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For centuries, irrigation has been viewed as a means to achieve human mastery and prosperity in the arid and semi-arid regions of the world. This is particularly true of the past two centuries as engineering advancements allowed humans to bring entire river basins under control and vast expanses of barren land were transformed into productive agricultural areas. Many modern societies have been constructed on the basis of irrigation and irrigated agriculture now accounts for about 40 percent of world food production (Merrett, 2002, 20).

Yet, over the past three decades, the long-prevailing consensus about the benefits of irrigation has been broken by emerging political forces that have successfully questioned both its environmental and financial sustainability. As a result, in many parts of the world, the state is being forced to redefine its role in irrigation. For much of the 20^{th} century, governments relied upon state subsidization, state ownership and minimal regulation in their efforts to expand irrigation as widely and as quickly as possible. With new emphasis on sustainability, however, some governments have abandoned this traditional approach in favour of new regulatory programs designed to make their irrigation sectors more environmentally secure and more financially self-sufficient. Reform of this type is best described as 're-regulation' and this paper explores two relatively recent examples of irrigation re-regulation that have taken place in Canada and Australia.

The Promise and Problem of Irrigation

Irrigation is an agricultural practice that has existed for millennia. In all its various forms, the basic idea of irrigation is to apply captured water to cultivated lands in order to help crops grow. Irrigation is most readily undertaken in arid or semi-arid climates where the soil is rich and sunlight is plentiful, but precipitation is scarce or extremely variable. In these circumstances, irrigation can serve to increase the yields of existing crops, to put previously marginal land into production, and to provide insurance against periodic instances of drought (Davidson, 1969, chapter 1). In all of these ways, irrigation can be an economic and social boon to agricultural production and it has played an important role in the development and persistence of many of the world's great civilizations.

Starting about 6,000 years ago, irrigation-based civilizations developed and thrived in nearly all parts of the world. One of the earliest and most intensively irrigated areas was in Mesopotamia, in the area between the Tigres and Euphrates Rivers (located in present-day Iraq). In this region, a succession of civilizations, from the Sumerians to the Babylonians, built their empires on the irrigated lands of what came to be known as the Fertile Crescent. Similar irrigation-based civilizations also developed in ancient Egypt, Imperial China, southwestern North America, Central America and parts of southern Africa. In all of these ancient irrigation systems, the technology used was simple but effective, utilizing gravity-fed channels or rivers' natural flooding cycles to get water to crops (Postel, 1999, chapter 2).

The primary benefit of irrigation was its ability to create, for the first time, a dependable food surplus that freed some people from working the land and allowed them to engage in other pursuits. The Sumerian civilization, for example, was the first society to undertake extensive urbanization because the food surplus created by irrigation provided a ready food supply for city-dwellers who

could not otherwise feed themselves. It was also in the irrigation-based civilizations of Mesopotamia where inventions such as the wheel and mathematics are thought to have originated. Some have even suggested that these inventions were related to irrigation and efforts to improve irrigation practices. Not only cities, but entire ancient empires were built upon the food surpluses that could be realized through irrigation. At the height of its power, the Roman Empire relied significantly upon the irrigated agriculture of the Nile and various parts of southern Europe. In an important sense, irrigation was a fundamental prerequisite for urbanization and the division of labour, two fundamental characteristics of modern societies (Postel, 1999, chapter 2).

Nevertheless, in most ancient irrigation-based civilizations, irrigation proved to be unsustainable over the long-term. Despite their limited technological means, ancient irrigators had such an impact on their environments that many of them simply collapsed under their own weight. A number of negative environmental impacts are important, in this regard.

One of the most common negative externalities of irrigated agriculture is salinization. All water contains at least some traces of dissolved salts, and water that is applied to agricultural land absorbs even more salts as it leaches through the soil toward the water table. If the soil is well drained, irrigation water will eventually return to surface rivers, but the water downstream, for the next irrigator, is higher in salinity. The cumulative effect of repeated irrigation is steadily increasing water salinity levels, particularly in downstream areas, which can diminish crop yields and poison the land. If the soil is not well drained, then a different problem arises. Continuous applications of irrigation water will cause the water table to rise and become increasingly saline. Eventually, the water table will rise to the point that it enters the root zone and inhibits crop growth. If the water table continues to rise, it will breach the surface and waterlog the land, making it completely unproductive (de Villiers, 1999, 168-171). The ancient irrigators knew very little about the dangers of salinity and entire civilizations crumbled as a result. For instance, there is strong evidence that the demise of a number of civilizations in ancient Mesopotamia was primarily the result of a series of salinization episodes (Postel, 1999, 19).

A problem often linked with salinization is over-appropriation. Irrigation proved to be such a successful agricultural practice that many ancient irrigation-based civilizations expanded their irrigation systems to utilize all accessible water resources. By appropriating water to this extent, however, little water was left to sustain riverine environments and what little was available had a high salinity content. This, in turn, had an adverse effect on the fisheries and drinking water sources on which many cities relied. In addition, over-appropriation left all irrigators more vulnerable to water shortages in times of drought, creating a considerable source of social conflict. Some ancient irrigators, such as the Egyptians, had an intuitive sense for the carrying capacity of their water resources, but others over-appropriated their irrigation sources to the point where entire systems were put out of production.

A further difficulty encountered by ancient irrigators in their relation with the natural environment was the problem of silting and infrastructure decline. To varying extents, all rivers carry deposits of silt in their natural flow. When river water is diverted and captured for use in irrigation, silt is carried with it and can accumulate in an irrigation system over time, wreaking slow havoc on dams and ditches. When silt builds up behind a dam, the dam continuously declines in storage capacity and gradually loses its functionality. The same is true of irrigation ditches, which may fill-in completely if silt accumulations are not physically removed or flushed from the system. Most of the irrigation-based civilizations had to devote considerable capital and labour to simply maintain their irrigation systems, and the decline of many civilizations was hastened when they could no longer muster the resources necessary to maintain their irrigation infrastructure.

In sum, the experiences of the ancient irrigation-based civilizations are notable because they point to many of the problems and challenges faced by modern irrigators. Modern technology and agricultural practices may have changed the ways in which irrigation is carried out, but the problems of salinization, over-appropriation and infrastructure decline have not disappeared. In fact, the larger scale and more intensive irrigation practices of the modern world have only served to increase the magnitude of these problems. It is well worth remembering that of all the ancient irrigation systems, only one of them – Egyptian irrigation along the Nile - proved to be sustainable for more than just a few centuries.[1]

The Political Economy of Modern Irrigation

According to Sandra Postel, an era of modern irrigation that is qualitatively and quantitatively distinct from the ancient era commenced around the beginning of the 19th century (Postel, 1999, 40). Qualitatively, the modern era is distinct because of the variety of new technologies that have revolutionized irrigation practices. Quantitatively, the modern era is separated from the ancient era by the rapid expansion in world irrigated acreage that has taken place over the past two hundred years, as compared to the relatively stable irrigated acreage that had existed for the previous thousand years. These two fundamental features of modern irrigation are obviously interrelated and they have combined to create a political economy that is quite distinct from the ancient irrigation-based civilizations.

Technologically, the advances most relevant to irrigation took place in physics and engineering. Hydrology emerged as a bona fide scientific discipline and the industrial revolution offered, for the first time, the means to mechanize water control. Engineers and their political masters grew increasingly confident in their capacity for large-scale water control through massive dams and storages, a capacity that was further reinforced by the advent of concrete in the late 19th century. Improvements in pumping technology made previously inaccessible water sources accessible and contributed to the development of new water application technologies such as spray, drip and underground irrigation. The importance of field drainage became better understood and the use of tile (first clay and then plastic) offered yet another way to keep marginal, poorly drained lands in production. The potential for new irrigation schemes seemed almost limitless and massive volumes of water began to be transported across deserts (in the American Southwest), between watersheds (in many places) and even through mountains (in the Australian Snowy Rivers Scheme). Reordering natural hydrologic systems and reclaiming unproductive land were popular ideas and engineers enjoyed the support of governments and peoples around the world in pursuing these goals.

As irrigation technology advanced and confidence in this technology soared, the amount of land developed for irrigated agriculture grew at a staggering rate, as did the size of most irrigation projects. In 1800, it is estimated that the world irrigated area was somewhere around 8 million hectares. By 1900 this figure had grown to 40 million hectares and by 1995 it had grown to 255 million hectares (Postel, 1999, 40-41). Between 1800 and 1995, then, the world irrigated area increased by more than a factor of 30. At least half of this increase can be accounted for by irrigation expansion in four countries: India, China, the United States and Pakistan (Postel, 1999, 41). Furthermore, among this seemingly diverse group, a standard pattern of irrigation expansion was evident. Through the construction of massive dams, storages and canal systems, these countries brought the water resources of entire river basins under control and utilized them to create irrigation projects on a scale never even contemplated in the ancient irrigation societies. This pattern of expansion through large-scale projects is typical of most irrigating countries in the modern era and is, arguably, the singular defining feature

of irrigation in the modern world.

In most places, large-scale irrigation was undertaken as a result of substantial state involvement. Social scientists such as Theodore Lowi and Roy Worster have studied irrigated agriculture in the American West and both, using different analytical approaches, have found the state to have played a very important role in both the development and perpetuation of large-scale irrigation. Lowi, for instance, has described the existence of an "iron triangle" between agribusinesses, western Congressmen and federal bureaucrats that captured the irrigation policy process and pushed the continuous expansion of western irrigation (Lowi, 1979). Roy Worster has described a similar political pattern but labeled it as the "capitalist state" (Worster, 1985, 281-83). Similar findings have been reported by irrigation analysts in other parts of the world, and extensive state subsidization and state ownership seem to have been common features of large-scale irrigation throughout most of the 20th century (Davidson, 1969; Ward, 2002).

In the past 25 years, however, this longstanding state role has been challenged by new political forces. Since about 1800, there had existed a wide consensus among farmers, governments and the general public about the value of fully appropriating available water resources to reclaim as much arid land as possible through irrigation. Irrigation was valued for its contributions to economic growth, food security and nation-building, among other things. By the 1980s, however, this consensus had started to breakdown as mounting evidence in many parts of the world showed that large-scale irrigation did not always live up to (often unrealistic) expectations. The simultaneous rise of neo-conservatism and environmentalism, two seemingly conflictual ideological movements, was instrumental in breaking this consensus (Tisdell, et al., 2002, 19-20).

As mentioned above, constructing the massive engineering structures necessary for large-scale irrigation usually required a significant degree of government subsidization or outright government ownership, but there was generally little objection to these considerable government outlays when they were proposed. These expenditures were regarded as one-time capital expenses that would eventually be recouped through irrigation water fees, and many subsidies were accordingly construed as long-term government loans. Furthermore, there were so many positive secondary effects anticipated from dam construction that they were widely regarded as a necessary public good. Over time, however, many of the benefits expected from large-scale irrigation did not materialize. In many projects it was soon discovered that irrigated farms were not profitable enough to pay back the capital expenditures from infrastructure construction and many governments were forced to assume these debts themselves. In some projects, irrigators could not even afford yearly infrastructure operating costs, much less periodic infrastructure repairs, and they became dependent on state subsidies for their yearly existence (Davidson, 1969). As neo-conservatism gained credence in the early 1980s, irrigators began to be identified as a class of "welfare bums" and faith in continuous, publicly funded irrigation expansion was deeply shaken. In many parts of the world, public assistance for irrigation was at least partially withdrawn and irrigated agriculture has struggled to adapt and survive, as a result.

The growth of the environmentalist movement since the 1960s also had a role in breaking the irrigation consensus, as the deleterious ecological effects of large-scale irrigation were made known and environmentalist groups rose to fight them. A favourite target of environmentalists was the large dam and diversion structures that transformed naturally flowing rivers into engineer-controlled water systems. During the 1980s, environmentalists lobbied, protested and sued against new dam construction proposals in places such as Alberta, Tasmania and the US Southwest, amongst many others. These actions garnered new public sympathy for the environment and successfully blocked dam construction in some cases. Another important environmentalist cause has been the designation and protection of environmental flows. As large-scale irrigation projects increasingly appropriated

available water resources, riverine environments were degraded, inland fisheries shrunk and wetlands disappeared. Environmental flows were intended to set aside a volume of water for these environmental purposes in intensively irrigated river basins as a means of preserving the natural environment. This implied that irrigation should not be inherently regarded as a priority user over environmental water uses and successfully posed a direct challenge to the prevailing consensus on the unquestioned benefits of large-scale irrigation (Ward, 2002).

The relatively recent breakdown of the irrigation consensus has left irrigators politically vulnerable, particularly in developed countries where neo-conservatives and environmentalists are strongest. Consequently, world growth in irrigation has slowed considerably in recent years. Since 1980, only a handful of large-scale irrigation projects have been undertaken in developed countries and world per capita irrigated area has actually started to decline, after having risen for more than a century (Postel, 1999, 61). Some of this can be accounted for in the diminishing returns of new irrigation development. By the 1980s, most of the opportune sites for dam construction and irrigation expansion had already been developed, leaving only the more marginal and costly schemes for the future (Postel, 1999, 64). Even many existing irrigation projects, however, have started to come under fire with both neo-conservatives and environmentalists arguing that the public benefits of irrigated agriculture do not adequately exceed their public costs, whether construed in financial or environmental terms.

In the face of these concerns, irrigation governance has reached a crossroads in many parts of the world. Some have advocated the abandonment of irrigation in all but the most ideal locations where water supplies are abundant and easily accessible, the soil is well-drained and biodiversity is not under threat. However, considering that 40 percent of the world's food is produced through irrigation and that agriculture in many regions of the world relies disproportionately upon irrigated land, the abandonment of many existing large-scale irrigation projects is simply not a realistic option (Merrett, 2002, 20). This would result in food shortages, increased rural poverty, widespread rural dislocation and considerable social conflict, even in many developed countries. So, governments are left with the imperative of trying to restructure irrigated agriculture, and the re-regulation of irrigation sectors in a number of jurisdictions has been the result.

The Re-Regulation of Irrigated Agriculture in Australia and Canada

In general, the re-regulation of irrigated agriculture has involved the withdrawal of government subsidies and government ownership as well as extensive regulatory reform intended to make irrigation more financially and environmentally sustainable. In terms of financial sustainability, re-regulation has aimed to create irrigation farms that are viable and profitable without reliance on extensive government subsidization. This usually means that marginal producers are encouraged to exit production and that the remaining producers are encouraged to grow higher value crops and adopt more efficient irrigation practices. Environmentally, re-regulation has aimed to ensure that irrigators engage in more sustainable farming practices so that the land and water resources on which they rely are not unduly degraded. This usually means that significant steps are taken to reduce over-appropriation, to manage and mitigate salinity and to restore riverine environments and biodiversity.

Though re-regulation varies somewhat between jurisdictions, it has been generally characterized by three main features:

1) Nested quota systems of water property rights;
2) Commercialization of water property rights; and,
3) Regulations that internalize many negative irrigation externalities.

These three features are illustrated below by drawing on cases of re-regulation in the Murray-Darling

Basin of Australia and the South Saskatchewan Basin of the Canadian Prairies.

1) *Nested Quota Systems of Property Rights*

Water property rights have long been a feature of water governance in irrigated areas, but the development of a nested quota system of water property rights is something that is much more recent. To grasp the importance of water rights, it is important to understand the nature of the property rights in question.

> Property rights pertaining to water are unusual in the respect that almost every culture and legal tradition has recognized that water has a fugitive and public character that precludes it from capture and ownership in the same sense that land can be fenced and owned by title…. However, access to water can be more readily restricted and controlled and it is the access to water that is owned rather than the water itself (Heinmiller, forthcoming)

As one would expect, water rights are very important to irrigators because they serve as the legal basis through which they gain access to water. In other words, by obtaining a water right, irrigators gain legal entitlement to a water appropriation and implicitly enlist the state's assistance in enforcing this right. At the same time, the state can modify these entitlements and this, indeed, is one of the main ways in which irrigators' water use is governed.

In the early development of large-scale irrigation, the main problem faced by governments was to get farmers settled on irrigable lands, so water rights were designed to be easily obtainable and, in some cases, open-ended in terms of water appropriation. These policies have worked so well that, decades later, many irrigated areas are now faced with the problem of over-appropriation. To remedy this problem, some jurisdictions have introduced quota systems that set a limit on total appropriations and transform individual water rights into entitlements to a resource share rather than entitlements to resource access. This re-regulation imposes restraints on individual water use, ensures that the collective resource is not degraded beyond the established limit and generally increases the reliability of all water entitlements. Furthermore, these quota systems tend to be nested across a number of governance levels: governments sharing a river basin may agree to a limit on total appropriations and establish shares for each jurisdiction; these shares then serve as the limit on total appropriations within each jurisdiction and shares are established for each irrigation district; these shares then serve as the limit on total appropriations within each irrigation district and shares are established for each irrigator. The result is a complex, interdependent configuration of water rights that is designed to avoid the problem of over-appropriation and ensure the delivery of reliable water entitlements.

In the Murray-Darling Basin, a nested quota system of property rights was first introduced with the Cap on Diversions in 1995. By the early 1990s, it had become apparent to water regulators in the Murray-Darling that over-appropriation was an imminent and pressing problem. The matter was brought to the Murray-Darling Basin Ministerial Council[2] and they responded with the introduction of the Cap. Each state was given a yearly quota of water appropriations, defined as the volume of water that would have been appropriated at their 1993-94 level of development.[3] In turn, the states have reformed their water entitlements to give irrigation districts shares in their respective quotas, and most irrigation districts have done likewise in relation to individual farmers. The result is a nested system of water quotas that is designed to limit total appropriations in the basin, but maintain the year-to-year reliability of all water entitlements (Quiggin, 2001). Encouraging compliance with quota limits has been the major challenge in the implementation of the Cap, particularly in New South Wales and Queensland, but the program is well-monitored by the Murray-Darling Basin Commission and general commitment to the Cap remains strong (Heinmiller, 2004).

In the South Saskatchewan Basin, a nested quota system of water rights has been introduced, but it is limited to the province of Alberta where irrigation in the basin is most intensive. In 1990, the Government of Alberta introduced the South Saskatchewan River Basin (SSRB) Regulation in response to concerns that irrigation water supply shortages were becoming increasingly frequent. The regulation established a maximum area of irrigated land for each of Alberta's 13 irrigation districts and then established a water quota for each district based on "reasonable" water needs for the irrigation of these maximum areas. The irrigation districts are now required to meet the water demands of their irrigators within their respective quotas, limiting total water use in the Alberta portion of the South Saskatchewan (Irrigation Water Management Study Committee, 2002, 20-24).

Though the nested quota systems in both basins are designed to severely restrict future growth in water appropriations, it is important to emphasize that they do not restrict future growth in irrigation. Irrigators are allowed to put more land into irrigated production, but they must do so within the limits of their water quotas. This means that future growth will only be possible if irrigators find water savings through increased water use efficiency. In other words, the nested quota systems are designed to increase the reliability of water entitlements but still hold out the possibility of future growth to enterprising irrigators.

2) Commercialization of Water Rights

During the irrigation consensus, states were actively involved in the distribution and protection of water property rights, but the commercial value of these rights was obscured by government regulation and subsidization. For instance, many governments severely restricted the transferability of water rights so the market value of these entitlements was neither known nor relevant. When water rights were redistributed, it was usually through state direction according to state water use priorities. In addition, the water delivery charges that irrigators paid the state for fulfillment of their water rights were often well below the actual costs of water delivery, creating a substantial source of subsidization. This subsidization lowered irrigators' costs by providing cheap water, but it also perpetuated wasteful water use practices and the continuous growth of lower value crops (Davidson, 1969).

In an effort to eliminate these unsustainable practices, some jurisdictions have re-regulated their water rights to introduce some aspects of commercialization. Water pricing, for instance, can take a full-cost recovery approach that aims to have the water prices paid by irrigators closely approximate the capital and operating costs of the water delivery system on which they rely. This usually means that water deliveries become more expensive, but the increased water revenues are used to operate, maintain and upgrade the water delivery infrastructure with less state subsidization. Because irrigators pay more for the water they use, they can achieve considerable cost-savings by using water more efficiently and much stronger incentives are created for investment in more efficient irrigation practices. More expensive water also means that some irrigators will be forced to grow higher value crops to remain viable. If water markets or water banks are also introduced, those who cannot adapt their cropping practices can sell or transfer their water rights to higher value water uses, making a profitable exit from production (Merrett, 2002, chapter 4). This usually results in a decline in the number of producers, but it also results in an irrigation sector that is economically stronger because production overcapacity has been reduced.

In the Murray-Darling, the commercialization of water rights has been primarily achieved through the water reform strategic framework negotiated by the Council of Australian Governments (COAG) in 1994. This was a national initiative that focused on water utilities and water-based public enterprises across the country and aimed to reform these organizations so that they would become more

financially self-sufficient. At the time, most of the irrigation districts in the Murray-Darling were government-run, so it particularly affected them. The water reform framework encompassed a number of diverse initiatives such as full-cost recovery in water pricing, trading in water rights and commercialization of government enterprises. The framework also became part of the National Competition Council (NCC) program of microeconomic reforms and state implementation was encouraged by a schedule of Commonwealth "tranche" payments that were distributed as a carrot for compliance. Consequently, the water reform framework has been well implemented. New South Wales privatized its irrigation districts in the late 1990s and the other states have devolved management authority over their districts to irrigator-run trusts. Government subsidization is being incrementally replaced by full-cost water pricing in most areas, and restrictions on the transferability of water rights are being lifted. Trading in water rights is now permitted within most irrigation districts, some states now permit limited water trading between districts, and a pilot program on interstate water trading has been established by the Murray-Darling Basin Commission. Irrigators are slowly adapting to this re-regulation, but there is already some evidence that trading in water rights has resulted in the movement of some water from lower value uses to higher value uses (Tisdell, et al., 2002).

In Alberta, some commercialization of water rights has also taken place, but not to the same extent as in the Murray-Darling. In 1996, provisions were added to the Alberta *Water Act* to permit the transfer of water licences between holders and prospective buyers. This was an unprecedented move toward increasing transferability, but all licence transfers still remain subject to government approval (Percy, 1996-1997, 236). Nevertheless, transfers are widely supported among irrigators in the South Saskatchewan Basin and some have already tried to take advantage of this new provision (Percy, 1996-1997, 235). Further steps toward commercialization have also been taken in the 1999 *Irrigation Districts Act* which "…provides the districts with more autonomy in decision making, more independence from government, and, of course, more responsibility and accountability to their water users" (Irrigation Water Management Study Committee, 2002, 18). Overall, in both aspects of this re-regulation, the primary objective is to make irrigators more financially self-sustaining and less dependent on the state.

3) Regulations to Internalize Negative Irrigation Externalities

During the irrigation consensus, the negative externalities produced by irrigation, such as increased salinity and riverine degradation, were often unnoticed or overlooked in favour of the anticipated benefits resulting from large-scale irrigation. When these negative externalities were addressed, it was usually through environmental policies focused on clean-up and remediation, generally unlinked to the water use practices of irrigators. This, in effect, was a form of indirect state subsidization as irrigators did not have to pay the full costs associated with their production processes, instead, externalizing many of these costs to the environment and the state.

Recent efforts at irrigation re-regulation have abandoned this practice in favour of policies that attempt to internalize many of irrigation's negative externalities onto irrigators themselves. Generally, this is accomplished by placing conditions on the use of water property rights. In some instances, irrigators are required to engage in extensive environmental planning processes for the watersheds from which they draw their water before governments will permit water appropriations in these areas. Similar planning and remediation processes are often required of irrigators to mitigate salinity. Another increasingly common set of conditions on water rights relates to the timing and extent of water withdrawals. By limiting when and how much irrigators withdraw from water sources, regulators can better maintain natural river flows and protect riverine environments. These types of regulations limit the freedom that irrigators may have once enjoyed in making their appropriations, but they also make

irrigators much more aware of the problems associated with irrigated production and force them to account for these problems in their irrigation practices.

As a result of the Cap and the COAG water reform framework, all of the Murray-Darling states have now introduced watershed environmental planning processes as part of their recent policy reforms. These planning processes are designed to recognize the environment as a legitimate user of water and to plan water allocations and irrigation activities to recognize this fact. Most states have now designated environmental allocations of water, within their respective Cap quotas, and irrigation districts have had to modify their irrigation practices to reduce salinity and increase environmental flows in order to have their water licenses continued. In most cases, the committees involved in the watershed planning processes have been continued on an ongoing basis and are actively involved in the monitoring and implementation of the plans they helped develop (Productivity Commission, 2003a; Productivity Commission, 2003b; Productivity Commission, 2003c; Productivity Commission, 2003d).

In Alberta, the introduction of environmental planning and environmental flows has not advanced as far as it has in the Murray-Darling. Nevertheless, there has been recent movement in this direction. The 1996 *Water Act*, for instance, now requires that a 'water management plan' be developed and approved by Cabinet before any new water licences are issued in the province. Furthermore, in the formulation of water management plans, due consideration must be given to environmental needs, particularly instream flows. If a watershed is found to be fully appropriated, then a moratorium on new water licences can be imposed (Percy, 1996-1997, 237-238). For existing water licences, varying conditions have been attached, many of them restricting water appropriation activities based on instream flow levels (Irrigation Water Management Study Committee, 2002, 19). Though these are not the comprehensive environmental planning processes found in the Murray-Darling, these recent measures do make irrigators more responsible for their impacts on the environment.

Conclusion

The breakdown of the irrigation consensus and the re-regulation of irrigated agriculture may be part of a broader trend of policy reform that has recently taken place in a number of economic sectors that rely on renewable resources in their production processes. For example, in some fisheries based in Canada, Australia, Ireland, Norway, New Zealand and the United States, governments have introduced individual transferable quota (ITQ) systems that set a total allowable catch for a fishing season and then divide it into shares among the permitted fishery participants. A recent social scientific study of a Nova Scotia fishery utilizing an ITQ system found that it was generally successful in encouraging conservation and reducing industry overcapacity, though at the cost of some employment losses and some concentration of fishing rights (Apostle, et al., 2002). Similar studies of irrigation re-regulation in the Murray-Darling and South Saskatchewan would seem well in order. At the very least, irrigation re-regulation has reduced the political vulnerability of irrigators in these basins. Reliance on state largesse left the irrigation industry seriously vulnerable to attacks from environmentalists and fiscal conservatives, but re-regulation has reconstructed the political economy of irrigation and reduced this industry threat.

[1] The Egyptian system was sustainable because of its “basin irrigation” approach that was designed around the natural flooding cycles of the Nile and did not fundamentally alter the basic features of this ecosystem.

[2] The Murray-Darling Basin Ministerial Council is an intergovernmental organization comprised of ministers responsible for land and water resources from the four Murray-Darling states, the Australian Capital Territory and the Commonwealth.

[3] The precise meaning of the Cap definition is best described by the Australian economist John Quiggin: “The Cap is not

the volume of water that was used in 1993-94. Rather, the Cap in any year is the volume of water that would have been used with the infrastructure (pumps, dams, channels, areas developed for irrigation, management rules and son on) that existed in 1993-93, assuming similar climatic and hydrologic conditions to those experienced in the year in question. Thus, the Cap provides scope for greater water use in certain years and lower use in other years."

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