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PERSPECTIVES ON INNOVATION, SCIENCE & ENVIRONMENT

School of Public Policy & Administration
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ISEMA: Perspectives on Innovation, Science and Environment

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Finally, we would like to thank in advance all the future ISE MA students who will pick up this torch and continue to inspire high personal and professional standards, and who will make our success their own.

Foreword

ISEMA: Perspectives on Innovation, Science and Environment began with a simple idea and the commitment of a core group of Innovation, Science and Environment (ISE) students at Carleton University's School of Public Policy and Administration (SPPA). We did not fully know what we were about to undertake, but we understood the promise of a graduate journal: to give students first-hand experience with peer-review, both as authors and as editors; to foster new relationships and reinforce existing ones among ISE students, faculty and alumni; to draw attention to the kinds of issues addressed in the ISE Stream and in ISE-based public policy; and finally, to showcase some of the best student work being produced in the SPPA, one of Canada's premiere schools of public policy.

In order to achieve this, we engaged in a unique double blind, peer-review process. Exceptional papers were nominated by ISE professors, and were then reviewed by experts in the SIGNALS alumni network. In total, eighteen professionals dedicated their time and expertise to the project. The result is four papers addressing four separate issues that speak to the depth and breadth of the ISE policy field, as well as to the dedication and capacity of both the authors and the Editorial Board.

This process, made up of countless steps from beginning to end, is the outcome of our own efforts to put innovation into practice. Building on the achievement of those who came before us, we attempted to set – and meet – high standards for the journal, in order to establish a professional benchmark for ourselves and for those who come after us.

Our intention was to lay the foundation for a dynamic and long-lasting publication that would inspire future ISE cohorts to build on what we have created and to reinvent our approach, enabling recurrent improvements in both process and product. Our hope is that *ISEMA: Perspectives on Innovation, Science and Environment* will take its place in the personal and professional lives of the ISE community as a

means of ingenuity, cohesion, knowledge, practice, motivation and accomplishment, as it certainly has in ours.

The *ISEMA* Editorial Board

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Climate Change Skeptics

Norah Holt

In a speech last year, the Republican Chair of the United States Senate's Environment and Public Works committee, claimed that "Despite the bias, omissions, and distortions by the media and extremist groups, the real story about global warming is being told, and, judging by the welcome success of Michael Crichton's *State of Fear*, it's now being told to the American public."[1] The real story, in his view, was that climate skeptics have gathered scientific evidence that refutes the core assumptions of the Intergovernmental Panel on Climate Change (IPCC).

This view is far removed from that of most scientists, and is not heard nearly as often now as it was in the lead-up to earlier Kyoto negotiations. Nevertheless, it raises several interesting questions: 1) Who still contests the scientific basis for climate change? 2) What are the links between these skeptics and political life in Canada and the United States? 3) What are the main scientific concepts underlying their arguments? This paper will explore each of these questions, and in doing so will attempt to shed some light on the science-policy challenges of climate change. Before doing so, it is worthwhile to consider the unique context of climate change science.

Post-Normal Science and the IPCC

The concept of post-normal science provides a useful way to think about the nature of climate science and the interaction between IPCC scientists, politicians and others. As explained by Funtowicz and Ravetz, post-normal science is a way of conceptualizing the science-policy interaction in an environment where high-stakes policy decisions must be made based on uncertain or 'soft' science. The concept challenges the view of research science as puzzle-solving in a framework of unquestioned values and operating assumptions. It also challenges the assumption of normal science that routine puzzle-solving by experts provides an adequate knowledge base for decision-making.[2] Post-normal science suggests that new approaches are called

for in dealing with issues that tend to be neglected in normal science: uncertainty, value-loading and the variety of legitimate perspectives.

Climate change science through the Intergovernmental Panel on Climate Change has been a new approach as well as an enormous undertaking. The development of IPCC reports, the first of which was published in 1990, has brought together hundreds of scientists and academics from a host of disciplines. In the reports, the authors' common goal has been to summarize the state of knowledge on climate change and provide recommendations for policymakers. This focus on inter-disciplinarity and consensus is a reflection of the need for clear messages in a contentious and high-stakes policy environment. And, with each IPCC report, the message has grown clearer: anthropogenic greenhouse gas emissions are causing the earth's climate to change.

As IPCC scientists compile research, develop emissions scenarios, and then project possible impacts, there is a cascade of uncertainty attached to the results, producing a range of possible outcomes rather than best guesses.[3] The IPCC's *Third Assessment Report* acknowledges this, and characterizes climate change decision-making as a sequential process under general uncertainty, with risks of abrupt and irreversible changes.[4] It also acknowledges that the benefits of different GHG emission reduction actions are incompletely characterized and cannot be compared directly to mitigation costs making the net economic effects of mitigation uncertain.[5] However, as a post-normal scientific process, the IPCC reports discuss uncertainty openly and clearly, making it easy for non-specialists to determine which findings are most robust.

Clearly, climate change science through the IPCC differs from normal science in significant ways. It provides the foundation for the high-stakes of policy decisions that must be made. Therefore, it is not surprising that the science of climate change has been highly political. New findings can be viewed as evidence for or against the Kyoto Protocol and the associated portfolio of greenhouse gas emissions reduction policies. Research areas such as paleoclimatology, which were previously of little interest to policy-makers, have gained a new importance in this context. As the following sections illustrate, these characteristics are at the heart of the debates between climate change skeptics and the mainstream.

Part 1: Who Are The Climate Skeptics?

So, what does it mean to be a climate skeptic? Labohm *et al.*. answer this question in the introduction of *Man-made Global Warming: Unravelling a Dogma*. The authors describe skeptics as "…those who doubt that there is such a thing as anthropogenic global warming".[6] A further belief held by many skeptics is that, even if the problem of climate change is real, Kyoto is not the right approach, but rather a waste of scarce resources. The authors attempt to prove both points, while claiming that their views receive support from many audiences, including politicians and academics.[7]

One can think of a range of different voices criticizing the IPCC's science, not all of which fall into the above definition. On the one hand, there are public relations lobbyists working on behalf of coal and petroleum producers and other interests. The Exxon-funded "Envirotruth" website aims to obfuscate the links between fossil fuels and climate change, and is an example of this type of climate skepticism.[8] On the other hand, there are expert skeptics whose criticisms within their disciplines play an essential role in scientific debate and in pushing for the improvement of computer modeling and other methodologies. Somewhere in between these two camps fall the 'informed' skeptics, who do not necessarily speak from a position of expertise, but are nonetheless vocal.[9] The problem for the concerned citizen is that it can be difficult to distinguish between these skeptics or determine the legitimacy of their claims.

Canadian climate skeptics Tad Murty, Tim Ball, Fred Michel and Tim Patterson have all attracted media attention with their criticisms of the science underlying Kyoto. For example, in December 2005, the *Ottawa Citizen* featured an article by Murty claiming that "we now know that we do not know why the Earth is warming. We do not know if humans have anything to do with it, and they may well not. The scientific assumption behind the Kyoto protocol, namely that humans are known to be significantly interfering with an otherwise unchanging climate, is simply false."[10]

Editorial style aside, the fact that such stories are not unusual in the media reflects the efforts of skeptics to attract media attention to their cause. Murty, Patterson and Ball serve on the advisory board of "Friends of Science", a group devoted to challenging the IPCC's

conclusions and presenting alternative causes for climate change. The group has developed a video entitled *Climate Catastrophe Cancelled: What You're Not Being Told about the Science of Climate Change*, as a part of its efforts.[11]

Another skeptical voice on climate change has been Canada's Fraser Institute, a think-tank whose vision is a "free and prosperous world where individuals benefit from greater choice, competitive markets, and personal responsibility."[12] In the Institute's publications from 2000 to 2005, common narratives include the alarmism of the IPCC and environmental activists, the lack of evidence for climate change, and the foolishness of the approach adopted in the Kyoto protocol. In its environmental commentary, the Fraser Institute has provided a platform for some of North America's most prominent skeptics, including Willie Soon, Sallie Baliunas, and Ross McKitrick. Skeptics are a diverse group, but some are linked by common affiliations, which will be discussed below.

Part 2: Skeptics And Conservatism

The Fraser Institute and other conservative think tanks often provide a forum for climate change skeptics. This section examines the common themes and links made in this literature, arguing that the roots of support for climate skeptics lie in views on the undesirability of further environmental regulation and federal intervention in the economy.

Many people point to the powerful influence of coal and oil lobbyists in the American and Canadian politics. In this light, it is interesting to consider groups funded by Exxon-Mobil, which in 2003 included the Fraser Institute, the National Center for Public Policy Research, and the Competitive Enterprise Institute. The American think tanks received $55,000 and $465,000 respectively, while the Fraser Institute received $60,000 for 'climate change' activities.[13] Some of the leading skeptic scientists are also affiliated with the fossil fuel industry. For example, prominent skeptics Patrick Michaels, Robert Balling, and Sallie Baliunas have been affiliated with the Greening Earth Society, founded by the Western Fuels Association in 1998 to promote the view that increasing levels of atmospheric CO_2 are good for humanity.[14] Baliunas has also published research with

the Fraser Institute and the Marshall Institute, and is a member of the scientific advisory board of "Friends of Science".

At the same time, it would be incorrect to conclude that all scientists involved in the fossil fuel industry are skeptics about climate science. A March 2006 commentary featured in the *American Association of Petroleum Geologists Bulletin* concluded that based on observational science, the case for the reality of potentially harmful anthropogenic climate change is strong enough to justify action to control our release of fossil carbon to the atmosphere. The author stated, "If we conclude that it is the wisest course of action, Earth scientists, not the least petroleum geologists, have a major role to play."[15]

It seems likely that a belief in the harms of government intervention in the economy fosters an anti-environmental regulation opinion. Does it follow that people with right-wing beliefs are less likely to believe that climate change is a real phenomenon? A recent study by Heath and Gifford attempts to answer this question. Their findings are not straightforward, but they do present interesting connections between political leanings and individual beliefs on climate change. Five of the six individual beliefs they tested in regression analysis were not statistically significant predictors of climate change beliefs.[16] However, Heath and Gifford found that environmental apathy – a lack of interest in environmental issues and/or the belief that environmental issues have been exaggerated - was a strong predictor of individuals' belief that global climate change is not caused by humans. They suggest a connection to right-wing beliefs in the following way:

> Those who subscribe to the free-market ideology tend to be optimistic that an uninterrupted free-market system will lead to beneficial outcomes for all, which leads to apathetic, unconcerned attitudes toward environmental problems. These apathetic attitudes, in turn, influence beliefs about global climate change, in the direction that global climate change is not occurring, humans are not responsible for it, and its consequences will not be negative.[17]

Matthew Bramley of the Pembina Institute has suggested that the two most common arguments from skeptics are as follows: 1) the IPCC's science is flawed; and 2) even if it were not, the Kyoto Protocol is too expensive or harmful to the economy to implement. If the first point against the scientific basis for anthropogenic climate change fails, the cost point is weakened.[18] This explanation helps to shed light on why there has been so much emphasis from right-wing individuals and institutions on criticizing the science of climate change.

Both of these arguments against climate change science appear in publications by the Fraser Institute. A 2003 paper by Kenneth Green, the Fraser Institute's Chief Scientist and Director of the Risk and Environment Centre, provides a summary of the most common ideas put forward by skeptics. Green relies heavily on the works of other skeptics to argue that the science of climate change is weak.[19] Without addressing any of the main findings of the IPCC's 2001 report, or commenting on the certainty levels attached to these findings, he goes on to provide a list of reasons that its science is flawed.

For example, Green claims that climate modeling suffers from inconsistencies in temperatures measurements from weather balloon measurements, shipboard measurements and satellite readings. He also feels that the available 150 years of temperatures recordings is not enough.[20] Like most skeptics, Green criticizes the computer models used by the IPCC. He claims that most climate researchers agree that the discrepancy in various temperature measurements casts serious doubt on the validity of the computer models.[21]

In the United States, counterparts of the Fraser Institute include the George Marshall Institute, the Competitive Enterprise Institute, and the National Centre for Policy Analysis. As far back as 1989, the Marshall Institute claimed that variations in the sun's intensity would offset any climate change associated with elevated greenhouse gases.[22] Since then, the Institute has published numerous reports downplaying the severity of global climate change.

In early 2006, American senators Domenici and Bingaman proposed key elements and principles for a national greenhouse gas mitigation program.[23] William O'Keefe, the Marshall Institute's CEO, criticized this proposal, claiming that it was based on misguided

assumptions about the state of knowledge about climate change:

> The assumption that human activity is the sole or even major cause for temperature increases in recent decades or the past century is simply not correct. Consequently, to assume that government actions to restrict those emissions through a complex energy-rationing scheme will have an appreciable impact on temperature fluctuations is simply not supportable.[24]

The arguments from both O'Keefe and Green seem to be motivated by the desire to prevent new environmental legislation. The Fraser Institute's Chief Scientist argues against what he calls a "laundry list of old-school regulations" by claiming their implementation would impose costs and slow economic growth. The list of allegedly harmful measures includes: increasing the use of renewable energy, increasing energy or vehicle efficiency, fuel switching, and anti-sprawl planning. Greenhouse gas registries are also singled out as an unfair measure that diverts "attention and resources away from better-characterized, more tractable environmental challenges such as preventing surface water degradation."[25] This fear of new regulation is a common thread throughout skeptic literature, and provides some insight into why certain institutions provide support for skeptics. One observer has commented, "Evidently, what differentiates self-proclaimed climate skeptics from the rest of us is not their skepticism but the extent to which they are in touch with the fear that climate change is rocket fuel for hard-left environmental extremism and intolerance."[26]

Bjorn Lomborg's *The Skeptical Environmentalist* describes environmentalists as having promoted a "Litany" of exaggerated statements warning that our environment is rapidly and catastrophically deteriorating. Lomborg argues that in fact, things are getting better, and that the size and future projections of global warming have been unrealistically pessimistic. He echoes many conservatives in arguing that it is not climate change we should be concerned about, but rather the policy solutions of early and rapid reductions in fossil fuel use, which he argues would be much worse for humanity.[27]

Suspicion of environmentalists is a common theme in skeptic publications. In the Fraser Institute's 2001 *Guide to Global Warming*,

the authors claim that environmentalists' climate change campaigns reflect three common characteristics: an underlying suspicion of economic development, an exaggeration of the risks – using the "ridiculous" precautionary principle – and a tendency to focus only on arguments that support their claims, which often means dismissing legitimate scientific debates and ignoring uncertainty.[28]

Other skeptics go even further in their denouncements of environmentalists. Labohm et al. claim that environmentalists exaggerate climate change for their own benefits: "There always lurks the danger that the public eye shifts to other, more demanding problems.... That is why climate change was a godsend for green NGOs ... they can argue that the environmental job is far from finished."[29] Republican James Inhofe, Chairman of the Senate Environment and Public Works Committee, echoes this suspicion, stating "environmental extremists and their elitist organizations ... exploit the issue for fundraising purposes."[30]

It seems that an orientation towards small government, suspicion of environmentalists, optimism with regards to the free-market, and the interests of fossil-fuel industries may all be factors that help to explain the support that certain conservative institutions have provided to climate change skeptics. The question to address then becomes: what is the scientific basis for skepticism?

Part 3: Skeptics' Arguments

Contrarian climate change views range from criticisms of the IPCC's peer-review process, to disagreements on its projections, to criticisms on the way computer programs model the movements of clouds.[31] Two important and contentious criticisms of mainstream climate science are: 1) that it does not properly consider natural climate variation linked to the sun, and 2) that it does not reflect a proper understanding of past climates. In other words, skeptics feel that IPCC science has not managed to separate the 'signal' of anthropogenic climate change due to CO_2 from the 'noise' of natural climate variations. These key issues will be discussed below, as the debates between skeptics and the mainstream scientific community are explored in more detail.

Twenty-First Century Warming in Perspective

A common theme in work by skeptics is that there have been substantial natural changes in temperature over time, so there is no need to invoke human influence on current changes in Earth's temperature. Kininmonth argues that the IPCC advances the false view that the climate system has been stable, and that recent warming is unusual. He says that this is "at odds with many individual proxies, which suggest warm periods in medieval times and cooling during the Little Ice Age. It ignores palaeoclimate evidence that points to climate having abruptly changed in the past."[32]

Both mainstream scientists and skeptics interpret past climates using proxies, such as tree rings, and the levels of specific elements found in ice cores and ocean sediment. The process of compiling and interpreting findings to reconstruct past climates has proven to be central both to the arguments of skeptics and to those of their detractors. Skeptics Soon and Baliunas attempted to summarize paleoclimatic research in an article published in *Climate Research* in 2003. The article reviewed over 240 previously published studies of climate proxy records for the last millennium, concluding that: "Overall, the 20th century does not contain the warmest anomaly of the past millennium in most of the proxy records, which have been sampled world-wide...the proxies show that the 20th century is not unusually warm or extreme."[33]

Appell, writing for the *Scientific American*, summarized the criticisms of Baliunas and Soon's controversial work. From the outset, the approach taken by Baliunas and Soon discounted temperature records, and emphasized data for which the uncertainties are much greater. Related to this, a significant weakness lay in the authors' approach to the literature review. They did not present their data quantitatively, but mainly categorized reviewed articles as either supporting or not supporting their particular definitions of a Medieval Warming Period or Little Ice Age.[34]

As Appell explained, Soon and Baliunas defined a "climatic anomaly" as a period of 50 or more years of wetness or dryness or sustained warmth (or, for the Little Ice Age, coolness). Under this broad definition a wet or dry spell would indicate a climatic anomaly even if the temperature trends did not change. Moreover, Baliunas

and Soon's research did not consider whether warm and cold periods occurred at the same time, which could be misleading since regional conditions do not necessarily mirror the global average. Even more importantly, the article's definition of climate anomalies was such that the warm period in the late 20th century was too short to count.[35] This approach clearly skewed the data to support the conclusion that the twentieth century has not been unusually warm or extreme.

This paper attracted a flurry of criticism from scientists, and caused the resignation of half of the journal's editorial board.[36] The publisher of *Climate Research* subsequently acknowledged the journal should not have published the paper as it was written as the reviewers had failed to detect methodological flaws. In an interesting link to American political life, the study was apparently well received by Republicans. According to one report, "Internal documents from the US Environmental Protection Agency ... show that the Bush administration attempted to get this paper cited in an Agency report on the state of the environment."[37]

The 'Hockey Stick'

The 'hockey stick' refers to the graph published by Mann, Bradley and Hughes in 1999. The graph is based on research that used tree ring records to reconstruct temperatures over the past millennium. It shows that temperatures of recent years are unusually warm in historical comparison. The 'hockey stick' has been a target for volumes of criticism from skeptics, so it is worth exploring the methodology used in more detail.

Mann et al.'s research relied on principal component analysis, a mathematical technique used to summarize the data found in a large number of 'noisy' records. The most common patterns in the data are captured in a number of principal components (PCs), which describe some percentage of the variation in the original records.[38] In the 'hockey stick', PCs were used to capture patterns from individual tree ring chronologies, in order to reconstruct North American temperatures. Mann et al. were interested in determining whether the tree ring data showed significant differences from the 20th century, and their methodology normalized the data so that the mean over this period was zero. This had the result of emphasizing records with the

biggest differences - either positive of negative - from that period.[39]

A 2005 Fraser Institute publication is one of many attacking the Mann et al. climate reconstructions. In the article, economist Ross McKitrick recounts his exchanges with Michael Mann. McKitrick claims that when his collaborator Stephen McIntyre tried to get the data from Mann, he encountered some delays and "it took a while for a useable file to be produced." From this, McKitrick concludes, "obviously the IPCC never checked the data since they weren't available, nor were the programs that generated the hockey stick available.…"[40]

McKitrick argues that the vast majority of data in the analysis does not look like a hockey stick, but that the peculiar method Mann used searched out the handful of hockey stick records and put all the weight on these. He then explains how his own analysis of the data show the highest temperatures of the millennium occurring in the fifteenth century, as opposed to Mann's graph which shows a sharp increase in 1990s temperatures. McKitrick interprets this analysis as meaning that the late twentieth century is "pretty much in the middle of natural climate fluctuations."[41]

A rebuttal from Michael Mann suggests that McKitrick's findings contradict not only his research but also all other known temperature reconstructions, mainly a result of omitting key proxy data. Other reconstructions since 1999 have supported Mann's findings, as does analysis based on full records as opposed to PCs. He further argues that their analysis "fails statistical verification exercises, rendering it statistically meaningless." Mann also emphasizes, "It is not the average 20th century warmth, but the magnitude of warming during the 20th century, and the level of warmth observed during the past few decades, which appear to be anomalous in a long-term context."[42]

The 'hockey stick' has been a favourite target of skeptics, likely due to its prominence in the IPCC literature. According to McKitrick, the figure has been the "poster-child in the popular case against global warming."[43] McKitrick concludes that the late twentieth century is not climatically unique in comparison to recent history, meaning that a key claim of the IPCC is invalid. Yet, even if Mann's reconstruction of Northern Hemisphere mean temperatures was flawed, other reconstructions have drawn similar conclusions. Furthermore, the type of evidence involved in the hockey stick is "one of a number of

independent lines of evidence indicating the strong likelihood that human influences on climate play a dominant role in the observed 20th century warming of the earth's surface."[44] Most importantly, recorded temperatures in the 1980s and 1990s can only be explained by climate models that consider both natural and human-caused forcings including aerosol and carbon dioxide emissions.[45]

The Sun's Activity as a Driver of Climate Change

According to many skeptics, there's a strong correlation between the sun's activity and the Earth's climate. Retired University of Ottawa Professor Jan Veizer is among those arguing that the sun may be a principle driver of climate change. He claims that he had been hesitant to release his research on cosmic rays, because questioning the fundamentals of climate change provokes so much animosity.[46] In a personal statement attached to his 2005 article in *GeoScience Canada,* Veizer says, "Personally, this last decade has been a trying period because of the years of internal struggle between what I wanted to believe and where the empirical record and its logic were leading me. This article is ... a plea for some reflection in our clamour for over-simplified beliefs and solutions in the face of the climate conundrum."[47]

In his article, Veizer suggests that the issue of the anthropogenic nature of climate change has been so polarizing partly because past, natural variations in the carbon cycle and climate are poorly understood.[48] He proposes that neither atmospheric carbon dioxide nor solar variability alone can explain the magnitude of the observed average temperature increase over the last century. Veizer acknowledges that total solar irradiance is not enough to explain observed temperature increases, but suggests that cosmic ray flux may be a missing part of the puzzle that is not considered in mainstream models of climate change. In his model, cosmic particles hit the atmosphere, generating cloud condensation nuclei, which in turn causes clouds to cool and act as a mirror, reflecting solar energy back into space. He suggests that beryllium-10, carbon-14 and chlorine-36 found in ancient sediments, trees, and shells, can serve as indirect proxies for solar activity.[49]

Veizer also suggests that at times of cold to warm transitions, temperature changes come first – leading carbon dioxide changes by

several centuries. Therefore, CO_2 levels may be a response to, not a cause of, the change in temperature and climate, meaning that CO_2 may serve as a temperature amplifier rather than a climate driver.[50] He supports this controversial proposal by suggesting that correlations between beryllium-10 and temperature in ice core data are evidence for cosmic ray flux as a driver. He also finds support for his ideas in cave and ocean sediment data, and in his examination of temperature trends in the 20th century. The empirical observations he reviews "point to celestial phenomena as the principal driver of climate, with greenhouse gases acting only as potential amplifiers."[51]

In his cautious and somewhat confusing conclusion, Veizer considers the environmental implications of his research, noting, "the decision as to the best strategy is not a simple prerogative of science, but must also take into account political, economic and social considerations." He states that policies that emphasize reduction of human emissions are sound, whether his theory is correct or not. But, he then adds, "Any remedial measures based on the global CO_2 scenario are also costly."[52]

Other scientists have taken issue with Veizer's article, pointing to a lack of systematic trends in cosmic ray flux and other solar activity proxies. Weaknesses in Veizer's cosmic ray theory include the fact that there are pronounced 11-year variations in cosmic ray flux, but that the presence of 11-year variations in the global mean temperature are much less pronounced than the warming trend of the last three or four decades.[53] One review of Veizer's article concludes that it does not fully address this ongoing warming trend, and that there is no indication that solar cycle variations could explain the trend.[54] It also questions the correctness of some of the graphs used in the article, one of which seems to be a hand-drawn and somewhat misleading summary of trends in temperature and CO_2.[55]

Mainstream scientists support the idea that the sun's activity cannot explain a great deal of the observed climate changes. For instance, Foukal, North and Wrigley explain that little is known about the links between the sun and the climate, however, the 11-year sunspot cycle has a variance in irradiation of only 0.08%, probably too little for a meaningful influence on climate. They add that the scientific basis for studies of longer-term variations, which could

potentially have a larger influence on climate, is speculative, rather than robust.[56] For instance, based on studies of sun-like stars, Baliunas and Jastrow suggested that variations in the brightness of the sun might have an influence on global warming.[57] However, Foukal et al. suggest that the stars studied were not similar enough to the sun for a proper comparison. While they do not rule out long-term luminosity variations of the sun, the authors conclude that so far, studies have not produced any convincing evidence that this is a driver of climate change.[58]

Conclusions

As one observer comments, "It is a normal, essential and very valuable part of science to develop and present alternative hypotheses, even if they appear unlikely at first, go against the mainstream, or turn out to be wrong later. Without this process, there would be no progress in science."[59] This point highlights the importance of differentiating between various types of skeptics. Some skeptics help to push the overall process of understanding climate change forward, emphasizing the importance of good methodology and clear explanations. Other skeptics simply confuse and obfuscate important findings, sometimes on behalf of vested interests. Climate science is high-stakes and highly-politicized, therefore, it is not surprising that some skeptics have found a platform in institutions sharing their concerns about the potential economic costs of climate change policies.

This essay suggests that concerned citizens and policy-makers should make the effort to distinguish between various types of skeptics by critically assessing the source: Do the authors have any ties to lobby groups or special interests? What political views are supported by the findings? Are arguments on minor points or graphs used to make unjustified conclusions? Are convincing explanations provided for observed trends? As the above discussion has shown, asking such questions highlights the weaknesses in the arguments of some of the most vocal critics of climate change science.

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Canadian Stem Cell Policy: Opportunities And Ethical Issues

Lillian Hayward

Stem cells are tiny things that have the potential to change the world. Since their discovery in the early 1960s, their applications and potential have continued to grow. They offer hope for those who suffer from devastating diseases like Parkinson's and Alzheimer's. They have the potential to repair spinal cords and cure paralysis. They can regrow tissue and produce custom organs. With potential that seems virtually limitless, stem cells may appear to be the Holy Grail of biomedical research, but with great potential come great implications.

Stem cells have created new and complicated ethical issues that range from the moral status of an embryo to the cloning of human beings. In an attempt to regulate the science and acknowledge some of the ethical issues, while maintaining a certain level of moral integrity in the scientific community, Canadian policy makers introduced extensive legislation for assisted human reproduction under which stem cell research falls. The policy direction has been criticized for being too restrictive and limiting scientific freedom. It appears, however, that while the policy has placed limitations on activities that are controversial because of their ethical and moral implications, it has not actually hindered research. Instead, it has challenged the scientific community to find new ways of doing research in order to realize the full potential of stem cells while also recognizing the ethical issues that exist within the field.

This discussion of stem cell research will examine the science, the ethics and the policies that must operate in tandem in order to attain the field's maximum potential. This will be achieved by first giving a brief overview of the nature and characteristics of stem cells and then moving on to the various sources of these cells. Then, after providing an overview of the history of Canada's policy for stem cell research, the interaction between the policy and the science of this issue will be explored. The moral issues will be discussed throughout due to the

fact that ethical concerns arise in every aspect, from the stem cell sources to the research methods to the policies that guide the science. Ultimately, this paper will demonstrate that while policy creates certain restrictions it also opens up possibilities for exploration in an attempt to satisfy certain policy objectives. Canada's policy for stem cell research, while restrictive in some ways, has created opportunities to rethink the problems of science and find new and more ethically acceptable ways of doing research.

What Are Stem Cells?

Stem cells are defined as "cells that have the ability to divide for indefinite periods in culture and to give rise to specialized cells."[1] These cells can be categorized into three different types: totipotent, pluripotent and multipotent. Each of these types has a different capacity for differentiation that determines what kinds of cells each type can become.

Totipotent cells have the most capacity for differentiation. They are formed within the first few hours after fertilization of a woman's egg (also known as an oocyte). They have unlimited potential in terms of specialization and any one of these cells have the capacity to become an entire organism. In fact, when two totipotent cells separate in the womb each of these cells can continue to develop into two separate but genetically identical embryos, also known as identical twins.

Four days after fertilization, these cells begin to specialize forming a hollow sphere called a blastocyst that consists of two different kinds of cells. The outer layer, which forms the sphere, if implanted into the womb would become the placenta. Inside the hollow sphere is a cluster of cells that form what is called the 'inner cell mass'. The cells that make up the inner cell mass no longer have the same unlimited capacity for differentiation as the totipotent cells which formed them and are now called pluripotent cells.

Pluripotent cells cannot form an entire organism because they are unable to produce the cells necessary to make up the outer layer of the blastocyst. In spite of this, they are still very versatile because they have the potential to form any tissue in the human body. It is generally these pluripotent cells from the inner cell mass that are removed and cultured into stem cell lines to be used for research purposes.

Further specialization of pluripotent cells creates the tissues that make up the entire human body. Some of these cells, however, do not become completely specialized in their functions and continue to display key characteristics of stem cells, such as indefinite cell division and the ability to give rise to specialized cells. These are what are known as multipotent cells and are found in tissues that need to be continuously replenished like bone marrow, intestine and skin. Because of the life-long requirement for the renewal of these tissues, multipotent stem cells can be found in the body into adulthood. These kinds of stem cells are more limited than pluripotent cells in their capacity to differentiate and are limited to forming the cells that make up the tissue from which they are derived. For instance, stem cells found in bone marrow are only able to produce red blood cells, white blood cells and platelets and, in their natural state, cannot form any other kinds of tissue.

Stem cells, whether they are totipotent, pluripotent or multipotent, all demonstrate a great amount of potential to cure diseases and alleviate suffering. Their value lies in their ability to proliferate and differentiate, characteristics that most cells in the human body do not possess.

Stem Cell Sources

It is the various sources of stem cells that create the bulk of the concern surrounding stem cell research. They can be found in certain tissues in the human body but they can also be derived from embryos. Each source is subject to a number of benefits and drawbacks that will now be discussed.

Adult Stem Cells

Adult stem cells are the multipotent cells that are found in tissues that continuously regenerate. Because they can be derived from adult donors, scientists using these cells for their research are generally able to avoid many of the ethical issues that are faced by embryonic stem cells. But, being multipotent, adult stem cells are only able to produce the cells like those in the tissues from which they are taken and thus have limited ability to differentiate when compared to other types of stem cells. In spite of this, researchers continue to work with adult stem

cells in the hope that these cells might be coaxed into a more primordial state, increasing their ability to produce other kinds of tissue. While this kind of research shows definite potential it is unlikely these cells will be able to differentiate or attain the versatility of embryonic stem cells.[2]

Embryonic Stem Cells

Embryonic stem cells are those cells that are derived from the inner cell mass of the blastocyst. As pluripotent cells, their only limitation is that they are unable to form an entire organism. In spite of this, they exhibit a great amount of potential to produce any other tissue in the body. However, the removal of stem cells from the blastocyst results in the destruction of the newly formed embryo, which is, in part, why this kind of research is immersed in controversy. Another part of the stem cell issue is the way embryonic stem cells are produced.

This kind of stem cell can be extracted from three different sources. The first source is excess embryos that have been created by in vitro fertilization for the purpose of infertility treatments but are no longer needed. The second source is embryos that are created by in vitro fertilization for research purposes. The third is embryos that are created through somatic nuclear transfer, a process that is otherwise known as cloning.[3]

Each of these sources produces the same kind of pluripotent cells with the same capacity for differentiation. However, each provides unique benefits as well as their own particular ethical issues.

Embryos created for infertility treatments

Infertility treatments have allowed numerous people to give birth to healthy children when natural methods of conception have failed. In these treatments, women are given fertility drugs that cause them to release several mature eggs at one time, a process called hyper-stimulation. These eggs are then removed and fertilized in vitro for approximately two days. Once the fertilized eggs have reached the four to eight cell stage, between three and six of the newly formed embryos are transferred into the uterus.

The process creates more embryos than are needed for a single treatment because some of those produced are nonviable and therefore cannot be used. Also, since only about twenty percent of these

treatments actually result in a successful pregnancy, producing more than the number required for one treatment ensures that there will be enough viable embryos remaining if the first treatment fails and another is required. If a successful pregnancy is achieved and the remaining embryos are no longer needed they are then simply discarded.

Since these embryos would be destroyed anyway, it makes sense to allow their donation for the advancement of stem cell research. This would give researchers access to a significant source of pluripotent stem cells, which have much more capacity for differentiation than adult stem cells and would provide researchers with a valuable tool for their work.

The use of embryos for research is embroiled in debate as to the moral status of the embryo. On one side are the scientists who claim that an embryo at this stage is similar to a piece of tissue. While in theory it has the potential to become a person, the embryos that remain following a successful infertility treatment are generally disposed of and therefore no longer have this potential. This means that their use would have the same moral implications as performing experiments on a piece of tissue.

On the other side of the debate are those who argue that life starts at the moment of conception, meaning that the embryo is given the same moral status as a person. It is this group that claims "there's no such thing as excess life, and the fact that a living being is going to die does not justify experimenting on it or exploiting it as a natural resource."[4]

A debate rages over the moral status of an embryo. It has slowed legislation, divided the public and politicians and has even resulted in the ban of the use of these excess embryos in some places. This does little to change the fact that infertility treatments are a widely accepted method of conception, and that as a result of these treatments there are many excess embryos that can either be used to advance very promising research or be destroyed without making any contribution at all.

Embryos created for research purposes

Although embryos that are created for research purposes are produced using the same techniques as those created for infertility

treatments, they are viewed very differently. The benefits of this kind of procedure include a more readily available source of stem cells. Researchers would not have to wait for a fertility treatment to take place, for a woman to consent to the use of the excess embryos and then for access to those embryos in order to perform their research. Not relying on fertility treatments would also mean that researchers could potentially have access to more stem cell lines, reducing concern about the cell lines' viability.

In spite of the benefits that these embryos confer over and above those created for fertility treatments, the reason that they are viewed differently has to do with the intentions that lie behind their creation. The IVF clinician is creating embryos with the intention of enabling the woman to give birth to a baby. Even though excess embryos are usually destroyed, they were not created with that intention. The stem cell researcher in contrast, is creating embryos with the intention of destroying them.[5] This difference presents itself as a fundamental one. It is because of this difference that embryos created for fertility treatments are a less objectionable source of stem cells.

Embryos created for research purposes are subject to further ethical issues when it comes to the source of the oocytes. To produce this kind of embryo there must be an oocyte donor, a woman who is willing to endure fertility treatments for the sole purpose of donating her eggs to science. This kind of donation leads to issues regarding donor consent. When women undergo fertility treatments for the purpose of having a baby, the methods through which consent must be obtained in order to use the excess embryos for research are clearly defined. Before it even takes place, there must be a discussion of all the risks inherent in the fertility procedure, which include 'hyperstimulation syndrome', a condition with symptoms that include pain, liver damage, kidney failure, future infertility, stroke and, in some cases, even death. Beyond the treatment with fertility drugs, the retrieval of oocytes produced as a result is an invasive procedure, which carries with it risks of bleeding as well as the risks associated with general anesthesia[6]

The clinical consent model is already in place for fertility treatments making the addition of consent to the use of excess embryos for research relatively simple. Thus, consent becomes a two-part process

that includes "a clinical consent that covers the (not insignificant) risks and benefits of the procedure used to procure the oocytes for reproductive purposes (drugs for hyperstimulation, removal of follicles, etc.) and then a research consent that focuses on the subject as a tissue donor."[7]

However, for those willing to donate oocytes solely for research purposes, the clinical consent model does not seem to work. "These women are not pursuing the procedure for any reproductive or medical benefit to themselves; rather they are exposing themselves to risk entirely for the benefit of others. If we were to think of them as simply clinical patients, their physician's fiduciary obligations would seem to require counsel against undergoing such a procedure."[8] Subjecting a donor to the high risks associated with fertility treatments for altruistic reasons seems unfair, especially when the consequences can include future infertility and even death. Until there is a sufficient consent model put into place for donations of this kind, there is a risk of ethical misconduct.

Sperm donation, on the other hand, is considerably less invasive and does not present risks to the magnitude that oocyte donation does. However, both types of gamete donation do face similar issues when it comes to the compensation of donors. Reimbursement for expenditures that are incurred as a consequence of the donation process results in relatively few ethical questions but any payments over and above these costs, whether they are direct or indirect, presents a serious moral issue. Not only is it morally repugnant to sell parts of the human body for a profit, it also risks the commodification of reproductive material and, in turn, the commodification of the donors themselves. It is necessary to prevent this kind of compensation in order to maintain certain important ethical standards and to protect donors from the buying and selling of their reproductive material.

Recently, issues with donations of this sort came to the foreground when an American scientist pulled out of a stem cell project taking place in South Korea due to concerns regarding the oocyte donations. Allegations of unethical conduct were made when it was discovered that two junior members of the team had actually donated their own oocytes for the research. "Such a donation, although not illegal, would

raise ethical flags because lab members might feel pressure from senior members or might think that they could benefit, for example by being named co-author."[9] Practices of this sort are widely condemned because of the hierarchical structure that is typical of a laboratory environment. Additional concerns arose following further allegations that these women had accepted compensation for their donations. The lead scientist of the team has since been indicted on fraud and bio-ethics law violations[10]

Significant benefits can be derived from the creation of embryos for research purposes, such as easier access to stem cells and an increased number of stem cell lines. But, the intentions with which these embryos are created, as well as the issues surrounding oocyte donations, must be considered as well. Producing embryos in this way has its advantages but it also increases the possibility of ethical misconduct.

Embryos created through somatic nuclear transfer

To create an embryo by means of somatic nuclear transfer, an oocyte is extracted from a female donor and its nucleus, where all of its genetic information is stored, is removed. Then, the nucleus from a donor's somatic cell (a normal cell from the body such as a skin cell) is transferred into the hollowed-out oocyte. The oocyte is then coaxed to divide as if it has been fertilized and then follows the normal progression to form an embryo. This embryo contains genetic information that is an exact copy of the somatic cell donor's, thus any stem cells extracted from it will match the donor's own genetic make-up.

The reason that a procedure like this is so appealing is because of the potential it has for tissue and organ transplants. Due to the chronic shortage of organ donations, patients usually have to put their names on waiting lists and hope that an appropriate donor is found before their situation becomes too grave to be able to accept a donation or before they pass away. For those who do receive organ transplants, one struggle is replaced with another as the diseased organ is substituted with the frightening prospect of rejection of the new organ and the life-long requirement for immunosuppressant drugs.

Somatic nuclear transfer may someday allow scientists to create tailor-made organs and tissues; although this process is still in its

infancy, it holds a great amount of promise. Since these stem cells can be made using the somatic cells of the person who will be receiving the transplant, there is little to no risk of rejection by the immune system because it will be a perfect genetic match. Quality of life for those receiving transplants would increase significantly with this technology.

The problem with this technology however is twofold. First, it requires the donation of oocytes and thus suffers from the same ethical issues discussed above. Second, somatic nuclear transfer is a means of human cloning and therefore subject to its own unique ethical dilemmas.

To begin, it is important to make a distinction between two types of cloning. The first is 'therapeutic cloning', where stem cells are taken from embryos that have been created by somatic nuclear transfer and used to produce somatic donor-specific tissues and organs. The second is 'reproductive cloning', where embryos are created by means of somatic nuclear transfer and then implanted into a womb where the embryo will develop into a baby that would be the exact genetic match, or clone, of the somatic cell donor.

Reproductive human cloning is an extremely controversial side of this technology. The technology is still in its infancy, meaning that there is very little control over the results of any experiments that attempt to clone a human being. As such, a human that is produced by means of cloning has the potential to be seriously deformed or have fatal mutations that would cause it to suffer.

In spite of the moral repugnance of human cloning for reproductive purposes, there have been a number of research teams that have attempted to produce a human clone. For instance, in late 2002, a religious sect known as the Raelians claimed that one of their members had given birth to a cloned baby. No DNA test results were ever produced to determine whether or not the baby was in fact the exact genetic duplicate of its mother. Whether or not the claims of the Raeliens were true, the international community quickly condemned this event.

While human cloning is viewed negatively, cloning is becoming a common practice in agriculture. Cloning technology has been used to create a number of animal clones, including the famous sheep Dolly,

who shocked and intrigued the world with her arrival. Applications of cloning in livestock have been widespread and have included cloning prized animals such as the famous Canadian bull Starbuck who was used extensively in cattle breeding. Because he was such a valued animal, he was cloned in order to maintain his genetic stock, creating Starbuck II. This kind of cloning is seen as a kind of insurance policy for farmers who have particularly valuable livestock.[11] The cloning of animals is, of course, subject to different rules and regulations than human cloning but, because it is being used more and more, cloning technology continues to progress.

Therapeutic cloning has many potential benefits, especially for those requiring transplants. But, because the steps for therapeutic cloning are the same as the initial steps used for reproductive cloning, which could theoretically lead to cloning humans, there remain serious ethical issues with the technology.

Canada's Policy For Stem Cell Research

Canada's policy for reproductive and genetic technologies, of which stem cell research is a part, took a very long time to develop. From the appointment of the Royal Commission on New Reproductive Technologies in 1989 to the adoption of legislation for this kind of technology in 2004, there was a fifteen-year gap where Canada had no overarching legal framework in place to guide this kind of research. Given the rapid advancement of reproductive and genetic technologies during this time, the scientific community was essentially left in a policy void while ethical issues and moral concerns about the direction of this kind of research continued to multiply. In order to understand why it took so long for Canada to implement policy for stem cell research it is important to examine the chronology of Canadian policy in this field.

In 1989, the Government of Canada set up the Royal Commission on New Reproductive Technologies in order to determine what sort of action should be taken in the face of the swiftly developing area of reproductive and genetic technologies. In 1993, the Commission tabled its report "Proceed with Care" which recommended that Canada adopt laws for these kinds of technologies in order to close the policy gap. It made a vast number of recommendations, which

included placing limits on buying and selling reproductive materials and embryos, licensing of certain activities and the creation of a national commission in order to regulate the use of reproductive and genetic technologies in Canada.[12]

Royal Commissions only have the power to make recommendations, so it is the government that decides whether or not to implement the advice from this panel of experts. Health Canada tried to address some of these issues as quickly as possible, placing "a voluntary moratorium on nine problematic [Assisted Human Reproduction] activities"[13] in 1995 and passing legislation governing the processing and distribution of sperm for reproductive activities under the *Food and Drugs Act* in 1996.

It was not until three years after the Royal Commission's report that legislation addressing reproductive and genetic technologies as a whole was tabled in the House of Commons. Bill C-47, also called the *Human Reproductive and Genetic Technologies Act*, acknowledged "the significant threat to human dignity, the risks to human health and safety, both known and unknown, and other serious social and ethical issues posed by certain reproductive and genetic technologies."[14] It placed several prohibitions on activities like human cloning, the creation of animal-human hybrids, sex selection, as well as payments to surrogates and compensation for reproductive materials. The Bill was created with the right intentions but was criticized for only addressing activities that were banned and for not outlining what kinds of activities were actually allowed under the Act. However, the *Human Reproductive and Genetic Technologies Act* never made it past its first reading, likely to the relief of its critics, due to an election.

A second attempt at regulating these technologies was made in 1997. The need for this kind of legislation was becoming increasingly urgent following the news that scientists in Scotland had successfully cloned a sheep (the now infamous Dolly). This event brought to the foreground the possibilities of cloning as well as the rapidly advancing capacity of this kind of science. It also brought with it the realization that if it is possible to clone a sheep then the cloning of a human being would not be too far behind. In order to prevent human cloning in Canada, a private member's Bill was introduced. Bill C-247: *An Act to amend the Criminal Code (genetic manipulation)* sought to make

amendments to the criminal code in order to outlaw human cloning as well as the manipulation of genetic material that could be passed on to subsequent generations. This Bill fared better than the *Human Reproductive and Genetic Technologies Act*. It passed its second reading in the House of Commons and was referred to the Standing Committee on Health for further review in the spring of 1999. But the Bill did not proceed past this stage because the Standing Committee became aware that "comprehensive and integrated legislation" was being prepared for the fall that would satisfy the requirements of the Bill.[15]

In November 1999, Bill C-13, the *Canadian Institutes of Health Research Act* was tabled for its first reading in the House of Commons. By the spring of 2000, the Government of Canada had established the Canadian Institutes of Health Research (CIHR) to act as the primary funding agency for Canadian research in the life sciences.

The scientific climate at the time was one that was very exciting. Stem cell research was advancing rapidly following the release of two separate reports in late 1998 which "were published by two independent teams of scientists that had accomplished the isolation and culture of human embryonic stem cells…."[16] There was also the progress of the Human Genome Project, which culminated in the release of the draft sequence of the human genome in the summer of 2000. But, the excitement of the time was somewhat tempered by the ethical questions that arose as the result of these advancements.

CIHR, given its responsibility for funding health research, had to quickly respond to the potential ethical consequences of these new scientific advancements and especially to the issues surrounding stem cell research in order to determine which areas, if any, would be eligible for funding. After serious consideration of the benefits and the ethical implications posed by this kind of research, CIHR determined that certain areas of stem cell research would be eligible for funding. Given the lack of legislation to act as a guide, CIHR had to develop its own guidelines to ensure the application of the highest ethical standards in this kind of research. The guidelines, entitled *Human Pluripotent Stem Cell Research: Guidelines for CIHR-funded Research* were released in March 2002.

Under these guidelines, a number of activities were determined to be eligible for public funding, such as research conducted on stem

cells derived from the excess embryos that remained following infertility treatments and adult stem cells. This document also outlined activities ineligible for public funding, such as the creation of embryos for research purposes, human cloning as well as the creation of animal-human hybrids. In order to ensure the application of these guidelines, CIHR established the Stem Cell Oversight Committee to conduct an ethical review of all proposals containing a stem cell component.[17] While these constituted a comprehensive set of guidelines and ensured the application of high ethical standards to stem cell research, they only applied to publicly funded research and there were no legal implications for performing research that did not comply with the ethical standards laid out by CIHR.

Finally, in March 2004, fifteen years after the appointment of the Royal Commission on New Reproductive Technologies and eleven years after the Royal Commission tabled its report, the Government of Canada passed legislation to fill the legal void surrounding reproductive and genetic technologies in the form of the *Assisted Human Reproduction Act*. This Act was declared by Health Canada to be "one of the most comprehensive pieces of legislation in the world concerning reproductive technologies and related research."[18] While not perfect, it closed a gaping hole in Canadian legislation and ended the uncertainty facing reproductive and genetic technologies.

The legislation draws heavily on the CIHR guidelines, placing prohibitions on human cloning, the creation of embryos for research purposes as well as the creation of animal-human hybrids. It also fills in the legal gaps that previously surrounded compensation for reproductive materials and embryos. Anyone found guilty or indicted of any of the activities forbidden by the legislation could receive a fine of up to $500,000 or up to ten years imprisonment or both.

The Act also outlines a number of controlled activities that require licensing, such as the use of excess embryos from fertility treatments, the import or export of embryos, oocytes and sperm and the reimbursement of costs incurred as a result of the donation of reproductive material.

The Act itself was quickly pushed through the legislative process to ensure its adoption prior to the election in June 2004. In the weeks prior to its passage, there were still debates regarding the classifica-

tion of cloning as a prohibited or controlled activity, especially given the research that had been released in March 2004 by South Korean researchers who had derived stem cells from cloned embryos.[19]

The legislation also establishes the Assisted Human Reproduction Agency of Canada to oversee the implementation of all areas of the Act. The Agency will be located in Vancouver, British Columbia and was scheduled to open in January 2006; however, as of August 2006, there was still no such Agency. As one journalist recently pointed out, without the Agency in place to implement the Act, "for all intents and purposes, the law does not exist."[20] With a new government now in place, the timeline for the appointment of the President/CEO, Chairperson and Board Members has been delayed, which means that the *Assisted Human Reproduction Act* must continue an already drawn out gestation period.

The Policy and The Science

When science and ethics come together as they do in the stem cell debate, policy can play an essential role in the regulation of scientific activities by providing guidance and reinforcing the ethical limitations of an activity. Policy for science is "the deliberate effort to influence the direction and rate of the development of scientific knowledge."[21] This is achieved by means of financial resources and restrictions as well as an administrative framework put in place by a political authority. The *Assisted Human Reproduction Act* employs policy in order to delineate ethical boundaries and provide guidance in order to protect all parties from a moral minefield. However, the Act has been criticized for being too restrictive, placing too many limitations on scientific freedom. Some "U.S. and Canadian commentators have suggested that scientific freedom may, in the context of stem-cell research, be constitutionally protected."[22] But, it is important to understand that this policy has been put in place, along with its bans and penalties, in order to implement necessary constraints to ensure the ethical integrity of the research.

As mentioned previously, the Act prohibits human cloning in Canada. In the weeks preceding the passage of the Act, there were still debates as to whether this activity should be controlled or prohibited. In the end, it was decided to ban cloning in order to avoid the

myriad of potential consequences that could arise with the allowance of this activity. In the weeks following the passage of the Act, policy makers were criticized for barring access to this very promising technology and raising fears that Canada would be left behind the international community. However, the benefits of human cloning are marred by the ethical connotations of this kind of research, making the decision to tread lightly around this kind of technology a safe one.

The penalties for taking part in prohibited activities like cloning are harsh but are they unnecessarily so? Policy makers have sent a clear message with the penalties and fines designated in this Act that certain kinds of research, the trade of certain specimen and payment for donations, along with other activities, will not be tolerated. While the Act places limitations on Canadian research both nationally and internationally, it also clearly delineates the boundary between what is allowable and what is not. By means of penalties, policy makers ensure that the ethical concerns surrounding this kind of work are taken seriously and that scientists consider the consequences of their actions before they proceed with certain kinds of research.

Policy, with its capacity to influence, also has the capacity to hinder scientific progress, acting as a barrier instead of as a guide. Critics of the *Assisted Human Reproduction Act* assert that the legislators have overstepped their bounds by limiting scientific freedom. However, scientific freedom is not absolute because it must operate within a social context and must be restricted when it can cause significant harm.

Scientific freedom needs to be mitigated by ethical considerations. Science operates within a social framework that values certain ethical principles, and as such research needs to be performed within an environment that recognizes the implications of all of its parts as well as its repercussions as a whole. Codes of ethics are put in place in order to protect the vulnerable, whether they are patients, research subjects or even research assistants. Ethical guidelines are implemented to ensure tissue samples and reproductive materials are obtained in a way that is morally sound. Ethics are a critical part of research and this is highlighted by the importance that is placed on the thorough consideration of potential ethical implications that must be clearly laid out before experiments even begin. While in some

cases ethics may restrict certain aspects of science, they are essential in preventing activities considered morally repugnant. The result is that the integrity of the research is maintained as well as the propriety of the field in general.

Within the realm of stem cell research there exist a number of actions that can be harmful. From the commodification of reproductive materials to the coercion of donors by superiors and even to the risks associated with the cloning of human beings, this kind of technology has the potential to cause harm on several levels. Protection from certain activities is a legitimate area of concern, especially considering the recent scandal that befell the famous South Korean research team at the World Stem Cell Foundation when it was discovered that they used oocyte donations from junior researchers. The admission of wrongdoing and subsequent indictment was shocking and has had a negative impact on the work being done at the World Stem Cell Foundation and on the field of stem cell research in general. In a case like this, one must ask: if something like this scandal can happen with the world watching, what could happen if nobody is watching?

The *Assisted Human Reproduction Act* was put into place to guide research and influence its direction. It was also put in place in the hope that it would ensure that Canadian scientists would conduct their work according to high ethical standards and moral practices. The legislation may restrict some of the scientific work done in this country, but if it is meant to maintain the integrity of the science and protect the public interest then policy makers are doing the right thing.

Stem cell policy has actually created an environment in which science has not been stifled, but has instead oriented research toward overcoming particular problems and ethical issues. Recent events demonstrate that science is developing in order to satisfy policy and advance research. For instance, in October 2005, the prestigious science journal *Nature* announced that two separate and distinct methods of producing stem cell lines had been developed.[23] The focus of both of these methods was to find a way to produce stem cells that addresses particular ethical concerns and, more specifically, attempt to find a way to avoid the debate on the moral status of an embryo.

The first does this by avoiding the destruction of the embryo while the second creates an embryo that is incapable of developing past a certain point.

The traditional method of deriving stem cells results in the destruction of the embryo when a stem cell is plucked out of the blastocyst. To avoid the loss of the embryo, a method has been developed using a process that is currently employed in preimplantation genetic diagnoses. This is a technique that is employed for screening the genetic make-up of an embryo for high risk and potentially fatal genetic mutations, such as those that cause cystic fibrosis and Huntington's disease, before an embryo is implanted into the womb. It involves the removal of a cell at the eight-cell stage of development. When a cell is removed at this stage it does not harm the other cells in the newly formed embryo and the remaining cells are able to form a blastocyst and continue developing normally.

The moral status of an embryo is an issue that must take into consideration the continuum from embryo to person. If, however, the embryo were unable to grow past a certain stage of development, the continuum from embryo to person would be disrupted, cutting the altered embryo off from the moral status debate. In this case, the embryo is genetically modified in order to inhibit the activity of a gene called cdx_2. In mice this gene is what allows a fetus to grow a placenta. An embryo created with this gene inhibited would be unable to develop into a viable fetus. When the gene is activated again, the embryo is viable and able to proceed with its normal development.

Scientists have developed both of these methods in order to help them get around the ethical issues that surround the moral status of an embryo. They are striking examples of how policy restrictions have had a positive effect on research, encouraging scientists to reconsider the way in which their work is done and challenging them to find solutions to ethical problems. Even though both of these solutions are still in their infancy, having only been applied to mouse stem cells, they demonstrate the kind of creativity that can arise when policy creates the need for it.

Policy can push science to find solutions to the problems that are created as a result of advancements in technology. When science must look for new ways of doing things because of policy restrictions it

often leads to creative solutions to problems. What may arise from these two new methods of deriving stem cells are ways of obtaining increased numbers of stem cells to use in research which do not suffer from the same ethical issues as current methods of extraction.

Conclusion

In cases of controversial new technologies and procedures, like stem cell research, policy attempts to influence and direct science in order to ensure certain ethical standards are met and that research activities that are considered morally abhorrent are strictly prohibited. The result is that science must continually find ways to adapt so that it can continue to progress and attain its full potential. The effect of policy in the case of stem cell research is a challenge to the industry to examine the ethics of what it does and to come up with solutions that take certain ethical ideals into account.

In spite of policy and legislation, stem cell research has continued to evolve and flourish in Canada, attracting world-renowned experts in the field,[24] government support (in March 2005, the government announced $5.3 million in annual funding for stem cell research)[25] and new research facilities (the Ottawa Health Research Institute's Sprott Centre for Stem Cell Research is set to open in November 2006).[26]. The *Assisted Human Reproduction Act* has restricted certain scientific freedoms, but it has also had a stabilizing effect on the research community, allowing it to function within legal certainty. The Act has attracted international attention for a number of reasons, not the least of which is the strict ethical requirements it places on this kind of research. As it turns out, this is one of the strengths of the legislation, especially considering how easily controversial experiments can degenerate into scandal.

The key to stem cell policy is to ensure that certain ethical principles are adhered to. At the same time, it must allow a sufficient amount of scientific freedom in order to ensure the science is able to achieve its maximum capacity. Stem cells are tiny things that have the potential to change the world and it is up to us to decide how this potential will be realized.

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Sustainable Housing: An Ottawa Perspective

Daniel Carr, Lillian Hayward and Serena Boutros

"As migration from elsewhere in Canada and other countries continues, Ottawa's population is projected to grow by up to 50 percent by 2021. And because the average number of people in each household is gradually declining, the number of households in Ottawa is projected to increase even faster than the rate of population growth – by up to 60 percent over this time period. This means almost 190,000 new homes may be needed in Ottawa within the next 20 years."[1]

Buildings are essential to civilization as we know it, and it is estimated that North Americans spend eighty to ninety percent of their lives inside buildings.[2] This dependence on shelter has strong implications for our relationship to the environment, as buildings use one third of our total energy, produce thirty percent of our greenhouse gas emissions and are responsible for sixteen percent of our fresh water withdrawals.[3] Further, buildings use over two thirds of the electricity produced in North America.[4] Our reliance on buildings has a significant impact on the environment, and this includes not only our offices, factories or stores but also the places in which we live, our homes.

The city of Ottawa faces significant challenges within the next twenty years as highlighted in the quote above. Given the impact that buildings have on the environment, the expanding local population and the increasing demand for houses, it is appropriate to examine this problem in the context of sustainable development. The definition of sustainable development that will be used in this paper is taken from a report by the UN World Commission on Environment and Development, *Our Common Future*. This report defines sustainable development as the process through which humanity "meets the needs of the present without compromising the ability of future generations to meet their own needs."[5] In this context, sustainable housing is housing which is integrated into the community, minimizing its

ecological footprint through high density housing in order to facilitate the use of more sustainable transportation, such as walking and public transit. It focuses on closed loop production processes and technology, and seeks to improve environmental and personal health while increasing energy efficiency.

The demand for housing is not unique to Ottawa, as growth in urbanization is causing the population of cities to grow across Canada.[6] However, if Ottawa's growth prediction bears true, the sheer magnitude of the challenges that will be faced by the city are enormous when examined through the lens of sustainability, and the lessons it learns will be applicable to municipal areas across Canada. The addition of 190,000 new homes to the Ottawa area in coming years will produce both problems and opportunities for real estate developers, materials suppliers and government policy makers. The issues that will be faced by the City of Ottawa within the next two decades give rise to two questions: first, how can the principles of sustainable development (SD) be applied to housing and construction in response to the challenges faced by the city; and second, what role can producers, consumers and policy-makers play in addressing the growing need for housing?

This case study will examine the application of SD to housing and construction through contact with practitioners in the private, public and not-for-profit sectors. Using current research and best-practice initiatives, the study will examine how the City of Ottawa can address the challenges posed by ongoing development and analyze these issues through the lens of sustainable development. Research will be divided into three areas of expertise: Real Estate and Housing; Building Materials; and Housing Technology. While this is by no means an exhaustive list of areas that could be covered by this field of research, they do highlight many of the key sustainable housing issues facing consumers, producers and policy makers. Exploration of these three areas will provide insight into what a sustainable construction and housing industry might look like, what it could mean for the residents of Ottawa, and what changes will be needed in order to make this vision a reality.

Housing and Real Estate

Suburban sprawl, characterized by low-density singly family homes and car dependent neighbourhoods, has become a growing issue within expanding cities. These houses can be constructed quickly and cheaply, and consumers benefit from quick occupancy and affordability. While these obvious benefits have made suburban developments popular, this kind of sprawl is beginning to come under greater scrutiny. Public concern with the economic, social and environmental problems has grown, largely due to the fact that this style of development requires significant expansion of municipal infrastructure and necessitates the extensive use of cars. The result has been a surge in developments that subscribe to the ideals of "New Urbanism", such as the community of Cornell in Markham, Ontario and East Clayton in Surrey, British Columbia,[7] which move away from simply constructing houses and rather place an emphasis on building communities.

This method of planning rethinks the traditional suburban plan, shifting emphasis away from low-density single family homes and towards higher-density buildings like town homes and apartments. These communities are generally constructed around a main street with mixed use developments consisting of shops, office space and condominiums. The importance of "walkable" neighbourhoods is also highlighted in New Urban design, which incorporates wider sidewalks and narrower streets into plans in order to encourage residents to leave their cars at home.

In many ways, New Urbanist developments are the remedy to many of the issues posed by suburban developments, but they also have some of their own problems. For instance, they tend to look surreal, having lost the organic feel of a well established community that has developed over time. Also, they do not attract the diversity of individuals as had originally been the intention of these developments. In spite of these drawbacks, there are important lessons to be learned from New Urbanism: the house does not need to be the central focus of development and there is a great deal of value in considering sustainable features like community, walkability and high-density housing. Within this framework, the house is no longer a stand alone unit but is instead integrated into a system that includes the surrounding environment.

The strengths and weaknesses of suburban and new urban styles of development are important to consider when addressing the changes that will be occurring in the city of Ottawa. If 190,000 new homes will be needed within the next twenty years, where are all of the houses going to go? The city has recognized the expense of continuing the suburban sprawl. Not only does this include the cost of adding roads, extending sewer systems and putting in power lines, but there is the additional cost of losing precious agricultural lands. Protecting agricultural lands is essential given that agriculture is the foundation of Ottawa's rural economy.[8] Given Ottawa's commitment to protecting its greenbelt, ninety percent of Ottawa's growth is planned for within the existing urban boundary. Two thirds of the city's development will occur outside of the greenbelt and of this, only sixty percent will be single family homes with the remaining forty percent being either townhouses or apartments. The remaining one third of development will occur within the greenbelt and will be mostly in the form of apartments.[9]

In order to ensure this growth occurs in a productive way, the city of Ottawa has developed the *Ottawa 20/20 Plan*, a framework for managing the city's growth over the next twenty years. It is a tool that is meant to anticipate and manage the changing city in a sustainable way by encouraging land-use intensification, infill projects and mixed-use developments. The plan itself consists of five growth management plans which cover the city's physical development, transportation, economics, human services, arts and heritage as well as the environment.

Perhaps the most interesting connection found in *Ottawa 20/20* is the link between the city's physical development and transportation systems. Transportation is essentially the backbone of how development projects throughout the city will occur. The city is making a concerted effort to focus density around transit stations with the goal of increasing ridership from 17% to 30% of commuters by 2021.[10] This plan should be successful, as Robert Paehlke, a professor of public policy and environmental politics at Trent University, points out: "When cities are relatively compact (a mix of multiple family dwellings and single family houses with relatively narrow lots arrayed on square street grids) and commercial and other non-residential

functions are nearby, people will opt for public transportation in fairly significant numbers."[11]

The *Ottawa 20/20* plan is still in its infancy having only entered its implementation phase in 2003, but the shift towards more sustainable forms of housing is well underway in the Ottawa area.[12] A number of new projects are currently in progress which apply many of the important elements of sustainable housing such as high density developments, pedestrian and public transit oriented neighbourhoods. One of these projects is EcoCité, a development that will be built in Ottawa's Glebe neighbourhood starting in 2006. This building will be located at the southern gateway to the Glebe across from Landsdowne Park, land that is currently occupied by a sports bar set back from the street with an expansive parking lot out front. The new development will not just make better use of the land; it will also include numerous green features, exceeding energy efficiency standards of the Model National Energy Building Code by fifty percent, incorporating healthy building materials and applying a passive solar design.[13]

Peoples' attitudes towards the project have been predominantly positive. The Glebe Community Association, which is notoriously conservative when it comes to new development projects, even asked why the building was not going to be bigger.[14] A building that is as energy efficient as EcoCité promises to be will save condo owners a significant amount of money during their occupancy. Also, as energy prices continue to rise and the cost of living becomes more expensive, the energy efficiency of these units will also play a favourable role in the condos' resale value relative to other buildings.

One significant barrier to a development like this is the cost of some of the technologies employed in the design. For instance, the building will use geothermal energy to heat and cool the units and this system is significantly more expensive than installing electric baseboards and air conditioning units.[15] Once technologies like this become more common however, the costs will start to fall, making them more reasonable for the average home builder and consumer.

EcoCité is a particularly noteworthy example of sustainable building that is happening in the Ottawa area but it is by no means the only one. For instance, the Currents is a project that is being built in

Ottawa's Wellington Village area. This building will feature innovations in water, air, energy and waste management.[16] It is also a mixed-use development which will, upon completion, be the new home of Ottawa's Great Canadian Theatre Company.

The application of features that will make homes and communities sustainable are not just being applied to urban infill projects. Jackson Trails for instance, is a development that is being constructed just outside of Stittsville, a suburb of Ottawa. This will be Canada's first EnergyStar certified community, which means that they are among the most energy efficient homes on the market.[17] Beyond savings on energy, this neighbourhood will feature recessed garages and large front porches to increase the "feeling of openness and downplay the role of the automobile".[18] Also, the developers of this community formed a partnership with Wildlife Habitat Canada before the project went forward to ensure the development's design preserves the local wildlife habitat.

These projects, while striking in terms of their applications of sustainable housing development, are likely the tip of the iceberg for the city of Ottawa, especially given the recent formation of the Ottawa Committee for Sustainable Community. The impact of this group remains to be seen, but support for its initiative has been overwhelming. Approximately fifty people participated in the Committee's first meeting and support continues to grow, attracting a group of individuals ranging from professionals in the field to interested citizens concerned with sustainable housing initiatives.[19]

The support for this committee, the new building initiatives that are pushing the standards in energy efficient and environmental design, and the trend away from low-density suburban-style developments indicate that attitudes towards housing are changing in the Ottawa area. While changes are in their early stages, it is becoming apparent that people expect more from their houses. People are starting to understand that a house is no longer just a home, it is rather the home's interconnectedness with the community and the environment that make it a desirable place to live.

Building Materials

The physical infrastructure fundamental to housing is formed by

building materials. Using sustainable materials in home construction decreases the impact that this industry has on the environment, leads to a healthier indoor and local environment, and can potentially have positive effects on the quality, cost and durability of the finished product.

Though they are often loosely grouped under the heading of "sustainable materials," there is no precise definition of this term. Generally speaking, sustainable materials are those that meet the following criteria:

1) Do not cause health problems or poor indoor air quality
2) Reduce environmental degradation caused by associated pollution, over harvesting, waste and hazardous by-products
3) Do not require energy-intensive manufacturing
4) Minimize building energy use
5) Create waste that can be reused, recycled, or landfilled safely
6) Are locally obtained, reducing the embedded transportation costs of the material[20]

This section will address current attempts to incorporate these principles of sustainability into the construction process. Attempts to reduce the environmental impact will be examined in the different stages of material use: production/harvesting; sales and installation; and waste. Modern examples will be used to highlight these different stages, and guide thinking about the future of the building industry.

Production/Harvesting

Materials can be divided into two categories: those derived from biological processes, and those that are based on inorganic, "technical" nutrients.[21] Methods of improving the sustainability of these materials depend on the route they take from raw material to final product. Sustainability for organic materials, including those derived from wood, straw and corn, stems from land stewardship, farming methods, and the production process. For crops that are not rapidly renewable, such as many types of wood, harvesting must be done in line with forest growth dynamics, and should coincide with regeneration.[22] Ecological health can be improved by increasing bio-diversity and avoiding chemical pesticides and fertilizers.

Inorganic materials common to the housing industry include drywall, cement, shingles, paints and adhesives. Innovative production processes can use less energy, reduce pollution, and recycle waste. For example, waste products like fly-ash or used tires can be recycled into Supplementary Cementing Materials (SCMs), reducing the amount of ordinary Portland cement needed, thereby reducing CO_2 emissions. The kilns that power this reaction can be made more energy-efficient and fueled by non fossil-fuel sources. As cement is the most common building material in the world, and accountable for 5% of global CO_2 emissions, these new production methods have global ramifications.[23]

Sales and Installation

Convincing customers that sustainable materials are preferable to traditional ones is a significant barrier to their use. While there is no denying the importance of price, which is often higher for these niche products, it is ignorance of the benefits, or even existence, of sustainable materials that must first be overcome. As a local salesperson explained, "people think that if it's environmentally friendly, it's going to be high-cost, boring and beige."[24] Once they have experienced these products for themselves, witnessing their attractive, unique character and high quality, customers are likely to change their minds; repeat customers and word-of-mouth are responsible for the strong growth of this market, says a local salesperson.[25]

While personal research and store recommendations are still an important method of identifying sustainable materials, labeling and certification are becoming increasingly common. Home Depot, for example, only sells Forest Stewardship Council (FSC) certified wood as part of its policy on Corporate Social Responsibility.[26] Using FSC-certified wood is also required to gain points in the relevant LEED (Leadership in Energy and Environmental Design) category.[27] As customer awareness grows and LEED, R-2000 and other building certifications becomes more common, the materials and processes used to create the buildings will also need to meet some certification standard, which will lead to an increase in their importance.

Sustainability in the construction process is often one of making careful choices and being attentive to details. Many practices that

decrease the ecological impact of construction, such as limiting energy use and reducing waste, are also good business practice. Energy efficient tools and machinery use less fuel, while reducing waste lessens disposal costs and decreases the amount of material purchased. Installation can have long-term affects on indoor air quality. Many varnishes, paints, and adhesives contain chemicals that release dangerous chemicals, such as volatile organic compounds and formaldehyde.[28] Choosing replacements for these products that do not give off harmful chemicals can increase the health of both construction workers and residents of the building.

Waste

Waste is an unfortunate reality of construction, signifying both an economic and material loss. It is currently estimated that the construction of a single-family home in the U.S. produces anywhere between two and four tons of waste.[29] If landfilled, excess material represents an additional cost of disposal; opportunities for recycling and reuse turn a liability into a new source of income, while also reducing the need for virgin materials to be produced.

Numerous waste diversion strategies can be applied to the construction industry. Waste materials can be returned to their original production process and mixed with new material to create a product of comparable quality, such as post-consumer cardboard or SCM-containing cement. Material can also be turned into a new product; for instance, leftover wood scraps and even drywall can be turned into garden mulch or soil amendments.[30] Larger pieces of material can be sold or donated to stores that sell to contractors or renovators at discount prices. The Ottawa-area Habitat for Humanity ReStore is one such enterprise; it is estimated to divert 400 tonnes of waste from landfills each year, while raising thousands of dollars for its cause of building low-cost housing for needy people in the community.[31]

Housing Technology

"Innovation in support of sustainable production is most likely to succeed if it occurs from individuals or the smallest possible units."[32] As mentioned at the outset of this discussion, there will be an

increased need for housing units in Ottawa in the near future. As housing infrastructure is well established and slow to change, the time to transform the housing and construction sector along the principles of sustainability is now. Innovation in the area of housing technology is integral for greater alignment with eco-effective principles, which stress efficient use of energy, minimization and re-use of wastes, and synergism with the local environment.[33] This section of the discussion will focus on the role public policy has played in the stimulation and creation of new housing technologies. The central drivers behind public policy in this field are to alleviate the burden of rising energy costs, improve indoor air quality within the home, and reduce greenhouse gas emissions.

eKOCOMFORT Program

The need to improve indoor air quality and increase energy efficiency has been recognized. The Canadian government has challenged the private sector to meet these goals by improving and creating new technologies that can be employed by the housing industry. One example of such a government program is the eKOCOMFORT program, sponsored through Natural Resources Canada (NRCan). NRCan worked with private manufactures to design and create technologies that were centered on integrating home systems so as to reduce energy consumption and improve indoor air quality. NRCan provided technical support, administrative assistance and almost $3 million in funding to six carefully selected private manufacturers in order to stimulate the creation and adoption of innovative housing technology. These private manufacturers have worked independently and in some cases collaborated, to design and create technologies that are centered on integrating various home systems so as to reduce energy consumption and improve indoor air quality.

Today's homes are built so tightly that the air inside can get trapped, reducing the flow of fresh, outside air. Furthermore, the air inside the home may become harmful to health due to pollutants found in the air; indoor pollution is caused by sources in the home that release harmful gases or particles into the air. Indoor air pollutants have both immediate and long-term health implications and, since most individuals spend so much of their lives indoors, it is

important to improve air quality.[34] A significant contributor to the problem of poor indoor air quality is inadequate ventilation. If too little outdoor air enters a home, pollutants can accumulate to levels that pose serious heath and comfort problems, especially in those homes that were constructed to minimize heat lost through cold outdoor air 'leaking' in through windows.

Besides the impetus to create housing technology that reduces energy consumption, another driver behind the eKOCOMFORT program is to have a heat recovery ventilation system installed in every home. A heat recovery ventilator collects stale and contaminated air in the house and flushes it outside. At the same time and in a separate duct, fresh air is brought into the house. The two streams of air pass each other in the heat exchanger core and the energy from the stale air is used to heat the fresh incoming air. The heat exchanger core is able to capture almost 85% of the energy from the stale air to heat the fresh air, thus using considerably less fossil fuel energy to heat the home and at the same time is actually improving indoor air quality.

The eKCOMFORT program seeks to incorporate a heat recovery ventilator with other technologies such as an air handler, mechanical ventilation, water heating systems and air conditioning into a single unit, thus reducing energy consumption even further. The integrated system works on a closed loop heating, cooling and water cycle. More importantly, the integrated system follows the foremost pillar of eco-effectiveness, the concept of "waste equals food".[35] The heat recovery ventilator takes the stale and contaminated air "waste" and uses the energy from it to heat the fresh incoming air "food."

The creation of new technologies is very expensive to design, risky to invest in, and faces the challenge of being thoroughly tested to ensure that energy efficiency is indeed achieved. This led to the creation of the Canadian Center for Housing Technology (CCHT). The CCHT was created in 1998 as a joint operation by NRCan, the National Research Council and Canada Mortgage and Housing Corporation. The goal of the CCHT is to accelerate the development of new housing technologies and to facilitate their acceptance in the marketplace.[36] The facility boasts twin research houses, side by side, with simulated occupancy to intensively monitor the performance of

new residential energy technologies in a controlled environment. The impetus for this project was the desire for more extensive research with regard to housing technologies. Essentially, there are many laboratories in Canada where the housing technologies are developed, but no bridge between the product leaving the laboratory and entering consumers' homes.[37] The fact that there were already numerous housing technology innovations in progress, and that NRCan had resources available to support this initiative, spurred the creation of the CCHT. The creation of this facility allowed the testing of eKCOMFORT products and provided a stepping stone for manufacturers working under the trademark to develop and test their products before full field trials in consumers' homes.

The largest barrier to the eKCOMFORT program is lack of market share for such housing technologies. Currently, technologies like these have a 10-15% market share with little prospect of increasing. Lack of obvious market demand is due in part to strong resistance from home builders who are wary of incorporating these technologies into their developments out of concern that it will drive up the cost of a home. This barrier of increased capital cost suggests a role for policymakers to actively pursue innovative solutions to this problem such as tax exemptions, energy-efficiency grants, subsidies and other tools, which will be discussed in the concluding section. Another barrier is the fact there are no big industry players in Canada that produce heating equipment. Canada imports most of its heating equipment from Asia and the United States, leaving only very small Canadian firms to work with to build this new equipment. Nevertheless, there is the opportunity that integration technology brings down energy consumption, thus reducing greenhouse gas emissions and energy costs. Additionally, there is the opportunity for the eKCOMFORT program to complement and feed-into other policy initiatives such as the R-2000 Standard, EnerGuide and EnergyStar.

R-2000 Standard, EnerGuide and EnergyStar

The R-2000 Standard originated in 1981 as a joint endeavor between the Canadian Home Builders' Association and NRCan. Its mission is to promote energy efficiency and reduce greenhouse gas

emissions in Canada's new housing stock.[38] The R-2000 Standard was borne out of the need to develop ways of building houses that are both healthy to live in and that use less energy than conventional homes. The R-2000 brings the opportunity to revolutionize home building science; the research behind the program produced the 'house as a system' concept.[39] This concept is aligned with the broad principles of eco-effectiveness because it recognizes that the home is affected by the interaction and interdependence between the flow of air, heat and moisture; essentially everything works together so that if changes are made to one area, it will affect other areas. Further, the house as a system concept recognizes that the interdependent home system also interacts with both the surrounding environment and its occupants. This simple concept has profoundly changed the way homes are built today and has led to the fruition of technologies (as illustrated through the eKCOMFORT program) that are centered on the concept of integration and remains the standard for leading edge cost-effective and energy-efficient construction technology.

One main barrier with regard to the R-2000 standard is that while it has led to new technologies and training, it is not a feasible means to measure mass performance, or rate of performance of houses, because it is too stringent. Too many houses were failing because they were unable to meet the strict passing mark. Therefore, the desire to introduce flexibility into housing standards was realized and in turn led to the creation of EnerGuide for Houses program and EnergyStar for New Homes.

EnerGuide for Houses is a policy initiative created by NRCan to endorse energy efficiency in homes, reduce greenhouse gas emissions and offer homeowners trustworthy advice to enable them to make informed and environmentally sound choices when renovating or retrofitting their homes.[40] There is also EnerGuide labeling which helps consumers purchase the most energy-efficient equipment on the market for their homes. As alluded to previously, there was a burgeoning desire to introduce flexibility with regard to housing standards and this was the main driver behind the EnerGuide for Houses program. The program was given five years of funding by NRCan and includes the opportunity to receive an EnerGuide for Houses retrofit grant. Through this program, homeowners are given the

opportunity to have their homes retrofitted to become more energy-efficient and those eligible to receive a grant can have almost their entire energy retrofitting bill paid for. While this program has been cancelled by the new Conservative government, it is too soon to say if it is gone for good, or if it will be implemented again after a program redesign.

Another similar policy initiative is the EnergyStar program. EnergyStar is an international symbol that allows consumers to easily identify products that are among the most energy efficient in the market.[41] NRCan seized the opportunity to expand this program and created a pilot project called EnergyStar for New Homes. This new program allows newly constructed homes to be labeled as EnergyStar if it meets the requirement of being 40% more energy efficient relative to a standard home. While the barrier of increased capital costs surfaced because an EnergyStar home is more expensive, the program did receive a great deal of provincial support and private sector funding. The Ontario Ministry of Housing has recently announced funding that provides rebates for consumers who buy EnergyStar air conditioning systems.[42]

Summary and Conclusions

This paper has described the challenges of creating a sustainable housing future for Ottawa by examining three distinct aspects of this industry while attempting to answer two questions: how can the principles of sustainable development be applied to housing and construction; and, what role can producers, consumers and policy makers play? The insights gained from this study offer meaningful suggestions for how the city can best address a significant population increase concurrent with developments in housing technologies, practices and theories of urban design.

The first step towards a sustainable housing industry is to recognize what it is, and why it is desirable. There is growing awareness of the need to reduce energy use, improve indoor air quality, and limit the negative impact that construction has on the environment for a variety of economic, social and environmental reasons. Sustainable housing can do much to decrease our ecological footprint and increase citizens' quality of life.

The application of SD principles to this industry is to recognize housing as a system. A house is not a stand-alone structure providing shelter to a few individuals; it is part of a neighborhood, and residents interact with each other to create a community. Urban design affects our way of life, and housing choices are influenced by the availability of local services such as transit, shopping, parks and schools. A house itself is made up of several systems that manage water, heating/cooling, air quality, and waste; recognizing their interdependence leads to better design. The construction industry draws on biological and technical "nutrients", most of which are renewable only on extended time scales, while also creating by-products of similarly long-lasting pollutants. Thinking of systems, rather than individual units, makes it easier to build houses that fit together, neighborhoods that fit in to the local landscape, and an industry that fits into a sustainable economy. This is a perspective that should inform policy makers at all levels of government.

The lessons learned from the three case studies suggest enhanced roles for consumers, producers and policy makers. If Ottawa is serious about meeting the goals it sets for itself in the *Ottawa 20/20* plan, it will need the cooperation of all three groups, which can each gain from a more sustainable housing industry.

Three broad roles can be distinguished for government policy makers, who face multiple challenges. As they proceed, it is crucial that different levels of government recognize that responsibility for regulation and laws regarding housing are divided among them, and coordinate their activities accordingly. Leadership is imperative; while it is not obvious that it must come from a particular level of government, municipalities are closest to the problem and might therefore be the source of momentum.

An important first step is to create and diffuse knowledge regarding sustainable housing, which can inform consumer preferences, increase awareness of business opportunities, and strengthen the market for sustainable housing. Because sustainable housing offers benefits to businesses and consumers, diffusing the desire for greater housing sustainability throughout society will enlarge the markets for these products, and increase their popularity. Because implementing sustainability requires costly research and innovation, public support

for sustainable housing will encourage governments to invest in this area, leading to new technologies, materials and production practices.

To overcome the cost-barriers caused by the current framework (such as the freedom to pollute, or subsidization of infrastructure like roads and sewers), governments could experiment with measures that favour sustainability. For example, municipal governments could buy efficient but capital-intensive home systems like eKOCOMFORT, and lease them to homeowners, reducing up-front costs by collecting fees over time along with local property taxes. Public investment would lead to lower financing costs, and a large-scale program would increase the speed of technology diffusion and develop expertise in operating this technology, while also bringing the benefits of higher air quality and more efficient temperature management. Policy can also influence economic decision-making by internalizing environmental costs and benefits into the pricing system in line with the eventual goal of ecological fiscal reform.[43] Taxes on carbon emissions, or tax-deductions for sustainable materials/technology, are means to this end.

Governments at every level can have a significant impact on the construction industry by their own procurement practices. Governments throughout Canada, including Ottawa, Vancouver, and the federal government, have instituted policies specifying that new public buildings achieve LEED-certification. Leadership in this field increases the market for sustainable goods, increases awareness and expertise by design professionals, and creates tangible examples of sustainable buildings, in addition to the other benefits offered by sustainable buildings.

Consumers can play an important role simply by informing themselves about sustainable housing, and applying this knowledge when renovating or buying a home. As the most significant property that most individuals own, houses are also where they spend years of their life; over the long-term, the benefits of healthy and efficient homes will outweigh the added cost of sustainable housing. Consumers can also act as citizens, by supporting government initiatives that support sustainability, and by organizing into community groups that amplify their voices. In Ottawa, community groups like the Ottawa Committee for Sustainable Community are actively involved in local development, and can influence the future housing situation.

Producers have a large role to play in changing the housing industry. By being aware of changing consumer preferences, and policies that affect decision-making, businesses can become leaders in industries that are growing and which offer promising long-term viability. Producers' expertise and specialization is essential if the knowledge and materials needed for sustainable housing are to be made available to the market.

Additionally, firms can defray the risk and lack of knowledge inherent in new industries through cooperation. Industry associations, such as the Cement Association of Canada, the Canada Green Building Council and the World Business Council for Sustainable Development pool resources and expertise and allow firms to have influence they could not have acting alone. For example, research into new technologies and practices are expensive, but lead to new products, while certification standards can increase visibility and market acceptance of new products.

Conclusion

In conclusion, there is tremendous opportunity for sustainability in the housing industry. While significant barriers exist, and the pace of change in a sector that plans on the scale of decades is bound to be slow, there is growing interest by business, government and citizens in promoting sustainability, as each sector recognizes the benefits that it brings them. The question that remains is whether changes will add up to real reform or merely a series of superficial adjustments to business-as-usual. Will our housing be good, or simply less bad? Will the homes of the future continue to draw substantially on valuable energy resources, or will they incorporate new technologies that significantly reduce energy use? Will cheaper materials from more efficient processes increase consumption, or will they incorporate waste and close the production loop? Will new urban planning maintain denser neighbourhoods that still revolve around the car, or will they succeed in changing lifestyles to incorporate public transit and travel by foot? The answers to these questions remain to be seen, and the only certainty is that we will be living with the decisions we make.

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The Assessment and Management of Substances in Canada Under the *Canadian Environmental Protection Act* (CEPA): The Listing of "Ammonia Dissolved in Water" as Toxic

Kathy Wilson

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Substances can provide many benefits to society; at the same time, substances can pose threats to the quality of life Canadians enjoy today and will experience in the future. For this reason, the assessment and management of substances is extremely important to ensure that the risks that toxic and other substances pose to human health or the environment are prevented, minimized and managed. In Canada, substances are reviewed, monitored and controlled through the legislative framework of the *Canadian Environmental Protection Act, 1999* (CEPA 1999). Using the case of "ammonia dissolved in water" as an illustrative example, this paper studies Canada's approach to the assessment and management of toxic substances through CEPA 1999. The paper will examine whether an appropriate balance between the benefits a substance like ammonia can provide to society and the need to protect human health and the environment was found.

Science-Based Policy Approaches and Canada's Toxic Substances Management Policy

Finding a balance between the benefits that substances can provide to society and determining an acceptable level of risk is a challenge for science-based policy and regulation in Canada. Science-based regulations, such as CEPA 1999, are important instruments to protect the environment and safeguard human health; however, science-based

regulations must also avoid imposing unnecessary restrictions, unless warranted by the potential for serious harm. A guiding principle of CEPA 1999 is a precautionary approach in which lack of scientific certainty cannot be used as a reason for not implementing measures to prevent potential harm or serious damage: "where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation".[1] For science-based regulations to be effective and enforceable, credible scientific information is required at each step of the process.[2] In situations of scientific uncertainty or risk, sound information provides policy-makers with the tools to develop solutions and make difficult political decisions.[3]

The Government of Canada's *Toxic Substances Management Policy* (TSMP), released in 1995, provides a framework to facilitate consistency among federal programs with its two key management objectives: the virtual elimination of toxic substances that are persistent (break down over a long period of time) and bioaccumulative (accumulate in living organisms) and lifecycle management to prevent and minimize the release of other toxic substances and substances of concern.[4]

Managing Substances in Canada

In Canada, environmental protection is a shared responsibility of federal, provincial and territorial governments. CEPA 1999 is the primary tool of the federal legislative framework to prevent and manage risks from toxic and other substances as well as to protect human health and the environment.[5] The federal Minister of Environment is responsible to Parliament and Canadians for the administration of CEPA 1999, while the Minister of Environment and the Minister of Health jointly oversee the assessment and management of risks posed by toxic substances.[6]

The environmental protection management process includes four key phases: (1) research and monitoring, (2) risk assessment, (3) risk management and (4) compliance promotion and enforcement.[7] Throughout each of these phases, intergovernmental cooperation, public participation, and reporting are considered essential to ensure that federal action is complementary to and does not duplicate actions

taken by other governments and to enable public involvement in the CEPA process.

During the research and monitoring phase, science-based research is used to assess the impact of substances on human health and the environment, and to determine the degree of exposure.[8] Science-based research also influences the development of risk management measures and identifies techniques that can be used in compliance promotion and enforcement.[9] Ongoing monitoring helps to identify changes and trends, enabling the impact of a substance on its surrounding environment and human health to be determined. Substance risk assessments, which are based on scientific evidence, illustrate the level of risk posed by the substance on the environment and human health and help to determine whether the substance should be listed as toxic under CEPA 1999.[10] During the risk management phase, strategies are developed to manage toxic or other substances and may include regulations, pollution prevention plans, environmental emergency management plans and environmental quality guidelines.[11] The last phase, compliance promotion and enforcement, ensures the protection of human health and the environment.[12]

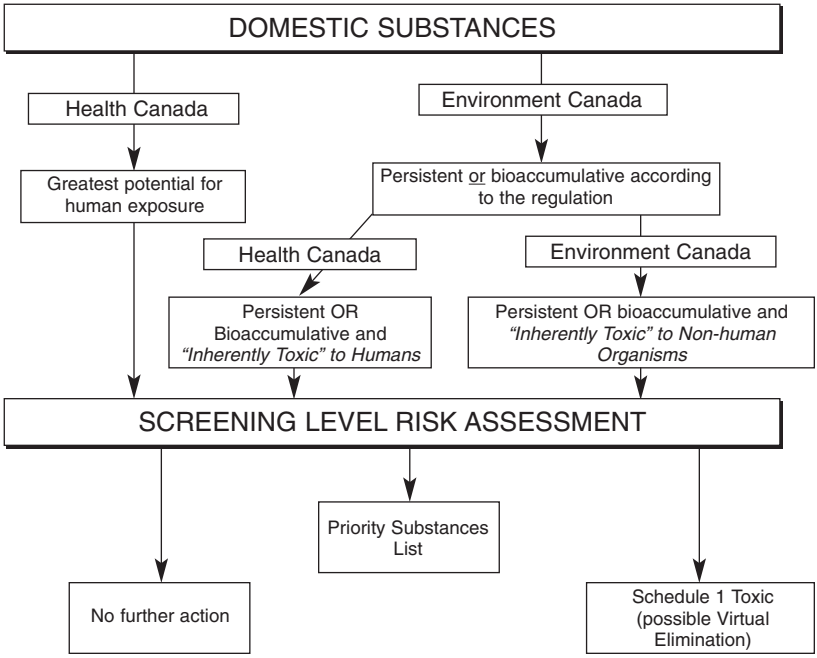
CEPA 1999 also includes specific requirements for the review and control of substances that are used and released into the environment. In Canada, there are currently 23,000 substances on the Domestic Substances List, that are manufactured, imported or in commercial use and have not been evaluated for their potential risks.[13] The Government of Canada has committed to categorizing these substances by September 13, 2006.[14] Substance categorization is a priority setting exercise that involves identifying substances on the Domestic Substances List that are toxic, persistent, or bioaccumulative.[15] Substances that meet these criteria enter the risk assessment phase under CEPA 1999.

Under CEPA 1999, there are also two other assessment processes: the Priority Substances Lists and the review of decisions from other jurisdictions. The Government of Canada can identify chemicals and other substances which require further assessment on a priority basis by placing them on a Priority Substances List.[16] Individual Canadians can also request that a substance be placed on the Priority Substances List. The first Priority Substances List was published in 1989. A

second Priority Substances List was established in 1995, which included ammonia in the aquatic environment and additional substances that were not already captured on the first list.[17]

The third type of assessment process involves the review of decisions made by other jurisdictions in Canada or member states of the Organization for Economic Co-operation and Development. When information is received about a decision in another jurisdiction, the Minister of Environment and the Minister of Health are obligated to review the decision. During the review the Ministers will determine the risk the substance may pose in Canada and decide whether the substance should be listed as toxic.[18] The intention of this process is to avoid duplication and streamline decision-making by sharing scientific information among jurisdictions.[19] Figure 1 outlines how the Domestic Substances List and Priority Substances List contribute to the categorization and screening process under CEPA 1999.

Figure 1: Categorization and Screening Process[20]



Toxic under CEPA 1999

Section 64 of CEPA 1999 defines a substance as toxic "if it is entering or may enter the environment in a quantity or concentration or under conditions that:

- have or may have an immediate or long-term harmful effect on the environment or its biological diversity;
- constitute or may constitute a danger to the environment on which life depends; or
- constitute or may constitute a danger in Canada to human life or health."[21]

If a substance is found to be toxic, based on the criteria outlined above, it is placed on the List of Toxic Substances (Schedule 1) of CEPA 1999.[22]

After a substance is listed as toxic, an approach is identified for its management, either virtual elimination or lifecycle management, to prevent or minimize the release of the substance to the environment.[23] Unfortunately, science cannot always predict the impact of a substance and as a result, a precautionary approach is necessary to prevent pollution and threats to human health.[24] Application of the precautionary approach presents three challenges for policy-makers. First, an acceptable level of risk must be established. Second, if the potential risk exceeds an acceptable level and could pose serious or irreversible damage, policy-makers need to be prepared to apply a precautionary approach, without scientific certainty, and manage or restrict the use of a substance. The third challenge is to determine appropriate measures for a substance that poses a risk in some cases but also has benefits for society in others. This last challenge relates to the case of ammonia and may become more common as additional substances are reviewed that have both risks and benefits.

Ammonia

In January 2003, "ammonia dissolved in water" was added to the List of Toxic Substances (Schedule 1) under CEPA 1999.[25] The fertilizer industry and agricultural organizations lobbied for additional information on the substance's risk and release characteristics

(description of the matter posing a risk and the source of its release) to be added to the listing. Three stakeholders, the Canadian Fertilizer Institute, the Canadian Cattlemen's Association and the Canadian Manufacturers of Chemical Specialties Association, argued that to be consistent with the intent of CEPA to assess and manage risks associated with substances, the substance should be described in a way that specifies the substance's risk and release characteristics as identified in the assessment report, such as "sewage ammonia" or "municipal sewage treatment plant effluent".[26] Some key milestones in the CEPA Process for ammonia include:

1995	Ammonia in the aquatic environment added to the second Priority Substances List
February 2001	*Priority Substances List Assessment Report – Ammonia in the Aquatic Environment* released
January 2003	"Ammonia dissolved in water" added to the List of Toxic Substances (Schedule 1)
May 2003	Proposed Risk Management Strategy for "ammonia dissolved in water" released
June 2003	Proposed Notice published in the Canada Gazette for preparation and implementation of pollution prevention plans
November 2003	CCME approves three-year mandate to develop a Canada-Wide Strategy for the management of municipal wastewater effluents
December 2004	*Guideline for the release of ammonia dissolved in water found in wastewater effluents* is published in the Canada Gazette

The February 2001 Priority Substances List Assessment Report for Ammonia in the Aquatic Environment noted that ammonia is released into the environment by industry and other human activity.[27] Ammonia also exists naturally in the environment as it is a waste product of most mammals. The assessment report noted that the main

human use of ammonia was as a source of nitrogen in fertilizers.[28] However, the assessment also found that "agricultural releases of ammonia to water cannot be quantified because of the diffuse nature of agriculture in Canada and the difficulty of quantifying such releases".[29] The assessment determined that municipal wastewater treatment plants released the most quantifiable source of ammonia to aquatic ecosystems.[30] The assessment concluded that freshwater organisms were at the greatest risk. More specifically the assessment report found that:

> the ecological impact of ammonia in aquatic ecosystems is likely to occur through chronic toxicity to fish and benthic invertebrate populations as a result of reduced reproductive capacity and reduced growth of young.[31]

The assessment report also included case studies to determine the likelihood of negative impacts on the environment. The case study on the Hamilton Harbour found that the un-ionized ammonia concentrations in the Harbour from municipal wastewater treatment plants were high enough to cause harm to sensitive organisms that inhabit the area.[32]

As a result, Environment Canada and Health Canada concluded that options should be examined on a priority basis to reduce the release of ammonia to the aquatic environment from municipal wastewater systems.[33] The assessment report stated that ammonia was released from other sources including run-off from manure-fertilized fields, but there was not sufficient data to determine the extent of potential harm. The agriculture sector and the fertilizer industry monitored the risk assessment phase for ammonia closely and were concerned about the implications it would have for the sector.

During the public comment period, various sector and industry stakeholders voiced concern about adding ammonia to the List of Toxic Substances and recommended that additional information be included about the substance's risk and release characteristics.[34] The additional challenge for Environment Canada and Health Canada was that substances were usually listed on the List of Toxic Substances

using their chemical name or molecular formula.[35] Listing ammonia using its chemical name or molecular form (NH_3) could potentially suggest that protein synthesis and waste creation by mammals as well as household cleaners would also be considered toxic.

When a substance's risk assessment indicates that it should be listed as toxic under CEPA, the government begins consultations to develop risk management measures. In the case of ammonia, the risk management strategy included the commitment to work with the Canadian Council of Ministers of the Environment to develop a long-term strategy for managing wastewater effluents.[36] Risk management strategies are one of the tools used to help confirm which instrument should be used to manage the substance.[37] Environmental release guidelines and pollution prevention plans are both risk management measures under CEPA 1999.[38] The legislated timeline under CEPA requires that the proposed instruments be finalized within 18 months from the first notice. In December 2004, the Minister of the Environment issued a *Guideline for the release of ammonia dissolved in water found in wastewater effluents* (the *Guideline*) which also confirmed the requirement for pollution prevention plans.[39]

Environmental release guidelines establish standards, expressed as concentrations or quantities, to limit the release of the substance from a facility or activity.[40] Since municipal wastewater treatment plants release the largest amount of ammonia into the environment, the *Guideline* established a threshold for acceptable quantities or concentrations that can be released.[41] The risk management measure was directed to anyone who owned a wastewater system at the time of publication and had a discharge flow of a certain amount.[42] According to the *Guideline*, facilities are required to prepare pollution prevention plans and establish steps for their implementation to help prevent or minimize the release of pollutants.[43] An additional challenge for municipal wastewater treatment plants to consider is that ammonia is not the only potentially harmful substance found in effluent from the facility.[44] Given this, facility owners also need to consider actions to eliminate risks that may be posed from other substances.

Canada's approach to managing "ammonia dissolved in water" includes intergovernmental cooperation through the Canadian Council of Ministers of the Environment (CCME). In November

2003, the CCME approved a three-year mandate to develop a Canada-wide strategy for the management of municipal wastewater effluents that includes specific national performance standards for pollutants found in municipal wastewater and a harmonized approach for managing them.[45] This strategy is scheduled to be completed by November 2006, and although consultations will be conducted during its development,[46] it will be interesting to see whether facility owners are prepared to fully implement these requirements.

Response of the Agriculture Sector and Fertilizer Industry

Ammonia is a nitrogen source in fertilizers used by the agriculture sector and is viewed as an essential nutrient in crop production.[47] The risk assessment for ammonia included numerous references to agricultural fertilizers as a source of ammonia, but available data was insufficient to determine whether the use of agricultural fertilizers was harmful to the environment or human health.[48]

Stakeholders contended that the addition of "ammonia dissolved in water" to the List of Toxic Substances (Schedule 1) "without due regard to relevant risk factors is inappropriate and furthermore, this could result in unwarranted association between a CEPA-toxic substance and ammonia manufacturing".[49] Including additional information about the substance's risk and release characteristics in the listing would have illustrated the government's intention to develop risk management measures specifically for municipal wastewater effluents.[50]

The risk assessment report identified further action, including the collection of additional data to determine the potential harm that ammonia from sources other than municipal wastewater treatment plants may pose to the environment.[51] However, in theory, these sources were already captured under the listing of "ammonia dissolved in water". It is also interesting to note that the assessment report was conducted for ammonia in the aquatic environment, which provided general information about where the substance could be found, but the final listing of "ammonia dissolved in water" does not provide information about the location or source. This change in language could be the result of a decision that it was not appropriate to include the location of the substance in the final listing. The lack of

context surrounding the listing created the perception that ammonia used for any purpose is toxic.[52] Potential implications of this toxic label for the agriculture sector and the fertilizer industry could include changes in food purchases in both domestic and international markets and potential trade restrictions on food and fertilizers.[53]

Voluntary Approaches by the Agriculture Sector and Fertilizer Industry

Voluntary approaches provide an opportunity for government and industry to be innovative in designing solutions that may be less costly and more effective than existing regulatory approaches.[54] To effectively implement voluntary approaches it is important for government and industry to work closely together to ensure that the principles of the science-based regulation are still met through voluntary approaches.[55]

Applied in the right amount and using correct methods, agricultural fertilizers (including those that are ammonia-based) help to improve crop production; however, excessive application or inadequate management can lead to environmental degradation.[56] Even before ammonia in the aquatic environment was added to the Priority Substances List in 1995, various levels of government, the agriculture sector and fertilizer industry were aware of the need to properly manage ammonia and other substances and were implementing voluntary programs to improve environmental conditions on farms. For example, in 1993, Ontario farmers could receive funding to develop a voluntary environmental farm plan from both their provincial and federal governments. Environmental farm plans allow farm families to increase their knowledge of their farm's environmental strengths and identify areas for improvement.[57]

In 2001, the Agricultural Policy Framework (APF), a federal-provincial-territorial initiative led by Agriculture and Agri-Food Canada (AAFC) was under development. The Prime Minister and Federal Agriculture Minister officially announced the APF in June 2002.[58] One of the goals of the APF is for the sector to attain environmental sustainability and make progress in the areas of soil, water, air and biodiversity.[59] Environmental programming initiatives under the APF included the development of a national Environmental Farm

Planning Program that allowed producers to identify potential environmental risks from their production practices and implement methods to prevent or minimize these risks.[60] Similarly, the National Farm Stewardship Program encouraged producers to adopt beneficial management practices through incentives for their implementation.[61] Examples of beneficial management practices that improve water quality include:

Managing agricultural inputs: nutrient management is the application of fertilizers and manure in amounts that are needed by the crop. Over applying fertilizer and manure increases the risk of contaminating surface and groundwater.

Controlling erosion and runoff: Techniques such as strip-cropping, shelterbelts and cover crops prevent erosion and reduce the movement of nutrients and pesticides from agricultural lands.

Barriers and buffers: Vegetation that slows water runoff allowing sediment to settle, water to be absorbed into the ground and nutrients to be soaked up by plants.[62]

AAFC also developed agri-environmental indicators to monitor the environmental sustainability of the agriculture sector. Through the National Agri-Environmental Health Analysis and Reporting Program, indicators provide science-based information on environmental conditions, potential risks, and changes that occur from agricultural practices. The indicators also monitor progress in adopting environmentally sound practices.[63] These indicators will help ensure that decision-makers have science-based information about the impact of agriculture on the environment and progress towards the adoption of environmentally sustainable practices.

The fertilizer industry is also taking steps to ensure that its practices are sustainable. Perhaps the most important way the fertilizer industry can prevent or minimize the negative impacts of its products is to educate its users on proper application techniques. The Canadian Fertilizer Institute, in cooperation with the Crop Nutrients Council is taking steps to inform retailers and producers about proper fertilizer application.[64] Their communication approach includes "providing

farmers with a variety of science-based best management practices (BMPs) to ensure fertilizer is applied at the *right rate*, *right time* and *right place*".[65] The Crop Nutrients Council was established in 2003, through funding from Agriculture and Agri-Food Canada, to respond to increased public interest in nutrient use and includes representation from agriculture industry associations and producers.[66] These efforts illustrate proactive, voluntary efforts by the industry and government to manage the risks associated with substances that also provide benefits to agriculture production.

The "Toxic" Debate

The agriculture sector and fertilizer industry lobbied Environment Canada and Health Canada to include context on the substance's risk and release characteristics based on the finding that effluents from municipal wastewater treatment plants were harmful to the environment.[67] Since the substance was not going to be listed by its chemical name or in molecular form, it is unclear why the listing did not include information on the sources of ammonia. Furthermore, if the government intended to develop risk management strategies only for municipal wastewater effluents, this context should have been provided in the listing.

Scientific evidence did not exist that clearly illustrated that the use of agricultural fertilizers had a negative impact on the environment or human health. The assessment report suggested that scientific evidence was not available due to the diffuse nature of agriculture and the challenge of quantifying ammonia from this source.[68] However, tools such as the agri-environmental indicators had been developed to monitor the environmental sustainability of agriculture. In 2000, the first report of the agri-environmental indicators initiative was available and included indicators on the management of farm nutrient and pesticide inputs, risk of water contamination by nitrogen and residual nitrogen.[69]

If all releases of "ammonia dissolved in water" are considered toxic, the question remains why risk management efforts, through the CEPA process, have only been directed toward municipal wastewater treatment plants. The broad listing of ammonia may have been an attempt to ensure that additional risk management measures could be

prescribed if scientific evidence became available that demonstrated negative impacts on the environment or human health from other sources of ammonia. Under CEPA 1999, even if a substance is listed as toxic, the Minister of the Environment and the Minister of Health can propose that no further action be taken if they determine that:

> actions being taken or about to be taken under other federal acts or by provincial, territorial or Aboriginal governments are sufficient to manage the risks in a timely manner.[70]

In this case, the risk assessment did not conclude that ammonia used for agricultural purposes posed harm or describe the voluntary measures already being taken by the federal, provincial, and territorial governments to manage the substance.

Furthermore, a federal legislative framework already existed to govern agricultural fertilizers. The purpose of the *Fertilizers Act* is to regulate agricultural fertilizers.[71] The Canadian Food Inspection Agency (CFIA) is responsible for registering fertilizers, reviewing product safety and labeling, and administering the Canadian Fertilizer Quality Assurance Program (CFQAP).[72] Industry submits samples of their product for review and CFIA determines whether the fertilizer meets the government's standards for safety and should be registered or not.[73] Proper labeling on the product and application instructions are also required to ensure potential risks from agricultural fertilizers are reduced. This existing legislative framework and the voluntary measures already being taken by the agriculture sector and fertilizer industry to encourage beneficial management practices were not examined in the risk assessment report.

It difficult to understand why context was not included in the listing to describe the source of ammonia that posed harm. This context could have been provided in a manner that is consistent with the intent of CEPA 1999 by describing the substance's risk and release characteristics through a listing such as sewage ammonia or wastewater effluent. A listing with this context would have also reflected the risk management efforts that followed and were directed toward municipal wastewater treatment plants. Furthermore, the List of

Toxic Substances (Schedule 1) includes substances that are not registered by their chemical name or in molecular form such as "chlorinated wastewater effluent" which indicates the release characteristic of the substance.[74]

Conclusion: Moving Forward

CEPA is reviewed every five years and is currently being reviewed by the Standing Committee on the Environment and Sustainable Development.[75] The results and recommendations of the review are expected by 2006.

During the review, the criteria that are used to develop a listing for Schedule 1 should be examined and a consistent, flexible approach adopted. For example, some of the substances currently listed on Schedule 1 are described by their chemical name or in molecular form, while others are not. In cases where a substance will not be listed in its chemical form, a consistent approach that focuses on describing the substance based on its risk and release characteristics should be used.

Since "ammonia dissolved in water" was added to the List of Toxic Substances in January 2003, the debate about whether ammonia used for agricultural purposes should be considered toxic has continued. During discussions about removing the word "toxic" from CEPA, the House of Commons Standing Committee on Environment and Sustainable Development acknowledged that:

> there are problems with using the word 'toxic' for every substance that meet the criteria of section 64 of CEPA. Labelling such substances as ammonia in water (which is listed) and road salt (which met the criteria but has not been listed) as 'toxic' is confusing to Canadians who use them in very different circumstances and may give an unfair stigma to products produced by Canadian industry.[76]

CEPA 1999 is very complex science-based legislation with the main objective of protecting the environment and human health. Its legislative framework provides policy makers with various tools to ensure

that potentially harmful substances and their associated risks are prevented or minimized. Overall, the concept of CEPA 1999 follows principles of sustainable development; however, CEPA 1999 faces the same challenge as all science-based policies and regulations – finding a balance between industry or sector needs and protecting human health and the environment. The ongoing challenge for all decision-makers is determining an acceptable level of risk. Proper communication of risk is important to avoid unnecessary public fear and misperceptions when decision-makers present their findings to the public and justify their decisions.[77]

In the case of "ammonia dissolved in water" it appears that, based on the findings of the assessment report, appropriate action was taken to address potential risks from municipal wastewater effluents through risk management strategies, pollution prevention plans and the *Guideline for the release of ammonia dissolved in water found in wastewater effluents*. However, by listing "ammonia dissolved in water" as toxic under CEPA 1999 and not providing information on the sources of ammonia, Environment Canada and Health Canada created the perception that ammonia used for any purpose is toxic, even though scientific evidence only illustrated that municipal wastewater effluents cause negative environmental impacts on aquatic ecosystems.

The risk assessment report identified follow-up action that should be taken such as the collection of additional data to determine the potential harm of ammonia released from sources other than municipal wastewater treatment plants. Listing "ammonia dissolved in water" as a toxic substance, without scientific evidence that ammonia from sources other than municipal wastewater treatment plants is toxic, lends itself to the conclusion that the government took a precautionary approach. The risk assessment report concluded that it was not possible to quantify the releases and determine the potential impacts of ammonia use in agriculture; however, it was not evident that agricultural uses of ammonia posed a threat of serious or irreversible damage. In addition, ammonia used for agricultural purposes provides beneficial impacts for society through increased crop production. As a result, it could be argued that a precautionary approach was not necessary for ammonia as the risk of potential harm was not indicated for all uses of ammonia.

Finally, the agriculture sector and fertilizer industry had already developed voluntary measures to manage ammonia, and a legislative framework already existed for fertilizers - details not taken into consideration during the risk assessment phase. Given this, in order to fulfill the guiding principles of CEPA 1999, Environment Canada and Health Canada should have ensured that the listing was clearly directed toward sources of the substance in which scientific evidence indicated potential harm. When additional data becomes available from the follow-up recommendation, the government will be able to review it and determine whether additional sources of ammonia pose harm to the environment or human health. Without this context, the agriculture sector and fertilizer industry are unfairly branded as using and selling a product that releases a toxic substance into the environment.

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