The Economics of Constitutional Change Series
Article Number 6/June 1991

CONSTITUTIONAL CHANGE AND THE ECONOMICS OF THE ENVIRONMENT

G. C. van Kooten, Associate Professor
Department of Agricultural Economics
and
Department of Forest Resources Management
University of British Columbia

CONSTITUTIONAL CHANGE, ENVIRONMENTAL ECONOMICS AND REGIONAL RESOURCE DEVELOPMENT

by

G.C. van Kooten
Associate Professor
Department of Agricultural Economics
and
Department of Forest Resources Management
University of British Columbia
Vancouver, B.C.

June 27, 1991

Paper presented at the meeting of Western Economists on the Constitution, University of Alberta, Edmonton, May 24/25, 1991. I wish to thank Bob Lucas, Anthony Scott and Rob Flick for their helpful comments and suggestions, although they are not responsible for any of the views expressed herein.

CONSTITUTIONAL CHANGE, ENVIRONMENTAL ECONOMICS AND REGIONAL RESOURCE DEVELOPMENT

Introduction

The papers presented at the May 1991 meeting of the Western Economists on the Constitution focused primarily on monetary or financial aspects (*viz.*, debt) of alternative constitutional scenarios, or on structural issues pertaining to particular sectors. With respect to the latter, Furtan (1991) reviews federal agricultural policies affecting western Canada, particularly the prairie provinces, and considers what might happen under alternative concepts of Canada. Chambers and Percy (1991) examine the implications of economic realignment on the structure of the primary or natural resource sectors of the western Canadian economy. Their concern is with the diversity, vitality and survivability of an economy that is resource-based, at least compared to the rest of Canada, particularly the central region (Ontario and Quebec). Scott (1991) examines the role of environment as an extension of his views on the sharing of "functions" (as opposed to "powers") among different levels of government. I mention these studies because my analysis will, to a certain extent, overlap the sectors dealt with by these authors. However, my objective is to focus on environmental consequences of constitutional change.

The main point of my analysis concerns the moral and constitutional failure of the federal government in providing leadership on matters pertaining to the environment and western regional development. Under current constitutional arrangements, Canada has not developed the institutions and expertise to adequately address an array of environmental issues, both current and

future ones. This inadequacy is examined by reviewing resource developments in a number of resource sectors and suggesting what the future holds for environmental concerns under a restructured Canada.

Three alternative constitutional arrangements are considered in the discussion: (1) the current federal system, (2) a restructured Canada that has sovereignty association with Quebec ("sovereignty association"), and (3) independent regions ("western independence"). The case of sovereignty association is assumed to be the same as that of an independent Quebec. The case of federal restructuring along the lines of a Triple-E Senate is an unrealistic political outcome because it would require a voluntary dilution of powers by Quebec and Ontario.

The time frame or outlook taken in this paper extends beyond that required to resolve constitutional issues. This is particularly true of global warming, but also for resource development projects. I begin by considering the role of the federal government in resource development and then proceed to examine some resource sectors in greater detail. In particular, I focus upon water resources (interbasin transfers, irrigation and environment) and air pollution, including Canada's position with respect to the greenhouse effect.

A Tale of Two Countries: Inconsistent Federal Resource Policy

The federal government has not provided leadership in the development of Canada's natural resources, particularly in the west. Federal policy is motivated more by the desire to please the electorate (i.e., voters in central Canada), than by economic efficiency concerns. Policy failures, as illustrated by federal energy and environmental policies, give credence to the notion that western Canada might fare better as an independent region.

Canadian Petroleum Policy

The National Oil Policy of 1961 guaranteed western oil producers a market for oil by forbidding consumers west of the Ottawa River Valley to purchase oil from sources other than western Canada. This resulted in Ontario prices that were 25 to 35 cents per barrel higher than what they would otherwise be (Norrie 1978, p.153). However, when oil prices increased dramatically in 1973 as a result of OPEC, the federal government responded by freezing the price of oil at $3.80/barrel. Taxes on exports and oil company profits were used to subsidize oil imports east of the Ottawa River Valley, at least until the Trans-Canada pipeline could be extended. Although the oil producing provinces (Alberta, B.C. and Saskatchewan) increased their royalty rates to capture a large portion of the resource rents, the low domestic price and export tax took away large potential revenues from the producing provinces, primarily Alberta. Further, the federal government established Petro-Canada in 1975 to provide a "window" on the industry and to encourage exploration in "remote" areas; by 1981, "the window" had become the fourth largest oil company in Canada. These policies did not sit well with westerners, who felt increasingly alienated, and they created tension between the then-Liberal government in Ottawa and the western provinces.

The low-price oil policy discouraged energy conservation, militated against adoption of energy efficient technologies and alternative fuels, and encouraged polluting activities in general. Later, as domestic and world prices converged, these policies inadvertently gave Canada's industry a competitive disadvantage relative to its trading partners because they had adopted energy saving technologies. Further, economists questioned the need for a large, crown corporation with a political mandate, arguing that this leads to more inefficiency (Anderson 1985,

pp.192-94).

The federal government was forced to back-off of its price freeze when Alberta decided to reduce oil production in 1980. Subsequently, the National Energy Program (NEP) was introduced in 1980 with the objective of slowly increasing domestic prices to the world level via phased-in price increases. The producing provinces and the primarily foreign oil companies continued to object to this policy because the resource rents available to them were lower than under a free market. These rents were dissipated among Canadian consumers, leading to inefficiency.

While, to some extent, the "Ottawa River Valley" policy of 1961 justified subsequent policies to keep prices low, it can also be argued that the original policy, while helping the west develop its oil production capacity, also provided a secure supply to Ontario (Norrie 1978). This was borne out by subsequent events. But, by first providing a secure source of supply and then below-market prices, these policies also gave rise to refining capacity in central Canada that was coveted in the west.

The point of this discussion is that, in the case of petroleum, and unlike environment and the other resource sectors, the federal government did not hesitate to implement a national policy, despite the aggravation it caused in the west. While motives are unclear, it is clear that the proper functioning of markets was circumvented and that the west paid a large price. Further, the federal government, by virtue of its control over transboundary movement of oil and gas, also impeded the export of energy to the U.S.

If western Canada is given greater autonomy over its disposition of petroleum resources under alternative constitutional arrangements, it is unlikely to price these resources below market

value at any time in the future. Other Canadians will be forced to compete for these resources with U.S. and offshore consumers. It is also possible that the west would attempt to develop greater refining and additional processing capacity, to the detriment of central Canada. The extent to which this might be possible under sovereignty association depends upon the power that western Canada will have vis a vis Ontario, although it is clear that such power would be available to the oil producing provinces under western independence.

Resource Development and Environment

In contrast to petroleum policies that were unpopular in the west, the federal government has been reluctant to implement a national environmental policy for resource developments. While federal oil policies were popular among those living in central and eastern Canada because they kept prices low (albeit with long-term costs), environmental effects of resource development projects tend to be felt only at the local or regional rather than national level. For example, water pollution in the Athabasca River due to resource development (pulp mills and tar sands projects) is generally not a concern to those living in central Canada. Stopping development projects in western Canada on environmental grounds is not likely to "buy" votes in the rest of Canada, despite expressions of concern about the environment by those voters. After all, voters in central Canada are more concerned about things such as acid rain and the quality of their own drinking water than about resource development projects in the west.

Resource development projects are undertaken with the consent and even urging of a provincial government, and development subsidies are often involved. Natural resources are owned by the provinces and they jealously guard their right to develop these resources without

interference from a higher level of government. Even environmentalists are unwilling to relegate ownership of resources to the federal government, although they do want to retain the ability to appeal to a higher authority than the province or owner of the resource (Scott 1991).

The federal government exercises authority over the environmental impacts of resource development in western Canada through one of four mechanisms. (1) Since resource development projects often rely on some federal funding, the federal government is able to say something about their impact on the environment. As well, the federal government is responsible for (2) transboundary movement of resources (control over exports of pulp, electricity, uranium, *etc.*, as exemplified in the restrictions placed on energy exports), (2) fisheries, and (3) navigation. It would seem, therefore, that the federal government has a large say in the development of water resources, for example, since these will affect fisheries and/or have international or interprovincial impacts. Possible exceptions occur when it is difficult to argue that a fishery is affected, as might be the case for the Daishowa pulp mill on the Athabasca River in Alberta. The same is true of forestry or agricultural practices that are ecologically unsound--the federal government may have no jurisdictional basis for implementing environmental guidelines. Nonetheless, there is every reason to expect the federal government to exercise control over the environmental impacts of resource development projects, but it has largely abrogated this responsibility.

With respect to environmental review of resource development projects, federal intervention is based on the Environmental Assessment Review Process (EARP) established by Cabinet in 1973. The Federal Court of Canada ruled that a 1984 EARP guidelines order by Cabinet had the force of law. The Federal Court of Canada, created in 1971 to adjudicate disputes involving federal law, has been accused of political activism (Koch 1990) and, hence,

is not the appropriate forum for interpreting and enforcing environmental review of regional resource development projects. EARP has no statutory basis and it appears that the federal government in unwilling to provide it with greater control over provincial projects than exists under the current federal system (see also MacDonald Commission 1985, pp. 512-13). Environmental reviews have been *ad hoc*, subject to political interference by both levels of government and a source of bickering between the federal government and the provinces. Thus, "EARP is little more than the voice of the federal government's ecological conscience, since its authority is based on moral suasion rather than on statutory force" (*ibid.*, p.513).

The consequence of EARP is that there is no clear federal policy to guide decision makers. Intervention in resource development occurs but is *ad hoc*. In some cases, the fact that federal monies are invested in the project justifies an environmental review; in other cases, intervention is based on potential damage to a fishery or because transboundary resources are involved.[1] The problem is that, for similar resource development projects in different provinces, an environmental review may be required for different reasons, or not at all. This creates uncertainty that results in economic inefficiency.

The Supreme Court has also entered the environmental fray recently on the basis of Peace, Order and Good Government (POGG) provisions in the Constitution (Scott 1991). Although this intervention came in a case involving ocean dumping in provincial waters, there is no reason why POGG provisions cannot be used in the future in other cases dealing with the environment. This

---

[1]Even in these cases, the federal government may assign its jurisdictional powers to the province. This has been the case with respect to the North American Waterfowl Management Agreement where each of the three prairie provinces has been allocated a proportion of the budget and put in charge of the local project.

introduces even more uncertainty and an interesting question: would the government permit the Supreme Court to rule against further James Bay development if such intervention is considered a violation of Quebec's "national rights"?

It is unlikely that the current federal system will lead to a statutory basis for comprehensive and meaningful environmental review. But the current federal system remains inadequate because the federal government lacks the political power or will to call provinces to task in developing their resources, while facing the threat of de facto usurpation of its power by the courts. Examples are Quebec's and Saskatchewan's ability to circumvent environmental reviews of James Bay and the Rafferty-Alameda project, respectively, apparently with federal government complicity.[2]

The Rafferty-Alameda and Kemano II projects are worth considering briefly because they illustrate the nature of the problem that needs to be resolved. The Rafferty Dam project affects the Souris River that, upon leaving Saskatchewan, flows through North Dakota and then into Manitoba. Although it has caused flooding in Minot, North Dakota, the stream flow is insignificant. Nonetheless, the state of North Dakota has tried to control stream flow in that state for flood control purposes, but was prevented by environmentalists. Subsequently, it offered to contribute $40 million to the Rafferty-Alameda project. Saskatchewan required a reservoir for cooling a thermal power plant, although a small number of acres could also be irrigated. The dams were to be built in the ridings of the premier and deputy premier of Saskatchewan. The original permits to begin construction were obtained by the Saskatchewan government *in*

---

[2]Other examples include the Three Rivers Dam on the Oldman River, the Other Six Lease Operations (OSLO) oil sands project and the Daishowa pulp mill, all in Alberta.

exchange for a commitment to translate the province's statutes into French. At the request of the Canadian Wildlife Federation, the Federal Court ordered a halt to the Rafferty dam while an environmental review was conducted, and the federal government offered to pay $1 million per month in compensation. Not only did Saskatchewan collect the compensation (plus subsidies for translating its statutes), work progressed on the Dam until it was completed and work was started on the Alameda dam as well (see May 1990).

Now consider the Kemano II project in northeastern B.C. Alcan already spent about $400 million on development of the project that would divert water from the Nechako River to generate power for expansion of the aluminum production facility in Kitimat and a new pulp mill. The Federal Court ordered a halt to the project so that an environmental review could occur despite the fact that the project had previously been given the go-ahead by both the provincial and federal cabinets. EARP requires only that an environmental review be completed, but there is no means to enforce compliance with the findings. As a result of the delay and subsequent negative publicity, that is unrelated to any actual adverse environmental consequences, Alcan may cancel the project. Funds expended by Alcan, relocation costs for workers, investments made by the pulp mill, and other such expenditures constitute a welfare loss to society, a loss that could have been avoided by less uncertain environmental institutions.

What does all this mean for Canadian unity? The obvious answer is that the current system provides the perception, even if unsubstantiated by the facts, that resource developments in some provinces (e.g., James Bay development in Quebec) are favoured over those in others (e.g., Kemano II in B.C.) when it comes to environment.

There is another issue that needs to be addressed, however, and that is the question of

why federal environmental standards and federal review are required to begin with. Are environmental standards likely to be tougher if they are established by a government in Ottawa as opposed to one in Victoria or Edmonton? If so, why? Cursory evidence from the U.S., for example, indicates that federal environmental standards could well be below those set by state legislators (e.g., automobile emission standards in California are much higher than those set by the federal government). This is in accordance with economic theory: if we are interested in economic efficiency, environmental standards need not be the same in every region. It depends upon the (marginal) costs of achieving the standard and the marginal damages caused by the polluting activities. Thus, an automobile emissions standard relevant for Vancouver results in excessive costs to automobile purchasers in Humboldt, Saskatchewan; the marginal costs of reduced automobile emissions in Humboldt exceeds their marginal benefits. The same is true not only of air pollution, but of other environmental goods as well. For example, *ceteris paribus*, it is efficient to maintain higher water quality in a river that has an important fishery and many people living along it compared to one that does not have a fishery and has few people living along it.

There is yet another, more fundamental issue to be considered. One often has the impression that there is less concern over the environment at the provincial level than the federal level. Resource development leads to jobs, and provinces are likely to be more interested in jobs and votes than environment. However, this argument is valid only if there are environmental benefits to people living outside the particular province--environmental damage from a resource development project affects the welfares of those outside the province. There is no reason why those who live in the province and are adversely affected by the project (local environmentalists)

have a better chance of affecting environmental decisions about the project at the federal as opposed to the provincial level. Unless the federal process is more susceptible to rent seeking by environmentalists and conservationists than the provincial one, those concerned about the environmental impacts of a resource development project should be able to affect outcomes through a provincial process to a greater degree since they form a larger constituency at the provincial than federal level. If it is true that the federal process is more susceptible to rent seeking, this in itself is a source of economic inefficiency that leads to a lower level of welfare for all.

The current system encourages resource development without proper concern about the environment in some cases, but creates additional uncertainty in others. What would happen under either sovereignty association or western independence? Unless the "rules of the game" change so that the environmental assessment review process is made statutory, or provinces are given exclusive power over the environment, it is unlikely that the situation would be much better under sovereignty association. Under western independence, environmental review would also depend upon the type of federal system that would evolve. Since the economies of western Canada are based largely on resource extraction and development, the environment will likely occupy a secondary position in decisions about resource development. This will change, of course, if incomes rise and there is more concern about the environment or if nonmarket benefits can be captured through increased tourism, for example. It is not clear, however, that under the current system a strong federal presence is needed to prevent uneconomic exploitation of environmental resources.

Agriculture and Land Degradation

Over the past several years, there has been growing concern about land degradation on the prairies, particularly from soil erosion. The Prairie Farm Rehabilitation Administration (1983), the Senate of Canada (1984), and the Science Council of Canada (1986), among others, have all pointed out that there are large on-farm costs of soil erosion on the prairies. Recent studies by Canadian agricultural economists have shown that: (1) prairie soils are not in imminent danger of being depleted (Lerohl 1991; Weisensel and van Kooten 1990);[3] and (2) estimates of on-farm costs of soil erosion are negligible because they fail to take into account the true economic costs, and user costs of soil erosion are exaggerated (van Kooten, Weisensel and de Jong 1989a, 1989b; Fox *et al.* 1990). Support for these views is provided by Anderson and Thampapillai (1990), who also point out that North America soils are highly buffered and respond well to conservation treatment after a period of exploitation. While the latter authors also question the high estimates of the off-site costs of soil erosion obtained by some, Fox *et al.* (1990) suggest that it is the off-site costs that constitute the major burden of soil erosion.

In addition to soil erosion, degradation of agricultural lands has occurred through increased salinization of soils, depletion of organic matter and expansion onto marginal lands. Cultivation of marginal lands is important because it results in destruction of wildlife habitat, decreased biodiversity, and loss of scenic amenities, and likely accounts for the majority of land degradation.

---

[3]Lerohl found rates of soil erosion in the Peace River region to be less than the rates at which soil is being rebuilt, or at least less than tolerance levels required to sustain agricultural production indefinitely. Assuming no soil regeneration, Weisensel and van Kooten found that it could take 250 or more years to erode soils in Saskatchewan.

Agricultural policies recognize the need for government subsidies to enable farmers to keep pace with the standard of living enjoyed by the rest of society--the so-called "farm problem" (Batie and Sappington 1986). But it is my contention that subsidies are at least partly to blame for land degradation. Agricultural programs have encouraged monoculture by reducing the risk of single-enterprise farms, thereby reducing the number of farms with cattle while increasing the susceptibility of the rural economy to exogenous shocks (Buttel and Gertler 1982). Subsidies, transportation policies and marketing programs such as the Canadian Wheat Board (CWB) marketing system have also encouraged the conversion of unimproved or marginal land (*viz.*, loss of wetlands and wildlife habitat) because they have resulted in reduced cattle numbers, high farm-gate prices and input subsidies (*ibid.*). However, as noted above, some of the problems of land degradation have been overstated.

Canada has no environmental compliance provisions in its farm programs, and agricultural policies for western Canada have generally ignored the environment. However, the federal government is now considering conservation compliance as part of its farm programs because it is generally thought that conservation compliance can be used to abate land degradation (reduce soil erosion) or preserve wildlife habitat. In developing such an approach, Canada can learn from the U.S. experience (Young, Walker and Kanjo 1991; Taff and Runge 1988), hopefully avoiding the pitfalls encountered south of the border. In my opinion, however, Canada cannot make conservation compliance work effectively at this time because an adequate knowledge base is lacking, and the necessary institutions and personnel to administer such a program are absent. It is unlikely that the required infrastructure for implementing conservation compliance, as exists in the U.S., will be developed in Canada.

The question that needs to be addressed here is whether alternative constitutional arrangements are likely to favour continued government transfers to agriculture. Given the large transfers expected under the most recent agricultural policy initiatives for western Canada, namely, the Gross Revenue and Insurance Plan (GRIP) and the Net Income Stabilization Account (NISA) (Furtan 1991), it is difficult to imagine a restructured Canada providing an equivalent level of support to western Canada's grain economy. Large transfers to the agricultural sector are less the result of political power wielded by farmers than an overt attempt to first obtain support for the Meech Lake Accord (1986 Special Canadian Grains Program) and, subsequently, to thwart the popularity of the Reform Party (GRIP and NISA). If this is indeed the case, it is likely that the farm sector will receive smaller transfers under either sovereignty association or western independence. In the latter case, however, greater efforts will likely be made to come to grips with the "farm problem" and related environmental issues, including perhaps development of institutions for land conservation (as exist in the U.S.). This is because agriculture will command a greater presence in the economy, while, at the same time, the costs of programs will have to be paid by taxpayers (rural and urban) actually living in the region. Not only will it not be possible to spread the burden of farm programs over a larger, eastern population, but taxpayers will likely demand greater environmental compliance.

Water Resource Development

Perhaps the greatest failure (or strength depending upon your point of view) of the Canadian federation is in the area of water resource development. Canada diverts more water than any other country in the world (Quinn 1981). The total amount of water transferred between

river basins is 4,450 cubic meters per second, an amount that exceeds the combined transfers of the next leading countries, the U.S. and U.S.S.R. (Environment Canada n.d., p.24). In western Canada, three examples are the Churchill to Nelson River diversion for hydro power, the Bow to the Oldman and Red Deer Rivers for irrigation, and the South Saskatchewan to Qu'Appelle River for municipal water supply. It is in this area that commentators have deplored Canada's lack of a national and effective environmental policy. It is also in this regard that differences between Canadian and American institutions are most pronounced. In this section, two issues related to water resource development are examined, namely, (i) water resource development and the U.S., and (ii) irrigation. These issues are important to B.C. and the prairie provinces, respectively.

Water Resource Development and U.S. Environmental Regulations

The Columbia River Treaty was negotiated in 1964. It calls for the storage of water in B.C. for the purpose of flood control in the U.S. The benefits to B.C. are electric generating capacity, including the right to power generated in the U.S. The costs are related to dam construction, power transmission and, importantly, loss of lands due to flooding (reservoirs). The latter costs are environmental costs associated with loss of wildlife habitat, scenic amenities and so on. These were not adequately addressed by the B.C. government in the negotiation process.

The process itself consisted of two sets of bilateral negotiations--Canada-U.S. and B.C.-Canada (Crabbe 1984). Two sets of negotiations were required because the Canadian system of federalism gives authority to the federal government for transboundary water resources, while provinces, as owners of the resource, are responsible for development. It is unclear how the

double negotiations have affected the final outcome, although it appears that B.C. bore a disproportionate amount of the cost of providing flood control in the U.S.

With regard to the Skagit Valley in southeastern B.C., disputes regarding the right of Seattle Power and Light to flood a certain amount of land in B.C. have been ongoing since the early 1940s (Perry 1977). What is interesting about this dispute is the role played by the U.S. environmental regulatory process in preventing the flooding of ecologically-sensitive land in Canada. While the B.C. government had agreed to permit the flooding in exchange for small annual compensatory payments and the federal government remained silent because of the agreement between B.C. and the Seattle utility, environmental groups on both sides of the border fought the right of the utility to raise the height of Ross Dam in the state of Washington. U.S. environmental law prevailed in Canada.[4] Likewise, environmental concerns about other projects (e.g., the Garrison diversion) are being fought in the U.S. and not in Canada. This supports the earlier contention that there may be externality benefits to environmental preservation (benefits accruing to those living in other provinces) that can only be preserved by a strong federal role in the environment, but one that is supported by appropriate legislation.

In the U.S., agriculture accounts for 83% of the nation's water consumption, but it is almost a free good. While there have been grand proposals to export water to the U.S., it is unlikely that such investments will ever take place. The reason is simply that demand management can do more to alleviate any real or perceived water scarcity than uneconomic investments in massive water diversion schemes from Canada to the U.S. (see Gardner 1991).

---

[4]In 1983, B.C. agreed to supply power (as much as 300 megawatts per year) to Seattle for 35 years in exchange for an annual payment of $21.8 million. Thereby flooding of the Skagit Valley was prevented.

Irrigation

Irrigation provides an entirely different problem of resource development. Agriculture is the largest user of water on the prairies, accounting for some two-thirds of the consumptive use. Irrigation is particularly important in the drier, southern regions of the prairies. The South Saskatchewan River basin is the most important basin in western Canada in terms of consumptive use, with irrigation accounting for 3/4 of use; in dry years, when irrigation use is high and river flows are reduced, about 96% of water consumption in the basin is for agriculture (Veeman 1985, pp.17-18). Agricultural use in the S. Saskatchewan basin can be expected to increase as more land is brought under irrigation in Alberta and Saskatchewan (Table 1). As indicated in Table 1, irrigation acreage in western Canada has expanded by more than 20% between in the early 1980s, particularly in Saskatchewan where it expanded by approximately 50%. Alberta has the greatest amount of acreage currently under irrigation and this is expected to almost double with the completion of the Three Rivers Dam on the Oldman River.

Despite the expansion of irrigated acreage, economists have almost unanimously argued that the economic benefits to irrigation are marginal or negative. In eastern Washington, the latest cost-benefit analyses of irrigation projects indicate that the most optimistic benefit-cost (B-C) ratio is 0.78, even when secondary benefits are *appropriately* accounted for (Weber and Whittlesey 1991). Gardner and Huffaker (1988) calculate that, in the Jan Joaquin Valley of California, farmers pay $20 per acre-foot (acf) for irrigation water that is worth $50/acf, but that it costs the Bureau of Reclamation $300/acf to deliver. Thus, the cost of providing a subsidy to farmers is about 10 times greater than the actual amount of the subsidy, a very inefficient means of transferring income. Similar studies are not available for the prairies, but I suspect the costs

of providing irrigation subsidies to farmers are substantially greater than what is actually received.

In the prairie provinces, estimated B-C ratios are frequently less than 1.0, even when farm-gate prices are assumed to be high (Veeman 1985). Attempts to make the B-C ratios appear larger rely on erroneous inclusion of secondary impacts derived from input-output (I-O) models (Hamilton *et al.* 1991) or the fact that the federal government is paying a large portion of the capital costs. In the latter case, the argument has validity only if these funds would be unavailable to the province under any other circumstances. Whether or not this would be the case is important when one considers alternative constitutional arrangements.

The problem in western Canada, at least on the prairies, is that low-valued crops are grown under irrigation. Over 70% of irrigated acres are sown to grains and hay, with a small proportion sown to speciality crops (sugar beets, potatoes, *etc.*). There are limits to where speciality crops can be grown. Heat units may be adequate in southern Alberta and Manitoba for growing sugar beets, for example, but not in Saskatchewan; even so, sugar beet acreage has not increased because cheap sugar is available from abroad. Further, irrigating subsidized agricultural products (such as sugar beets and wheat) makes no economic sense; it implies that farmers are provided with a double subsidy--an irrigation subsidy and a crop production subsidy. Finally, it is argued that irrigated hay and grain production stimulates a livestock sector.[5] However, it needs to be asked why a livestock industry would come about as a result of growing hay (or feed grains) on irrigated acres but not on dryland acres (albeit with lower yields).

---

[5]Saskatchewan points to the livestock sector in southern Alberta to justify expansion of irrigation in that province, but expansion of the Alberta sector occurred as a result of subsidies and not irrigation.

Hamilton *et al.* (1991) specifically identify the forward-linked markets argument as an inappropriate justification for irrigation projects.

The problem with economic evaluation of irrigation and other regional development projects is that methodological errors are committed in applying tools of analysis.

> "Many of the more serious misapplications of these tools [of cost-benefit and I-O analyses] are not in the mainstream professional literature but in the myriad of environmental impact statements, forest timber plans, community development analyses, and other applied impact studies. These studies often represent the attempts of regional planners, semiprofessional economists, or project promoters to apply tools and concepts learned or mislearned from professional economists" (*ibid.*, p.335).

Politicians favour irrigation projects because they like to see physical results; this is the "make the desert bloom" syndrome that is most visible in the western U.S. Engineers are interested in large construction projects that require the building of dams for interbasin transfers, hydro-power generation and irrigation (Reisner 1986). However, irrigation projects often do not pay and, given current grain prices, there is likely no need for interbasin transfers since there is no water shortage in any of western Canada's river basins (Veeman 1985). Indeed, many real or perceived water problems can be resolved simply by pricing the water resource so that it more truly reflects either its opportunity cost or the cost of providing it. As noted, irrigation costs are subsidized and farmers in southern Alberta, for example, pay a flat rate per acre for water).

The question that needs to be addressed with respect to irrigation is whether constitutional restructuring will lead to more or less water resource development for agriculture. Again, the best answer likely requires knowledge about who is to pay. If costs can be spread over the rest of Canada, future projects are more likely to be implemented. However, if the costs of irrigation are to be borne only by regional taxpayers, there will be a greater attempt to shift the burden of such projects onto the beneficiaries (the farmers). If this is the case, it is unlikely that as many

projects will be pursued. Thus, irrigated acreage will likely be lower under western independence than under either of the other scenarios, unless western autonomy is significantly enhanced and the federal government's fiscal role greatly reduced.

Air Pollution and Climate Change

Air pollution is not a major problem in western Canada, at least from the standpoint of our relations with the rest of Canada, or with our neighbour to the south. Acid rain is produced locally, with the worst point sources of sulphur dioxide identified as a small number of coal-fired generating plants (e.g., west of Edmonton), some industrial plants and the nickel smelter in Flin Flon, Manitoba. Non-point sources of acid rain pollution include mainly motorized vehicles. Compared to central Canada and the northeastern and north-central U.S. states, acid rain produced in western Canada or the northwestern U.S. states is small, and transboundary acid rain cannot be considered a problem.[6]

Western Canada has abundant supplies of high quality (low sulphur content) coal. While Japan has been a traditional market for B.C. and western Alberta coal, this market is becoming less important as Japan moves away from steel and into plastics. Although there have been shipments of low-sulphur coal from western mines to Ontario, the distances involved are simply too great to make such ventures profitable. Ontario will likely continue to purchase coal from the northeastern U.S. and/or pursue its hydro and nuclear options. However, there will be

---

[6]Pollution from the Flin Flon smelter is dispersed throughout the wilderness of northern Saskatchewan and has not caused damage to lakes and forests, except in the immediate vicinity of the smelter. Prairies soils have a high pH and could benefit from some acid rain (Hilborn and Still 1990, p.62).

increased pressure to reduce sulphur dioxide and CO_2 emissions for reasons discussed below. Western Canada will continue to use a mix of hydro, coal and natural gas to generate electricity. No matter what constitutional scenario is considered, it is unlikely that it will have an impact on coal exports or local use of coal for power generation. Other exogenous events unrelated to constitutional issues are likely to be more important in this regard.

Other forms of air pollution are not a problem in western Canada, at least in terms of their impact on constitutional negotiations. As with acid rain, air pollution is localized and there are no transboundary problems with regard to air pollution.[7]

There is one form of air pollution that is important, namely, CO_2 and other greenhouse gas emissions. While the scientific community has not yet reached a consensus concerning the timing or magnitude of an aggravated greenhouse effect, nor whether draconian methods are appropriate for altering the rate of atmospheric accumulation of greenhouse gases, most scientists agree that some action is necessary (White 1990). Often this action takes the form of "tie-in" strategies that address more immediate economic and environmental problems such as ozone holes, high energy prices and acid rain, while at the same time reducing greenhouse gas emissions. In the following discussion, two issues related to the greenhouse effect are examined: (1) the impact of global warming on western agriculture and (2) the role of forest policy.

Global Warming and Western Canada's Agricultural Sector

In a study of the welfare effects of climate change on U.S. agriculture for the

[7]An exception may be soil erosion caused by wind. Atmospheric scientists at the Saskatchewan Research Council indicate that soil lost by wind enters the upper atmosphere and leaves Saskatchewan, but they do not know where it is deposited.

Environmental Protection Agency, Adams (1989) (see also Adams *et al.* 1990) uses the climate results for a double CO_2 atmosphere from both the Goddard Institute for Space Studies (GISS) and the Geophysical Fluid Dynamics Laboratory (GFDL) general circulation models (GCMs). Assuming a CO_2-fertilization effect, climate change results in a gain of $10 billion per year to the U.S. agricultural sector if the GISS GCM is used, but a loss of the same amount if the GFDL GCM is used. This is not surprising given that, for the central interior of North America, GFDL shows July soil moisture to be lower, while GISS indicates that it will be higher (Schneider and Rosenberg 1989, p.17). In both studies, the distribution of gains and losses varies from one region to another. The conclusion is that there is a great deal of uncertainty concerning the measurement of economic gains and losses to climate change for agriculture.

Global warming is expected to have a greater impact on northern latitudes and, thus, Canada should warm to a greater extent than the continental U.S. Economic studies of climate change impacts on agriculture in Canada were conducted by Arthur and her colleagues for the prairies (Arthur 1988, 1990; Arthur *et al.* 1987; Mooney and Arthur 1990). As in the Adams' studies, various GCMs give mixed results concerning whether conditions will become more or less favourable to prairie agriculture, *but no CO_2-fertilization effect was assumed.* In all cases, the length of the growing season increases, usually by two weeks or more, but in some cases moisture deficits also increase and crop yields decrease. However, with the longer growing season, new cropping options become available to prairie producers (e.g., sweet corn, soybeans, sorghum), increasing crop diversity and reducing risk due to cropping decisions (but *not* risk from weather variability). In some regions (such as southern Alberta) and using weather from some GCMs, results show moisture to be insufficient to support these new crops and irrigation may

be required.

In addition to changes in crop yields, changes in cropping area can also be expected. Global warming could result in substantial increases in arable acreage, particularly in northern Alberta and B.C. where adequate soils are available. This is illustrated by comparing Canada's ecoclimatic provinces under current atmospheric concentrations of CO_2 (Fig. 1) and under double CO_2 (Fig. 2). The grassland ecoclimatic region increases from 49.9 million hectares to 199.1 million hectares if transitional grasslands are included, almost a fourfold increase (Rizzo and Wiken 1989).[8]

The length of growing season, changes in precipitation, crop response, and potential for increasing arable area are all uncertain and depend on original assumptions concerning climate change (i.e., GCM results) and the accuracy of crop simulation models. The result is mixed conclusions regarding the status of prairie agriculture under climate change. However, models that account for the farm sector's ability to adjust to the changing conditions generally conclude that the region will benefit from climate change, even when no CO_2-fertilization effect is assumed (Mooney and Arthur 1990).

As a result of yield increases, substitution of higher-valued crops and seeding of 1.3 million additional hectares of arable land in the north, Mooney and Arthur (1990) estimate that climate-induced output expansion in Manitoba could result in a $1.5 billion increase in agricultural exports from Manitoba alone, or a 190% increase over current conditions. Even for

---

[8]The grasslands ecoclimatic province increases from 5% to 12% of Canada's total land area, while transitional grasslands increase from 0 to 8% (Rizzo 1990). The entire increase in the former is located in the western provinces, while some of the latter is found in northwestern Ontario (Fig. 2).

scenarios with major crop yield losses, revenue increases could be achieved through substitution of new crop varieties alone. Even in a worst-case scenario, net revenues declined by only 3 percent, due to the ability to substitute crops with improved yields for crops with reduced yields, although this flexibility varied by region within the province. Results for Alberta and Saskatchewan show similar crop substitutions but less potential for introduction of new crops (Arthur 1991). Mooney and Arthur (1990) also suggest that agribusiness processing would increase by $64.9 million, transportation by $34.2 million and wholesale and retail trade by $112.6 million. Some 17,820 jobs would be added to the provincial economy.

It is apparent that restructuring of the agricultural economy will be required over the next 50 to 60 years to adjust to climate warming. In some regions, agricultural expansion will be possible, while either retrenchment or greater reliance on irrigation will be required in other regions, principally southern areas of Alberta and Saskatchewan. If expansion of irrigation is a policy objective, it is not clear that there will be adequate water supplies in river basins in the southern prairies to meet this need. Interbasin water transfers (from north to south) may be required, but such projects are expensive. If irrigation is not expanded, then southern regions could experience decline and adjustment policies may need to be implemented.

What effect will alternative constitutional outcomes have upon this restructuring? It is likely that the current federal system, which is characterized by intervention, will make available funds to enable western farmers to expand into northern areas, while, at the same time, continuing to provide money for water development projects, including interbasin transfers, if necessary. These funds will be made available through a variety of regional development or regional diversification grants, and this requires acquiescence on the part of the non-agricultural

community, which will be easier to obtain when costs are spread over a large number of taxpayers. The same will likely be true under sovereignty association: development and diversification grants to the prairie provinces will likely continue, and one form that such grants take will be for agricultural development. However, it is not clear that the funds will be as readily available under a scenario of western independence because the (water development) investments are basically unsound, and the attitude toward expansion onto more northern lands will be one characterized by greater reliance on individual initiative.

In summary, western agriculture will likely benefit from climate change, and western Canada will continue as a dominant agricultural region. Nonetheless, adjustments in the location of agriculture and outputs will likely be required. Constitutional change will have an impact on the mechanism by which the needed adjustments are made and, hence, on eventual land uses. However, other agricultural policies (freight rates, subsidies, *etc.*) that are influenced by constitutional changes can have an even larger impact on the agricultural economy than global warming.

Forest Policies and Global Warming: "No Increase in Emissions"

The most likely international policy response to global warming will be an international agreement similar to the Montreal Protocol on Substances that Deplete the Ozone Layer, which limits production of chlorofluorocarbons (CFCs). A similar agreement on emissions of CO_2 and other greenhouse gases will likely require countries to freeze their emissions of these gases at, say, the 1990 level or to reduce emissions by 10% from that or some other level. The former can be interpreted as "no net increase in CO_2 emissions", and it is the one considered here.

There are several ways to attain the objective of no net increase in emissions. A carbon tax can be used to reduce consumption, while industry can further be encouraged to become more efficient (recall arguments concerning the inefficiency created by low oil prices). Reductions in methane by reducing pipeline leaks, for example, could substitute for reductions in CO_2 emissions. However, Canada could pursue a policy of reforestation and afforestation that enables expansion of industrial output without unnecessarily handicapping growth. In another paper, I compare alternative approaches to reducing greenhouse gas emissions (van Kooten, Arthur and Wilson 1991). This analysis is briefly summarized below, followed by a discussion of its implications under alternative constitutional restructuring.

One approach to the problem of climate change involves delaying the buildup of CO_2 in the atmosphere by sequestering carbon (C) in plantation forests or dramatically reducing harvests for a period of time. The world's forests constitute a large carbon sink and, by growing more trees at a faster rate, forests can offset buildup of CO_2 resulting from burning of fossil fuels. The idea is that forests experiencing net growth will sequester C from the atmosphere so that an increase in forest biomass will reduce the buildup of atmospheric CO_2. The extra wood produced could be burned, stored in structures, or buried. Burning the wood will cause CO_2 to enter the atmosphere but new growth will remove it. Thus, a cycle is established whereby C is released into the atmosphere by burning and removed by growing trees. It is the increase in forest biomass or stock that will alleviate CO_2 buildup in the atmosphere, while future wood availability will reduce reliance on fossil fuels. If wood is stored in structures or buried, the amount of C that can be sequestered is greatly increased. Large subsidies will be required to implement any of these schemes, although firms or individuals could be required to purchase emission permits

from those engaged in tree planting.

The carbon equivalent amount of anthropogenic emissions of CO_2 from energy sources in Canada for 1990 is estimated to be 123 million tonnes (Mt) per year (Jaques 1991). Canada currently has approximately 440 million hectares of forest land, which is estimated to sequester about 203 Mt of C per year (van Kooten, Arthur and Wilson 1991). This implies that Canada is a net carbon sink, although there remains controversy about this conclusion. Nonetheless, by planting trees, Canada could reduce its contribution to the greenhouse warming even more.

Canada's forests are not as productive as they could be. One proposal for reducing atmospheric CO_2 is to cut existing forests and replace them with faster growing species. While this would result in greater sequestering of C, there is a reduction in the amount of C stored with a subsequent increase in the amount of C entering the atmosphere.. It is unlikely that much of this can be converted into structures given that the most important use of trees growing in northern regions is as pulp. Paper products tend to decay faster than timber products such as lumber and particleboard used in structures. Further, since most northern, continental forests are susceptible to forest fire and other natural denudation, trees tend to be younger and grow relatively rapidly to begin with. On the other hand, harvesting old-growth forests and replacing them with faster-growing trees results in a net release of carbon. Since the amount of C released by harvesting old-growth timber can be substantial (accounting for 2% of total C released over the past 100 years), harvesting old-growth forests in B.C. would result in a negative charge to Canada's CO_2 account; but it is likely that the amount of old-growth timber to be harvested in the near future will decline dramatically.

There remains the possibility in certain regions, however, of replacing slower growing

species with ones that grow faster. While this is likely to result in greater sequestering of C, it is an expensive proposition to harvest trees and plant new ones. This is particularly the case where sites are remote and not easily accessible. Further, there is very little research pertaining to the growth rates and ecological ramifications of introducing new species in northern areas.

A measure of the inadequacy of past reforestation effort is the accumulated backlog of denuded land that remains unstocked, the so-called Not Satisfactorily Restocked (NSR) lands. Restocking of these lands will increase timber volume growth, the annual amount of C that is sequestered, and the stock of C stored in vegetation. Although estimates of NSR backlog are difficult to obtain and vary from one province to the next, latest estimates indicate that there are approximately 840,000 ha of backlog NSR in British Columbia and 18.9 million ha in the rest of Canada. It is estimated that restocking the B.C. sites will result in sequestering of an additional 1.0 Mt of C per year, while restocking backlog NSR sites in the rest of Canada would result in the sequestering of an additional 12.3 Mt per year. The cost of rehabilitating all the backlog NSR in Canada is enormous, $15.8-23.6 billion.

Finally, a number of writers have recommended afforestation of agricultural land as a method for reducing atmospheric CO_2 and conversion of marginal cropland (Dudek and LeBlanc 1990). The prairie provinces have the largest area of cropland and have benefited the most from agricultural support programs that have, to some extent, encouraged cultivation of marginal lands. Assuming that trees can be grown on unimproved lands converted in the prairie agricultural region between 1951 and 1986, 4.41 million ha are available for tree plantations. By establishing high-yielding tree varieties on this land, the amount of C that can be sequestered on these plantations is 3.4 billion tonnes/yr, at a cost of $1.3-2.2 billion.

There remain 16.64 million ha of unimproved farmland in the prairie provinces. Although some 1.7 million ha are currently forested, productivity is low. It is possible to both increase productivity and the area growing trees. If it is assumed that 1/4 of the unimproved land can grow trees and that productivity is somewhat higher than currently, then 2.7 billion tonnes of C will be sequestered annually, at a cost of $2.1-2.9 billion.

The foregoing estimates are summarized in Table 2. The costs of sequestering carbon by planting trees range from $29 to $168 per 1,000 kg (or $26.35 to $152.70 per ton). These estimates compare favourably with other estimates of the per unit costs or taxes required to reduce CO_2 emissions (Nordhaus 1991, p.50). The annual amount of C that can be sequestered by forestation policies is some 19.5 billion tonnes/yr, representing a 9.6% increase in the sequestration of CO_2 by Canadian forests. This constitutes approximately 15.8 percent of Canada's anthropogenic contribution to atmospheric CO_2. By implementing these forestation policies, Canada could reduce its contribution to atmospheric CO_2 by a significant amount, or about one-third of the reduction required to cut Canadian CO_2 emissions by half. Ignoring the net benefits associated with the harvest and utilization of the timber (either for fuel or timber products), the annualized cost (at a 10 percent discount rate and 80 year harvest rotation) of removing this CO_2 would be $1.7-2.6 billion. This compares with predicted agricultural subsidies of $2-3.5 billion per year (or $5 billion if there is drought) (Furtan 1991). If one looks at western Canada alone, forestation policies would result in the sequestering of an additional 11.3 Mt of C per year.[9]

---

[9]This assumes that 1/3 of the NSR backlog lands outside of B.C. are found in the prairie provinces.

What is the implication of all this for constitutional change? Since planting trees is popular among environmentalists world wide, Canada can, through judicious use of forest policy, claim to be doing its part to alleviate global warming. Under an independence scenario, western Canada can lay an even stronger claim in this regard. Further, under the current federal system and a "no increase in emissions" scenario, the gains of forestation will accrue to the industrialized central regions of Canada. Under sovereignty association, the same might be true, although the west may have a greater ability to wrest payments from the rest of Canada. (Perhaps this is already occurring in B.C. where the federal government has contributed to the costs of reforesting backlog NSR lands.) However, under western independence, there is room for industrial growth without violating the no-increase-in-emissions protocol. It might also be possible to sell such rights to other countries or to the rest of Canada.

Discussion

With the exception of an energy policy that was politically motivated to appeal to voters in central Canada, the federal government has failed to take a lead in establishing national priorities with respect to the environment and in developing Canada-wide policies to manage resource development. The current federal system is too decentralized and politicized to give the federal government an effectual voice in environmental management. To be blunt, the federal government has abrogated its responsibilities and created a void in this area. The Federal Court of Canada is only one of any number of possible pretenders to fill the void.

The current federal system is characterized by weak central control over resource development projects and environment. This is evident from the controversy surrounding James

Bay, the Three Rivers Dam on the Oldman River, the Rafferty-Alameda Project, Kemano II, and other resource development projects. Controversy and inconsistency in the application of environmental guidelines are the result of unresolved constitutional issues. The current environment of weak central control makes large-scale resource projects difficult to coordinate, but, more importantly, appears to be leading to destabilization caused by uncertainty which promotes further decentralization. However, it is not clear that the environment will suffer as a result. This depends upon the existence of external costs and benefits; it depends upon the extent to which Canadians living in other provinces are affected by resource developments.

The question that needs to be addressed is whether alternative constitutional arrangements will improve the situation. If constitutional negotiations lead to greater decentralization and resource development externalities exist, the answer may be no. However, this would depend upon the ability of separate regions to negotiate with each other over environmental issues, as is currently the case with Canada and the United States. Existing environmental agreements between these two countries provide some indication of the types of agreements that might be expected under a western independence scenario. But it is not clear that the same would be the case under a scenario of decentralization with Quebec remaining in confederation. Under this scenario, as well as under sovereignty association, it is possible that a stronger federal environmental review process (one with a statutory basis) could emerge, but it is unlikely. I do not think Quebec would tolerate environmental reviews by the federal government of its resource development projects. It would also be difficult to achieve agreements on environmental matters in a manner similar to what now occurs between sovereign states. Ontario or any other province would be at a serious disadvantage bargaining with Quebec if the latter acted as a sovereign state

while the former was represented by a government that had elected representatives from Quebec. At the very least, this would not be tolerated by the western provinces.

Western independence might turn out to benefit the environment if the western provinces create a strong federal system rather than a loose collection of subregions (provinces or something smaller) within a weak federal system. The reason is that there is likely to be substantial external effects from resource development between adjacent provinces in the west, with little impact upon the rest of Canada. In dealing with the U.S., it is unlikely that an independent western region would be disadvantaged. It is true that a large federal entity might be in a better bargaining position, but such an entity is disadvantaged by having representatives who may be unfamiliar with western resources. Further, the resources of western Canada are sufficiently large to give a separate west enough clout in its dealings with the U.S. That is, it is not at all clear that western Canada is better off bargaining on its own or being represented by a federated Canada in its dealing with the U.S. on resource issues. However, under western independence, it would also appear that certain development projects (e.g., irrigation) will not be pursued, not because they are environmentally unsound but because they are simply uneconomic and their costs cannot be spread over taxpayers in other regions.

Finally, it is important to point out that western Canada's resource base is large and that it is not in danger of being depleted, at least in the foreseeable future. Climate change will likely benefit agriculture and forestry; in addition, the region is in a good position to implement policies to curb buildup of greenhouse gases if that is to be a global policy, and may even be able to export emissions rights to other countries based on its forests. It would appear, therefore, that alternative constitutional arrangements would not endanger the economy of western Canada.

However, it is my impression that strong control, either exercised by Ottawa or some other centre (Moose Jaw?), is required to reduce the impact of externalities and to reduce uncertainty. The current federal system has failed in this regard. Finally, when it comes to the fiscal accountability of resource development programs, Canada is likely best served by decentralization of spending power so that a region's taxpayers bear the costs of resource development projects, and not taxpayers in other, unaffected regions.

REFERENCES

Adams, R.M., C. Rosenzweig, R.M. Peart, J.T. Richie, B.A. McCarl, J.D. Glyer, R.B. Curry, J.W. Jones, K.J. Boote and L.H. Allen, Jr., 1990. "Global Climate Change and U.S. Agriculture", *Nature* 345(May 17): 219-24.

Adams, R.M., 1989. "Global Climate Change and Agriculture: An Economic Perspective", *American Journal of Agricultural Economics* 7(December): 1272-79.

Anderson, F.J., 1985. *Natural Resources in Canada.* Toronto: Methuen.

Anderson, J.R. and J. Thampapillai, 1990. *Soil Conservation in Developing Countries: Project and Policy Intervention.* Policy & Research Series 8. Washington: World Bank.

Arthur, L.M., 1991. Personal Communication.

Arthur, L.M. 1990. "Global Climate Change: Potential Labour Impacts in Canadian Resource Sectors." Proceedings, Parliamentary Forum on Global Climate Change, House of Commons [Ottawa, April 24].

Arthur, L.M., 1988. "The Implications of Climate Change for Agriculture in the Prairie Provinces", *Climate Change Digest* 88-01: 1-13.

Arthur, L.M., V.J. Fields and F. Abizadeh, 1987. *Socio-Economic Assessment of the Implication of Climate Change for Agriculture in the Prairie Provinces: Phase III.* Report presented to the Atmospheric Environment Service. Winnipeg: Dep. of Agric. Econ., University of Manitoba, March.

Batie, S.S. and A.G. Sappington, 1986. "Cross-Compliance as a Soil Conservation Strategy: A Case Study", *American Journal of Agricultural Economics* 68(Nov): 880-85.

Buttel, F.H. and M.E. Gertler, 1982. "Agricultural Structure, Agricultural Policy, and Environmental Quality: Some Observations on the Context of Agricultural Research in North America", *Agriculture and Environment* 7: 101-119.

Chambers, E. and M. Percy, 1991. "Natural Resources and the Western Canadian Economy". Paper presented at the meeting of Western Economists on the Constitution, Edmonton, May 24-25.

Crabbe, P.J., 1984. "The Columbia River Treaty: Twenty Years After". Paper presented at the Canadian Economics Association's Annual Meeting in Guelph.

Dudek, D.J. and A. LeBlanc, 1990. "Offsetting New CO_2 Emissions: A Rational First Greenhouse Policy Step", *Contemporary Policy Issues* 8(July): 29-42.

Environment Canada, n.d. (approx. date 1989). *Federal Water Policy*. Ottawa.

Fox, G., A. Adamowicz, G. Debailleul and P. Thomassin, 1990. *Agriculture and the Environment: Economic Dimensions of Sustainable Agriculture*. CAEFMS Occasional Publication No. 1. Guelph: Dept. of Agric. Econ. and Business. Nov. pp.45.

Furtan, W.H., 1991. "Western Agriculture in a Restructured Canada". Paper presented at the meeting of Western Economists on the Constitution, Edmonton, May 24-25.

Gardner, B.D., 1991. "Irrigation Subsidies--Some Efficiency, Equity and Environmental Implications". Paper presented at the Festscrift Symposium in Honor of D. Gale Johnson. Chicago: 3-4 May. 37pp.

Gardner, B.D. and R.G. Huffaker, 1988. "Cutting the Loss from Federal Irrigation Water Subsidies", *Choices* 1st Q: 24-26.

Hamilton, J.R., N.K. Whittlesey, M.H. Robison and J.Ellis, 1991. "Economic Impacts, Value Added, and Benefits in Regional Project Analysis", *American Journal of Agricultural Economics* 73(May): 334-44.

Hilborn, J. and M. Still, 1990. *Canadian Perspectives on Air Pollution*. Environment Canada SOE Report No. 90-1. Ottawa: Minister of Supply and Services Canada.

Jaques, A.P., 1991. Personal Communication, June. [Environment Canada, Ottawa]

Koch, G., 1990. "Trudeau's Invisible Hand", *British Columbia Report* February 26, pp.10-11.

Lerohl, M.L., 1991. "Sustainability of Prairie Crop Rotations". Paper presented at the CAEFMS/Science Council of Canada Workshop on sustainable Agriculture, Winnipeg, May 5-7.

MacDonald Commission, 1985. *Report. Royal Commission on the Economic Union and Development Prospects for Canada. Volume Two*. Ottawa: Minister of Supply and Services Canada.

May, E., 1990. "A Tangled Tale Set on a Tiny River", *Globe and Mail* November 6, p.A17.

Mooney, S. and L.M. Arthur, 1990. "Impacts of 2 X CO_2 on Manitoba Agriculture", *Canadian Journal of Agricultural Economics* 38(December): In press.

Nordhaus, W.D., 1991. "The Cost of Slowing Climate Change: A Survey", *The Energy Journal* 12(1): 37-66.

Norrie, K.H., 1978. "Some Comments on Prairie Economic Alienation". In *Regional Economic Policy: The Canadian Experience* edited by N.H. Lithwick. Toronto: McGraw-Hill Ryerson. pp.142-56.

Perry, T.L. Jr., 1977. "The Skagit Valley Controversy: A Case History in Environmental Politics". Chapter 17 in *Managing Canada's Renewable Resources* edited by R.R. Krueger and B. Mitchell. Toronto: Methuen.

Prairie Farm Rehabilitation Administration, 1983. *Land Degradation and Soil Conservation Issues on the Canadian Prairies*. Regina: Soil and Water Conservation Branch.

Quinn, F., 1981. "Water Transfers--Canadian Style", *Canadian Water Resources Journal* 6(1): 65-76.

Reisner, M., 1986. *Cadillac Desert*. New York: Penguin Books.

Rizzo, Brian, 1990. "The Ecosystems of Canada in 2050: A Scenario of Change", *State of the Environment Reporting*. Environment Canada Newsletter 5, January, pp. 4-5.

Rizzo, B. and E. Wiken, 1989. "Assessing the Sensitivity of Canada's Ecosystems to Climate Change". In *Landscape-Ecological Impacts of Climate Change. Discussion Report on Fennoscandian Regions*. Proceedings of a Conference, Lunteren, Netherlands, Dec.3-7. pp.94-111.

Scott, A.D., 1991. "Coordination, Centralization and the Provision of Public Goods and Services". Paper presented at the meeting of Western Economists on the Constitution, Edmonton, May 24-25.

Senate of Canada, 1984. *Soil at Risk*. Report of the Standing Senate Committee on Agriculture, Fisheries and Forestry. Ottawa: Supply and Services Canada.

Schneider, S.H. and N.J. Rosenberg, 1989. "The Greenhouse Effect: Its Causes, Possible Impacts, and Associated Uncertainties". Chapter 2 in *Greenhouse Warming: Abatement and Adaptation* edited by N.J. Rosenberg, W.E. Easterling III, P.R. Crosson and J. Darmstadter. Washington: Resources for the Future.

Science Council of Canada, 1986. *A Growing Concern: Soil Degradation in Canada*. Ottawa: Science Council of Canada.

Taff, S.J. and C.F. Runge, 1988. "Wanted: A Leaner and Meaner CRP", *Choices* (1st Q): 16-18.

van Kooten, G.C., 1991. *Economic Issues Relating to Climate Change Effects on Canada's Forests*. Forest Economics and Policy Analysis Project Working Paper #151. Vancouver: Univ. of B.C.

van Kooten, G.C., 1990. "Soil conservation and Cropping Practises on the Great Plains: An Alternative Point of View". Vancouver: Univ. of B.C., mimeograph, October.

van Kooten, G.C., L.M. Arthur and W.R. Wilson, 1991. "Potential to Sequester Carbon in Canadian Forests: Economic Considerations". Department of Agricultural Economics, UBC, Vancouver, mimeograph.

van Kooten, G.C., W.P. Weisensel and E. de Jong, 1989a. "Estimating the Costs of Soil Erosion in Saskatchewan: Reply", *Canadian Journal of Agricultural Economics* 37(November): 555-62.

van Kooten, G.C., W.P. Weisensel and E. de Jong, 1989b. "Estimating the Costs of Soil Erosion in Saskatchewan", *Canadian Journal of Agricultural Economics* 37(March): 63-75.

Veeman, T.S., 1985. "Water and Economic Growth in Western Canada". Discussion Paper No. 279, Economic Council of Canada, Ottawa.

Weber, J. and N. Whittlesey, 1991. "Revisiting State-Level Project Evaluation: Estimating the Direct and Indirect Net Benefits of Irrigation". Pullman: Dept. of Agric. Econ., Washington State Univ., mimeograph.

Weisensel, W.P. and G.C. van Kooten, 1990. "Estimation of Soil Erosion Time Paths: The Value of Soil Moisture and Top Soil Depth Information", *Western Journal of Agricultural Economics* 15(July): 63-72.

White, Robert M., 1990. "The Great Climate Debate", *Scientific American* 263(July): 36-43.

Young, D.L., D.J. Walker and P.L. Kanjo, 1991. "Cost Effectiveness and Equity Aspects of Soil conservation Programs in a Highly Erodible Region", *American Journal of Agricultural Economics* 73(November): forthcoming.

Table 1: Irrigated Area in Western Canada, 1980 and 1985

Province	Irrigated Area (Hectares)	
	1980[a]	1985[b]
Manitoba	6,935	9,732 (40.3)[c]
Saskatchewan	55,913	83,931 (50.1)
Alberta	393,969	466,281 (18.4)
British Columbia	100,475	117,811 (17.3)
TOTAL	557,292	677,755 (21.6)

[a] Source: Statistics Canada, *Census of Agriculture 1981*, Cat.#96-901, Table 20.
[b] Source: Statistics Canada, *Census of Agriculture 1986*, Cat.#96-112, Table 11.
[c] Percent change provided in parentheses.

Table 2: Carbon Sequestering and its Costs under Various Proposals

Proposal	Annual Amount of Carbon Sequestered (mil. tonnes)	Cost ($bil.)	Cost per 1,000 kg of C ($)
Rehabilitating backlog NSR lands	13.3263	15.8-23.6	107-161
British Columbia	1.0413		59-89
Rest of Canada	12.2850		112-168
Plantation Forests on the Prairies			
marginal land converted to cropland	3.4398	1.1-2.0	29-53
current unimproved land	2.7040	1.9-2.7	64-91
TOTAL	19.4701	18.8-28.3	-

Source: van Kooten, Arthur and Wilson (1991)

FIG. 1

ECOCLIMATIC PROVINCES:
OF CANADA: 1990

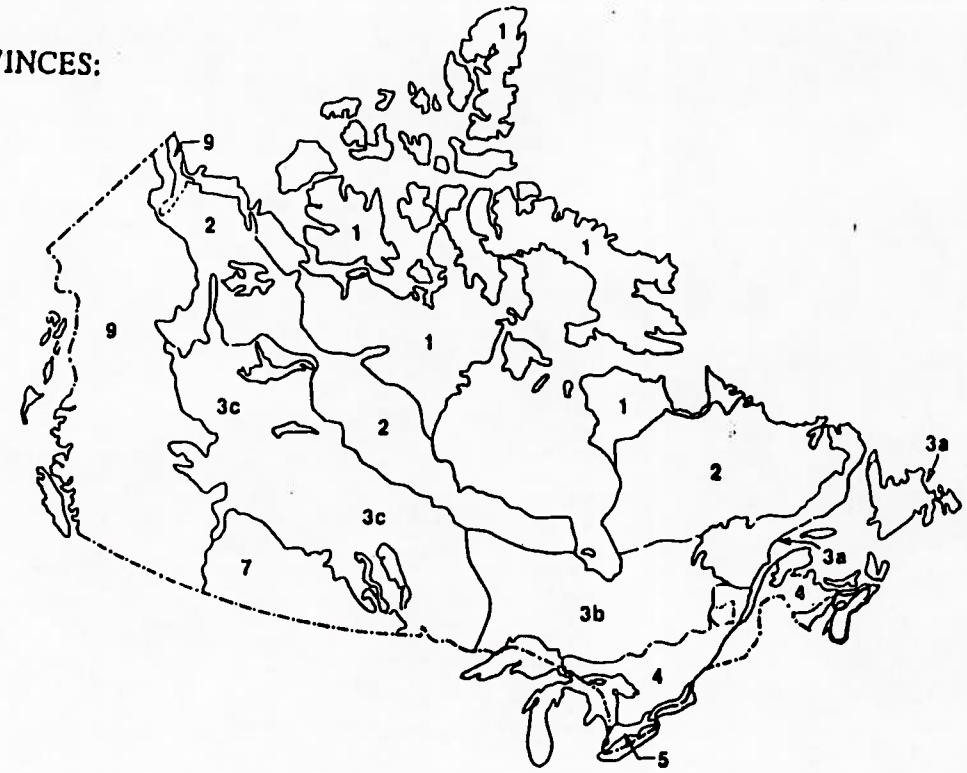
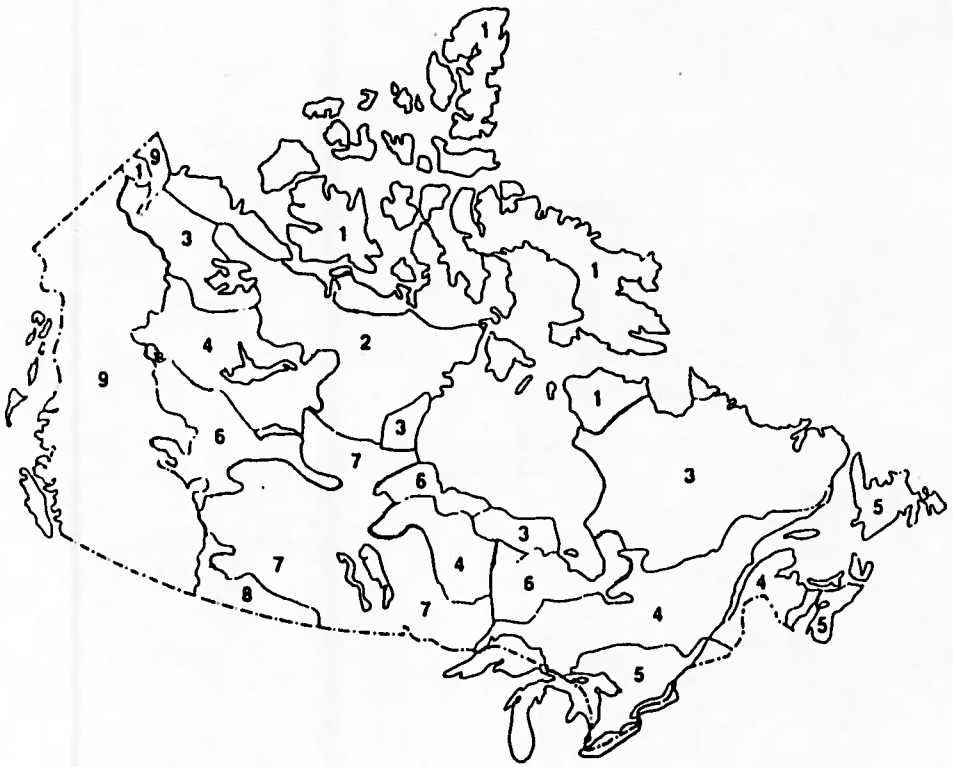


FIG. 2

ECOCLIMATIC PROVINCES:
A 2050 SCENARIO



ECOCLIMATIC PROVINCES

1. ARCTIC
2. SUBARCTIC
3. BOREAL
   - 3a MARITIME BOREAL
   - 3b MOIST CONTINENTAL BOREAL
   - 3c DRY CONTINENTAL BOREAL
4. COOL TEMPERATE
5. MODERATE TEMPERATE
6. TRANSITIONAL GRASSLAND
7. GRASSLAND
8. SEMI-DESERT
9. UNCLASSED, CORDILLERAS NOT SHOWN