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SOCIAL LEARNING IN THE MANAGEMENT OF GLOBAL ATMOSPHERIC RISKS: A CANADIAN EXAMPLE OF ISSUE IDENTIFICATION

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ABSTRACT: Social learning is how humans, as individuals and groups, adopt and spread new concepts, knowledge and skills. There was a clear recognition during the late 1980s of the need for a better understanding of how human societies perceive and respond to global environmental change. Applying this "social learning" framework to the identification of global atmospheric risks, this paper traces the evolution of efforts of individuals and agencies in Canada to address the issues of stratospheric ozone depletion and climate change focusing on how an issue became an issue, how it was framed and how it received attention. Four conclusions are drawn from this study: One obvious observation is that scientists "learned" from other scientists, although Canadian scientists usually "learned" from scientists from countries other than Canada. Another obvious observation is that media attention to a scientific issue acted as a "teacher" of the Canadian public (the "learner") creating a controversy that sparked scientific investigation and government action, although the surprise here is that the media attention was American in origin. A third conclusion was that the common stable of atmospheric scientists in Canada (the Meteorological Service) allowed for cross-issue learning in the areas of atmospheric monitoring, research and modelling. And finally, the study concludes that the time period for an idea of global change growing into an accepted issue can be quite long, even decades.

Keywords: social learning; history; stratospheric ozone depletion; climate change; Canada

1. Introduction

Simply put, social learning is how humans, as individuals and groups, adopt and spread new concepts, knowledge and skills. There was a clear recognition during the late 1980s of the need for a better understanding of how human societies perceive and respond to global environmental change. Most of our understanding reflected the perspectives of a very narrow range of countries and groups, and was focused on key scientific discoveries and decisions with little attention to the historic connections between them. There was little critical discussion of what might be appropriately "learned" from the experience of dealing with other environmental problems, and from the experience of dealing with them in other places or countries.

A study was developed under the leadership of William C. Clark, Harvard University and funded by the John D. and Catherine T. MacArthur Foundation to garner a better understanding of how human societies "learned" from earlier

responses and other countries and organizations in the management of global atmospheric risks. The study examined a period extending from an organization of global environmental science known as the International Geophysical Year (IGY) of 1957 to the celebration of international environmental politics that was the UN Conference on Environment and Development (UNCED) of 1992.

The study asked the questions: (1) Who (individual, organization, country) learned? Was the learning from within the social group, among social groups or from another country? Who was the teacher? Who was the learner? (2) What was learned? What knowledge, experience, or norm was learned? How did this knowledge, experience or norm fit or redefine existing practices, models and decision-making processes? (3) How did the learning occur? *Who* brought new information to bear on the existing issue? *Where* did the new information come from? *How long* did the new information take to formulate into an issue?

This paper traces the evolution of efforts of individuals and agencies in Canada (Note: While this paper addresses only Canada, the overall study included a comparative exploration of the development of global issues across a range of national and international settings consisting of Japan, the United States of America, Mexico, the United Kingdom, the Netherlands, Germany, the former Soviet Union, Hungary, the European Union and the family of international environmental organizations) to address the issues stratospheric ozone depletion and climate change (The overall study also included the issue of acid rain) focusing on how an issue became an issue, how it was framed and how it received attention.

2. Identifying the Stratospheric Ozone Depletion Issue in Canada

The concept of humans polluting the upper limits of the Earth's atmosphere was considered astounding in the early 1960s. This was a time of many deplorable examples of human pollution of local and regional environments, but the idea that humans could pollute the far reaches of human travel remained astonishing. Given the sheer magnitude of the Earth and its atmosphere, few individuals even considered the possibility that humans could change things on a worldwide scale. A Canadian was one of those few individuals.

John Hampson working at the Canadian Armament Research and Development Establishment (CARDE) in Val Cartier, Quebec in the early 1960s provides the first statement of concern that human activities could harm the stratospheric

ozone layer. Hampson was looking for radiative early-warning signals of incoming missiles, focusing on water vapour from both high-flying aircraft and rockets, arguing that hydrogen species arising from the photochemical dissociation of water could catalyze ozone destruction. His work appeared only in CARDE technical reports which, though widely circulated among both Canadian and American atmospheric and defence research communities, were never taken seriously. (Hampson's colleagues report that his highly eccentric temperament, his weaknesses in both written and oral communication, and the messianic fervour with which he warned of the risk of ozone depletion, all contributed to his not being regarded seriously).

These and other reports on the concern over stratospheric harm from water vapour emissions of high-flying aircraft circulated informally in the United States through the late 1960s, becoming salient enough in the early 1970s as the controversy surrounding the effects of high flying aircraft, or super sonic transports (SSTs) as they were then known, on stratospheric ozone heated up that the US Commerce Department sponsored a scientific meeting to consider the problem at Boulder, Colorado in March 1971. Canadian chemist Harold Schiff was invited because of his laboratory work on ozone chemical reactions. At this meeting, James McDonald presented his calculations of estimated increases in skin cancer, based on Hampson's photochemical calculations, and Harold Johnston challenged the participants with his contention that nitrogen emissions posed a much more serious ozone depletion risk than water. After heated discussion at the meeting left the question unresolved, Johnston sought to raise an alarm by quoting his estimates to an American newspaper, the New York Times, in an article that raise considerable public attention.

Johnston's claim came to the attention of the Canadian Prime Minister's Office which asked the Canadian Cabinet's Science Advisor for a note on the effects of SSTs on stratospheric ozone. Schiff prepared the note, who despite personal misgivings over the possibility of a catastrophic risk, supported the cautious consensus conclusion of the Boulder meeting - that the risk was significant but unproven, and that only further research was warranted. As Schiff reported to the Globe and Mail, Canada's National Newspaper - "It's on two levels: what if Johnston is right? I am worried for my children, not for myself. The other level is the credibility of science."

Only in 1973, after concerned scientists had briefed Environment Canada's Management Committee, and the chair of the US Climatic Impact Assessment Program (CIAP) had formally solicited a Canadian response to CIAP (at the

prodding of Canadian scientists), did two significant responses from the Canadian executive occur. First, a jointly sponsored Environment Canada and Transport Canada funding proposal was approved by the Canadian Cabinet for a Canadian stratospheric pollution research programme including monitoring, modeling and laboratory chemistry. Second, an Advisory Committee on Stratospheric Pollution, made up of scientists from several government departments and universities, was established in April 1973 to coordinate Canadian research and advise the government on its policy implications.

Though the Committee was established to address the stratospheric risk posed by SSTs, this job became less urgent during the long delay that attended the Committee's formation. By the time of the first Committee meeting in May 1973, the US SST program had been stopped and the Concorde's introduction delayed so that estimates of 1975 SST operations had dropped from 17,000 to 4,500 flights per year. The Committee recognized a strong need for continued stratospheric research, however, arguing that: "there is no excuse for ignorance of a region (the stratosphere) so close and important to man … regardless of the immediate concern over SST operations".

By 1974, the first suggestions that chlorine could threaten stratospheric ozone appeared in the Molina and Rowlands' paper published in Nature which developed the mechanism for chlorine catalysis of ozone, and identified chlorofluorocarbons (CFCs) as the largest potential source of stratospheric chlorine. In Canada, the Advisory Committee on Stratospheric Pollution met to assess the state of knowledge on the "freon-ozone problem" (The ozone-depleting compounds that we know today as chlorofluorocarbons or CFCs were then referred to as the Dupont firm's brand-name of "freons" or chlorofluoromethanes (CFMs)). Schiff had just returned from being appointed to the US National Academy of Science (NAS) Panel on Ozone Depletion and informed the Committee that the NAS would now be treating chlorine as the primary issue, which the Committee agreed should now be the priority for Canadian research.

The Committee noted US activity on CFCs including state legislation banning aerosols in New York and Florida, a consumers' union lawsuit against the US Environmental Protection Agency (EPA) and a US Senate committee's recommendation for increased research into the chlorine-stratospheric ozone connection. The Canadian Advisory Committee Chair Barney Boville suggested that restrictive legislation could appear soon in Canada. Boville took the Committee's deliberations before the public in late 1974 stressing that he was

not advocating an immediate ban on spray cans, but merely a slowing in their rate of growth. Canadian aerosol producers, represented by the Canadian Manufacturers of Chemical Specialties Association responded that a moratorium on spray cans would have grave economic implications. H. Crawford of Dupont Canada, the primary CFC producer in Canada, said that industry wanted a research program to gather data on what was actually happening in the upper atmosphere.

Calls for immediate regulatory action continued. Attending a 1975 seminar at York University in Toronto, Ontario, Sherry Rowland called for an immediate phase-out of CFCs 11 and 12. He suggested that it was increasingly unlikely that a major flaw would appear in the scientific calculations indicating that CFCs have serious environmental effects. Industry repeated its objections to a ban, arguing that predictions of environmental effects were based on speculations that lacked evidence.

When briefing the Official Canadian Government Opposition Critic in September 1976, Boville expressed with "full confidence (95 percent)" that ultimate stratospheric ozone loss from continued 1973 CFC emissions would be from 2 to 20 percent - levels that his own scientists' models were showing, and levels that international scientific committees were predicting. Boville expressed his personal support for a Canadian aerosol ban but carefully delimited the scientist's role in policy-making - to identify and quantify potential problems and communicate the conclusions, leaving the public and politicians to balance the risk of increased skin cancer from stratospheric ozone depletion against the benefit of air conditioning and underarm deodorants.

In its 1976 assessment report, the Advisory Committee on Stratospheric Pollution concluded that the scientific evidence was strong enough to warrant a response, and stated that if scientific evidence was the only consideration, they would recommend immediate regulations to achieve a significant reduction in CFC releases. Immediately after receiving the report, the Canadian executive through the Environment Minister announced it would regulate the non-essential uses of CFC aerosols in the following year.

3. Identifying the Climate Change Issue in Canada

Throughout the world and in Canada, there have been early indications of concern about the human influence on the world's climate. In the 1950s, the question of climate change was entrenched in the Canadian climatology

community through its development as a topic at university courses and meteorological training courses, as well as a subject on the weekly radio broadcasts to the Canadian public called *Meet Your Weatherman*. The general topic of unusual weather patterns was continually debated with fears of nuclear testing being the major cause, yet there was continued scientific agreement that the burning of fossil fuels were increasing atmospheric carbon dioxide concentrations which could lead to a changing climate.

Even with the potential environmental consequences of human activities on the climate, there was an initial ambivalent response from the executive of the Canadian government, Environment Minister Jack Davis: "If we burned up all the coal, oil and natural gas in the Earth's crust, we still would not bring the carbon dioxide content of the atmosphere up to one tenth of one percent. As the carbon dioxide content of the earth's atmosphere rises, it is taken up by plants at an increasing rate. About half of all the carbon dioxide released into the atmosphere by the burning of fossil fuels has already disappeared. Our earthly biosphere tends to counteract our every action."

Greater concern was placed on climate variability or even climate cooling during a time of food security concerns in the early 1970s. A hostile climate was seen as a serious threat to future world food supplies at the 1975 UN Conference on Food. This conference deliberated the idea for the first World Climate Conference held in Geneva in February 1979 where the issue going into the conference was climate variability, the issue coming out of the conference was carbon dioxide identified as the major culprit in global warming.

In recognition of the impact of climate and climatic fluctuations on society, the Canadian government established a Canadian Climate Program to integrate efforts of the various federal and provincial agencies as well as universities and the private sector in the field of climatology. An important aspect of the early program was the holding of workshops in 1979 across the country designed to examine important impacts of climate on several key resource and economic sectors in Canada's energy, agriculture, forestry, water, oceans and fisheries, recreation and tourism, and transportation. The workshops were designed as an information dissemination tool to examine the impacts of climate change and variability, to apply climate knowledge to Canadian resource and environmental management, and as a way to increase the member participation in the Canadian Climate Program. Gathering together the top Canadian meteorologists of the day, the workshops concluded publicly that "society has about 15 years to address the urgent questions before the onset of possibly catastrophic global climate changes".

Both events in 1979 helped advance recognition of the climate change issue to the executive levels of the Canadian government. At the 1979 Economic Commission for Europe's (of which Canada is a member country) Meeting on Protection of the Environment, Canadian Environment Minister John Fraser stated that "combustion of fossil fuel on a world-wide basis is known to be producing a global increase in atmospheric carbon dioxide concentrations which may influence the earth's heating balance and cause climate changes with far-reaching consequences."

While climate warming was being discussed between scientists and pronounced by politicians, the climate itself remained variable giving rise to an obvious confusion in the media. In 1981 and 1982, there were two articles written at the same time of the year (winter) in the same Canadian newspaper (Vancouver Province) separated by one year - one indicating a potential climate warming and one indicating a potential climate cooling.

In 1981, the Canadian government supported the Canadian Climate Centre with an large increase in funding and approval to purchase a supercomputer (shared with the main national weather forecasting centre) to develop an advanced climate model to provide predictions of climate scenarios for impact studies. During the early and mid-1980s, the Canadian Climate Centre's climate models consistently supported a 1.5 to 4.5 degree Celsius temperature change from a doubling of carbon dioxide concentrations.

Three international climate conferences held in the mid-1980s established climate change as an issue in its own right among the scientific community. At Villach, Austria in October 1985, a joint UNEP/WMO/ICSU conference was convened to assess the role of the increased carbon dioxide and other greenhouse gases on climate changes and associated impacts. The concern in this case was how future climates might affect the decisions being made on long-term irrigation and hydro-electric projects. The conference concluded that it was a matter of urgency to refine estimates of future climate conditions to improve this decision-making. Two workshops at Villach and Bellagio, Italy in late 1987 followed the 1985 Villach conference, forwarding the scientific consensus that international action to curb escalating levels of atmospheric greenhouse gases was "inevitable".

The single moment galvanizing the climate warming issue in Canada was the 1988 conference on Our Changing Atmosphere: Implications for Global Security held in Toronto. The Toronto Conference firmly established global warming as

an international issue. As Canadian climatologist Henry Hengeveld stated about the conference, the media response "together with political leaders from a number of industrialized countries who pledged to push for further action within the international political community, gives reason for optimism that the conference was not just a one-conference wonder, but a major step towards global action to protect the atmosphere".

It is not surprising that public interest in the climate change issue peaked at the time of the 1988 Toronto Conference. First, there was a high degree of scientific consensus at the conference as to the future direction of global temperatures and the likely social and economic disruptions that might result. This consensus was consistent with the testimony of James Hansen of NASA on June 22, 1988 before the US Senate Committee on Energy and Natural Resources, just four days prior to the Toronto Conference. The second factor that gave credibility to the mounting public concern about climate change was the fact that the conference was held during a continent-wide heat wave and drought, a sequel to severe droughts experienced in preceding years. Temperatures in Toronto for example, exceeded 35 degrees Celsius on six occasions in the month of July 1988, at the time the greatest number for that month since measurements began in 1846.

The Toronto Conference called for governments and industry to "reduce carbon dioxide emissions by approximately 20 percent of 1988 levels by the year 2005 as an initial global goal" as an attempt to combat climate change. The Toronto Conference target was incorrectly identified as a Canadian commitment to carbon dioxide reductions, where in fact, the Canadian government proceeded more cautiously.

4. Conclusions: So who learned what from whom?

The two stories above provide the history behind the development of the issues of stratospheric ozone depletion and climate change in Canada. Applying our "social learning" framework to investigating these histories provide several conclusions about social learning in Canada.

4.1 Scientists-to-Scientists Learning

One obvious observation is that scientists "learned" from other scientists. What was not so obvious was that the cadre of Canadian scientists from Environment Canada who inform and advise the Canadian government to action usually "learned" from scientists from countries other than Canada about issues, even if

scientists from Canada were "teaching" the same message. For example, Hampson raised the concern of ozone depletion from increased air traffic in the atmosphere yet the Canadian government did not take action until the issue was raised in response to an American research program investigating the issue of SSTs.

The avenue for "learning" from scientists-to-scientists places an importance on the "teachings" being in person, either by sending a Canadian scientist to an international gathering to act as the messenger bringing the "teachings" back to Canada such as Schiff and the Boulder meeting, or by bringing the "teacher" directly to Canada such as Rowland's visit to York University.

The "teaching" was not blindly accepted by the "learners" as Canada required its own monitoring, modeling and science to confirm for Canada the implications and necessity for response. For example, Boville relied on his own modelers results of predicted stratospheric ozone depletion from chlorine before he took his message public and recommended regulatory actions. Also, Canadian government officials relied on the Canadian Climate Centre's climate model runs as confirmation of predictions of temperature changes under a regime of climate change.

Canadian scientists have now "learned" the lessons above and take their scientific findings to international gatherings to gain legitimacy so they can be brought back to Canada through an "acceptable" community of international scientists.

4.2 US Media-to-Canadian Public Learning

Another obvious observation is that media attention to a scientific issue acted as a "teacher" of the Canadian public (the "learner") creating a controversy that sparked scientific investigation and government action. The surprise here is that the media attention was American in origin, thus making the US media a "teacher" and the Canadian public and Canadian media "learners". For example, the New York Times article of US scientist Johnston's concern about SSTs sparked an immediate response from the Canadian government for an information note. Also, media coverage of the US Senate Committee hearings of NASA scientist Hansen's concern with the climate change issue, sparked Canada's own media (the "learner") to report on the "consensus" of scientists that climate change was a real concern.

4.3 Cross-Issue Learning

Most atmospheric scientists in Canada are federal civil servants, mostly employed in one organization, Environment Canada's Meteorological Service of Canada (formerly known as the Canadian Meteorological Service and the Atmospheric Environment Service). The expertise of this organization was applied to both issues of climate change and stratospheric ozone depletion. The scientists, for the most part, were one and the same. This allowed for cross-issue learning in the areas of atmospheric monitoring, research and modelling. The atmospheric science community that developed was stable, bureaucratic and conservative in character, bringing several important advantages. It provided secure support for the kind of careful, long-term, unglamorous monitoring and observational work that is essential for the development of baseline data and the identification of long-term trends. It also reliably provided resources to support extended participation in international research and coordination activities. The remarkable involvement of the Canadians in the activities of the UNEP, WMO and other international bodies in part reflected the value their government employers placed on such activity and their ability to support it.

4.4 Learning takes its own sweet time

The time period for an idea of global change growing into an accepted issue can be quite long. In the case of stratospheric ozone depletion, the idea of humans causing damage to the upper atmosphere was discussed in the 1960s, but it did not become a salient issue in Canada until the mid-1970s. As for climate change, the idea of human-caused carbon dioxide emissions influencing the global climate was around since the 19th century, but it did not become an issue until the 1988 Toronto Conference.

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