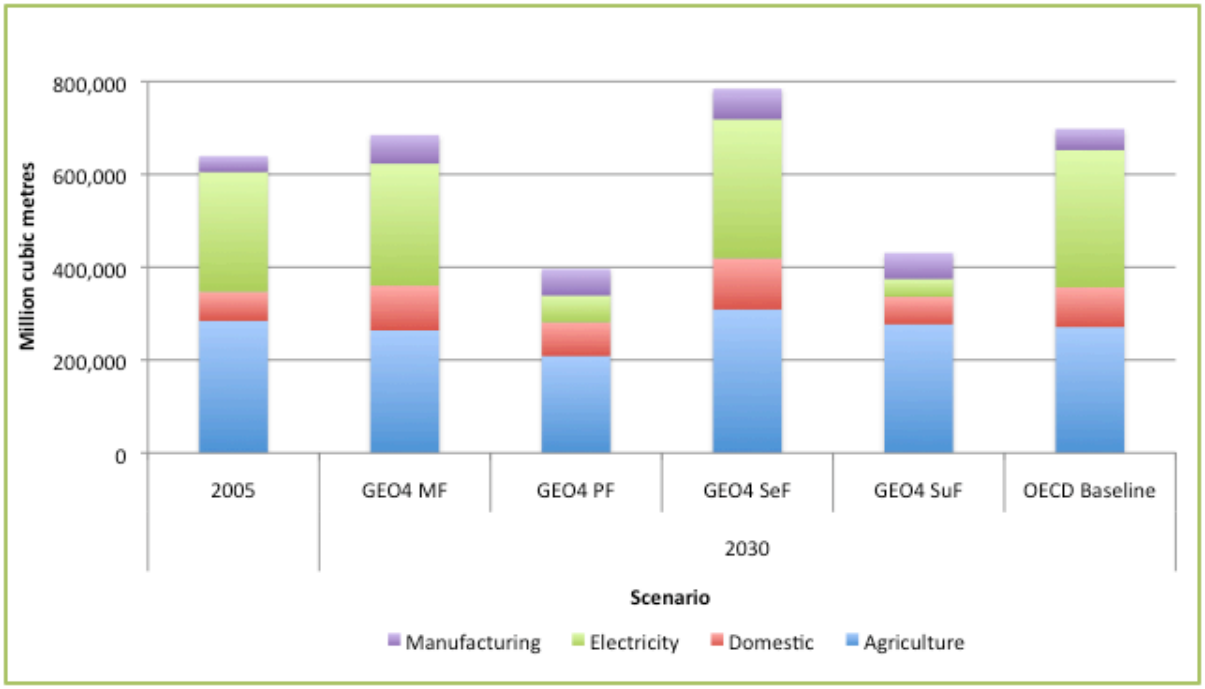


Figure 9: Population Facing Severe Water Stress



3.4 Human Health

As evidenced by the work of the World Health Organization, the CEC, and others, human health and the environment are known to be interlinked (CEC 2006; Prüss-Üstün and Corvalán 2006). Traditional concerns have focused on air and water pollution, as well as

certain toxics, e.g., lead. More recently, the health impacts of stratospheric ozone depletion, climate change and persistent toxics, e.g., persistent organic pollutants (POPs) and bio-accumulative toxics, have taken a more important place in the scientific and policy dialogues. Most projections, however, have explored the impacts of future environmental change on human health only in a limited way. The one issue that has been treated explicitly is urban air pollution.

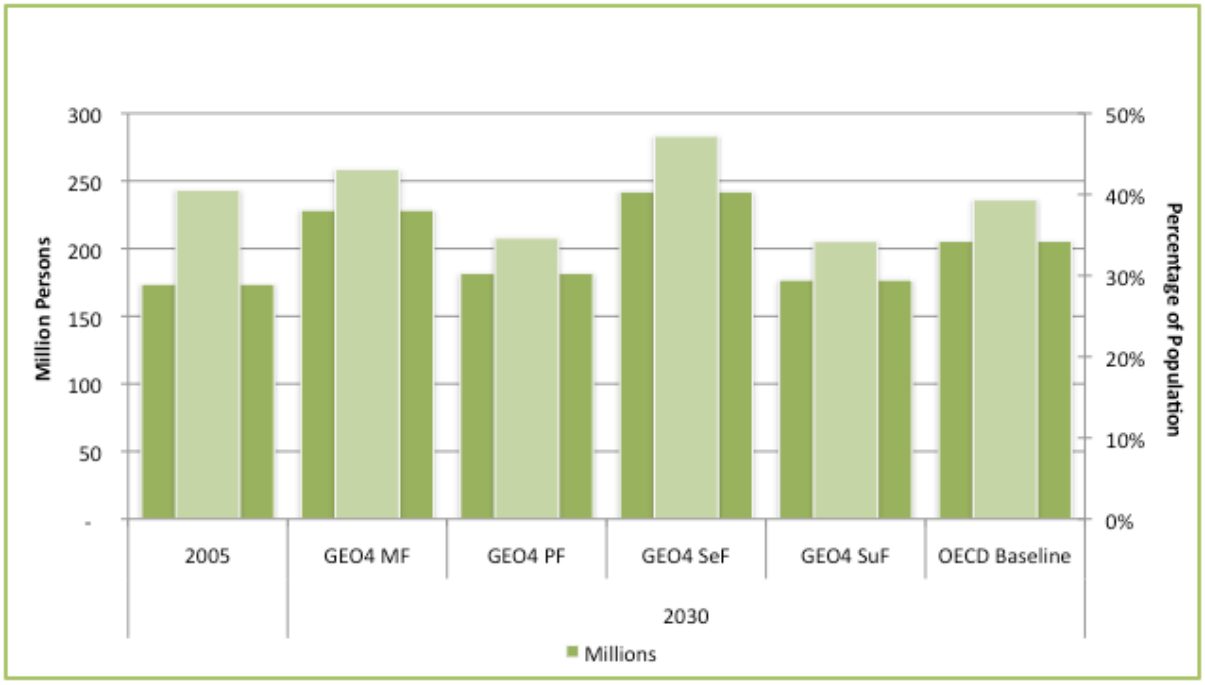
Air pollution in urban areas has been a key concern in the past, as well as a target of significant regulation. The OECD foresees a mixed picture with respect to urban air pollution in North America. It projects a continued improvement in urban air pollution throughout North America, with average concentrations of particulate matter[7] falling by nearly a third by 2030 in its baseline scenario and two thirds in an accelerated policy scenario. This is primarily related to a reduction in key emissions, e.g., sulphur oxides, driven largely by stronger regulatory policies targeting urban air pollution. Mexico, in particular, is expected to make significant advances, but continues to lag behind Canada and the USA. Associated with the reduced exposure are significant reductions in mortality and morbidity related to PM_{10} (Figure 10). The additional policies in the OECD ppGlobal scenario project decreases in mortality and morbidity from 2000 to 2030 approaching 95 percent, as opposed to just over 50 percent in the OECD Baseline scenario.

Ground-level ozone will continue to be a concern, however. The OECD Baseline scenario projects a slight increase in average levels in urban areas in Canada and the United States and almost no change in Mexico.[8] Combined with the increase in total urban populations and the rising average age of the population, this translates into a three- to four-fold increase in mortality rates and a five- to six-fold increase in morbidity rates related to exposure to elevated levels of ground-level ozone.

[7] Measured as micrograms per cubic meter of PM_{10}, i.e., particulate matter smaller than 10 microns in diameter.

[8] No results are provided for ozone levels or associated health effects in the OECD policy scenarios.

Figure 10: Changes in Mortality and Morbidity as a Result of Air Pollution



3.5 Biodiversity

The loss of biodiversity can be driven by a host of factors including land use changes and the fragmentation of habitats, climate changes, pollution, and the introduction of invasive species. Thus, in many ways, it can acts as an integrated indicator of environmental impact. Furthermore, given its importance in the provision of ecological goods and services, it can also be seen as an indicator of the potential impacts of environmental degradation on human society.

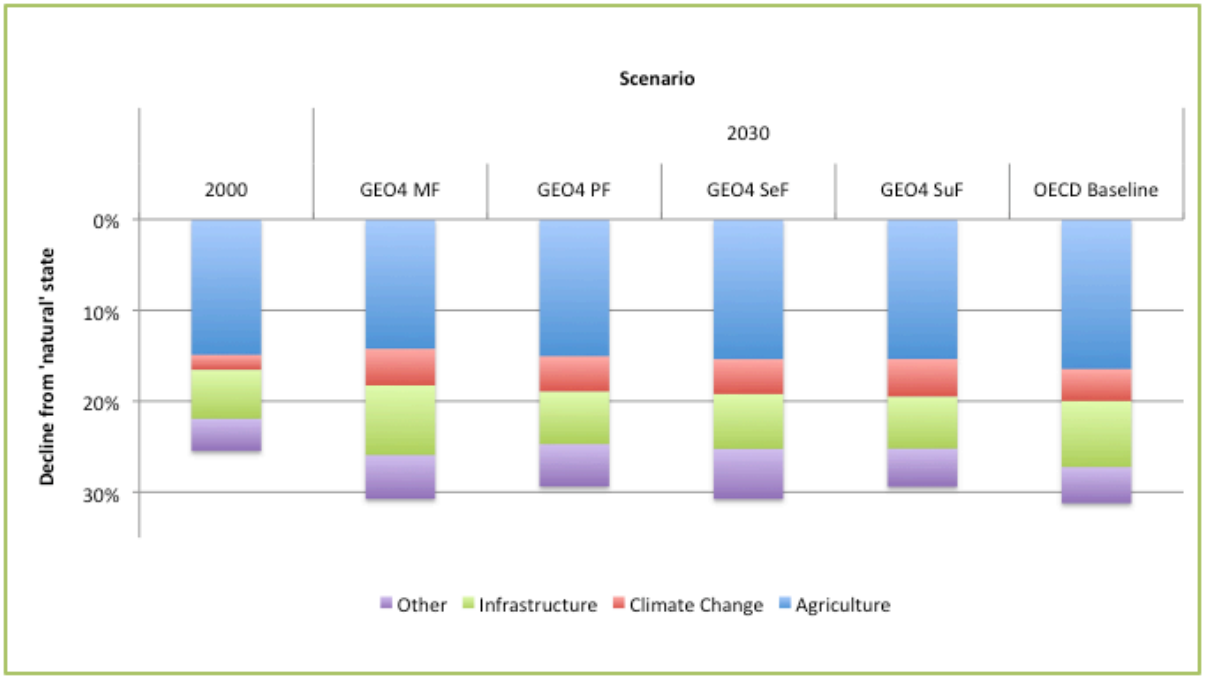
While it is very difficult to make projections of the loss of specific species, indicators are being developed that consider the more general issue of biodiversity loss. One of these is the notion of mean species abundance. Mean species abundance (MSA) captures the degree to which biodiversity, at a macrobiotic scale, remains unchanged. If the indicator is 100 percent, the biodiversity is similar to the natural or largely unaffected state. The MSA is calculated on the basis of estimated impacts of various human activities on "biomes." A reduction in MSA, therefore, is less an exact count of species lost than an indicator that pressures have increased (OECD 2008).

The North American continent has already seen a significant decrease in terrestrial biodiversity estimated at around 25 percent in the year 2000, using mean species abundance as the measure (Figure 11). The conversion of natural land for agricultural purposes has been the primary cause, but the expansion of human infrastructure, e.g.,

roads, has also played a significant role.[9] Canada has experienced less of a decline, reflecting its large landmass and relatively small population.

Looking to the future, a further loss of another three to six percent is expected by 2030, with more significant losses even farther into the future. The major contributors to this are climate change and expanding infrastructure—urbanization, transportation networks, construction related to resource exploitation and other elements of human settlement. There is some further decrease due to the expansion of agriculture, but this occurs almost exclusively in Mexico. Looking closely at the results, it can be seen that the direct impact of climate change will be hard to address in the short term. Policies related to the development of infrastructure, however, can have a significant effect over this period. A key policy issue underlying the results presented here is that of protected areas, not only their extent, but also the nature of their use.

Figure 11: Declines in Mean Species Abundance



[9] The 'other' category includes forestry, fragmentation, and pollution, specifically nitrogen deposition. The existing tools do not allow the identification of biodiversity loss from such factors as the introduction of invasive species.

4 Discussion

Although 22 years away, the year 2030 is close enough that many of the environmental changes identified in this paper appear inevitable because of the inertia in both physical and societal systems: the continuing build-up of greenhouse gases in the atmosphere ensures the climate will continue to change. This, along with continuing human encroachment on wild areas and the spread of invasive species, implies that there will be further losses in biodiversity. There will be socio-economic consequences to these and other environmental changes. North Americans will face certain costs to adapt to climate change, clean up urban air pollution, control the spread of toxic substances and protect endangered species. On the other hand, some solutions may promise net economic benefits over the long run. Whether the price is affordable must be measured against the costs of inaction and inertia.

At the same time, experts agree that the range of possible scenarios for North America's environment increases the farther we look into the future. Most often, what differentiates these scenarios are policy decisions about matters such as energy use, urban density, water pricing and product design: near-term decisions with longer-term consequences. Thus, even against a backdrop of some inevitable change, policy decisions made today can and will have a substantial impact on environmental quality two and three decades hence.

Furthermore, the environmental implications of a wealthier, more populous North America consuming more natural resources cannot be seen purely in the context of this continent. This is not only because North America imposes environmental impacts on other parts of the world while it also is subject to some impacts coming from outside its borders but because our current patterns of production and consumption are not sustainable if widely replicated elsewhere.

While the scenarios presented in this paper are not projections and could end up wide of the mark, they do provide decision-makers the opportunity to explore the pros and cons of different policy options and ask:

1 Is the level of environmental degradation implied in most of the scenarios acceptable? Do the Parties have sufficient information to understand the full environmental implications (e.g., cumulative effects, environmental thresholds, risks of irreversible changes) and socio-economic consequences implied? If not, what measures are required to improve this understanding?
2 Do the benefits of the continued rise in the material standard of living fully offset the environmental and socio-economic costs and risks identified? If they do, are the costs and benefits of growth shared equitably? If not, what policies are required to ensure a fairer distribution?

3 What policy measures are required in key sectors (e.g., energy, agriculture, fisheries) in order to keep environmental impacts to acceptable levels? What would it take to implement a *Sustainability First* scenario, as described by UNEP?
4 While their circumstances differ markedly, in what areas can the Parties collaborate to greatest advantage to reduce environmental degradation or to achieve environmental benefits?
5 Is North America prepared to manage possible abrupt environmental changes over the next several decades? If not, what mechanisms does it need to put in place to prepare for such eventualities?

As the CEC has documented with its pioneering work on the relation between trade and the environment, the right policy choices can make the difference between positive and negative outcomes. North America possesses the capital—financial, intellectual, and human—to move us forward. Perhaps more than ever, answers to the above questions and the policy choices we face today are vital to set us on the path of sustaining our economies and preserving our environment for the benefit of present and future generations.

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