

Impacts of AGRICULTURE on  
WATER QUANTITY in the  
GREAT LAKES —  
ST. LAWRENCE RIVER BASIN



Outlining a Research  
Agenda for  
Agriculture, Trade &  
Water Quantity Management

Executive Summary, November 2002  
Institute for Agriculture and Trade Policy

Impacts of Agriculture to Water Quantity in the Great Lakes and St. Lawrence River Basin  
Outlining a Research Agenda for Agriculture, Trade & Water Quantity Management

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# A LETTER FROM THE PRESIDENT

Water quantity issues in the Great Lakes Basin are at a critical juncture. An increasing awareness of general water scarcity and proposals to export bulk water from the Great Lakes to other countries have forced policymakers to address deficiencies in domestic policy and trade law. The recently signed Annex 2001, an update to the Great Lakes Charter, is a good place to begin this process. This agreement and corollary legislation set standards for water use and provide a separate binding agreement among states and provinces to keep Great Lakes waters within the basin. This is critical for farmers, communities, local economies, and our environment.

Little is known, however, about the relationship between the basin's largest consumptive water user — agriculture — and measurable impacts to Great Lakes water levels and ecosystem health. For example, the amount of irrigated land in the basin has increased significantly in recent years and substantial volumes of water are used in livestock and dairy operations. Meanwhile, climate change, population growth and other factors are making it clear that even the abundant waters of the Great Lakes are finite. As the overall demand for water increases — and the environmental impacts of water withdrawals are better understood — agriculture's water consumption will come under even greater scrutiny.

An immediate response by some who are concerned about Great Lakes water withdrawals is to call for greater regulation. Regulatory efforts certainly will play an important role in managing consumption. Before setting regulations, much more information is needed on science and policy:

- Agriculture is a key component of the region's "working landscapes." Farmland provides not only food and fiber, but also wildlife habitat, the protection of air and water resources, landscape and "open space" preservation, and the

foundation for many rural communities. Placing greater restrictions on agriculture's water use can lessen consumption, but it can also increase the costs of farming, potentially driving farmers out of business. In many areas, the loss of farmers could result in more suburban development — a much greater threat to water resources.

A potentially better alternative would be to strengthen the agricultural economy by providing incentives for efficient water use and conservation;

- Of the water consumed by farming operations, most of it is taken from the ground. Very little is known regarding the interaction of groundwater and Great Lakes water levels, or the percentage of irrigated water that percolates back to groundwater sources;
- Water withdrawals are notoriously difficult to control, and restrictions that are placed without broad community support are not likely to succeed.

This summary and the full report (included on a CD-ROM) provide a review of the current scientific research and policy tools available on the interaction between agriculture and water consumption in the Great Lakes Basin. While the report doesn't answer all questions, it helps define questions still needed to be answered. It provides solid, specific recommendations for filling information gaps and developing effective policies. Perhaps most importantly, this paper will help foster more effective discussion between farmers, environmentalists, businesses, sportsmen, policymakers and other community members on how to most effectively protect the Great Lakes and our communities.

Mark Ritchie, President  
Institute for Agriculture and Trade Policy

# DECREASING WATER AVAILABILITY IN THE GREAT LAKES-ST. LAWRENCE RIVER BASIN

The freshwater resources of the Great Lakes-St. Lawrence ecosystem are becoming increasingly threatened due to the projected impacts of climate change, population growth, and an overall increase in water use, primarily for agriculture. Containing nearly 20 percent of the world's supply of fresh surfacewater, it is the largest and one of the most intensively used freshwater systems in the world, serving multiple interests including transportation and navigation, hydropower, irrigation and livestock production, municipal and industrial water supply, mining, and recreation. Of these, the major consumptive water use (water withdrawn and assumed lost from the system) is food production.<sup>1</sup>

basin, combined with potential future impacts from population growth, climate change, land use, and other changes, will lead to a combination of decreasing water availability and an ever-increasing value of freshwater due to competing interests.

**Growing water uses in the basin, combined with potential future impacts from population growth, climate change, land use, and other changes, will lead to a combination of decreasing water availability and an ever-increasing value of freshwater due to competing interests.**

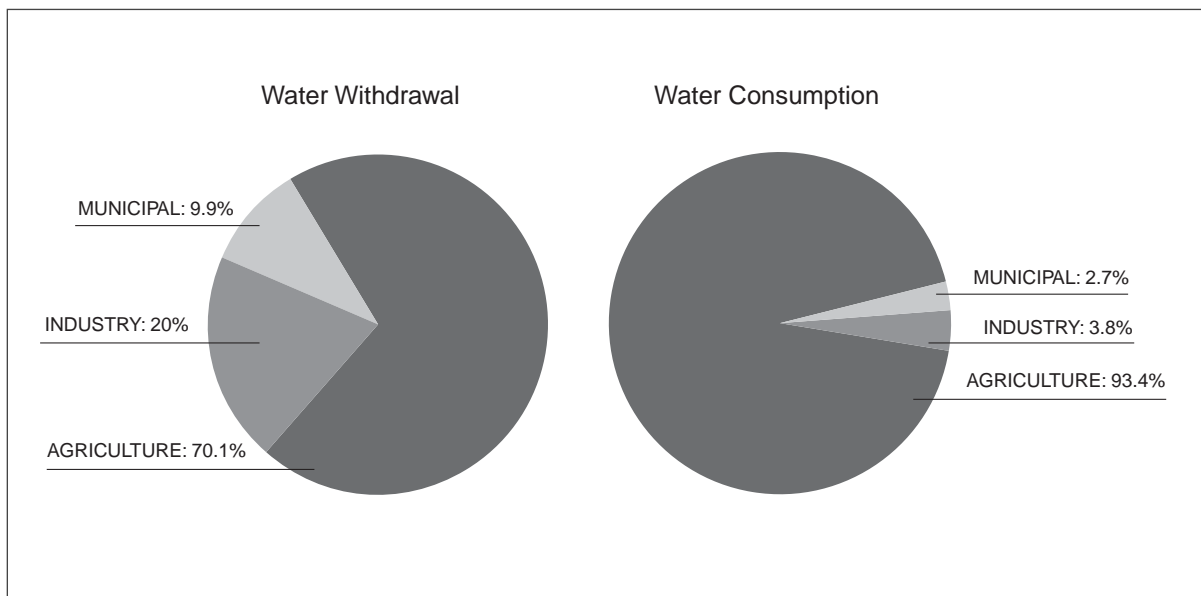
Research indicates that the cumulative impacts of increasing freshwater use in most sectors will lead to decreasing water quantity in the Great Lakes-St. Lawrence River Basin.<sup>2</sup> It is estimated that if water is consumed at currently projected growth rates, and if projected impacts of climate change do occur, Great Lakes water levels will drop dramatically.<sup>3</sup> In less than 40 years, the flow from the Great Lakes system out of the St. Lawrence River could be reduced to less than three-quarters of its current flow, in addition to the compounding impact that diversions out of the basin could have on the lake levels.<sup>4</sup> Growing water uses in the



# CURRENT CONDITIONS: TRENDS IN WATER USE

Global water usage has increased dramatically over the last century, with consumption of freshwater doubling every 20 years.<sup>5</sup> The predominant increase in water withdrawals is attributed to agriculture, with irrigation accounting for 70 percent of the water taken from lakes, rivers, and underground sources worldwide.<sup>6</sup>

## GLOBAL WATER WITHDRAWAL AND CONSUMPTION BY SECTOR, 1997



Source: World Meteorological Organization, 1997

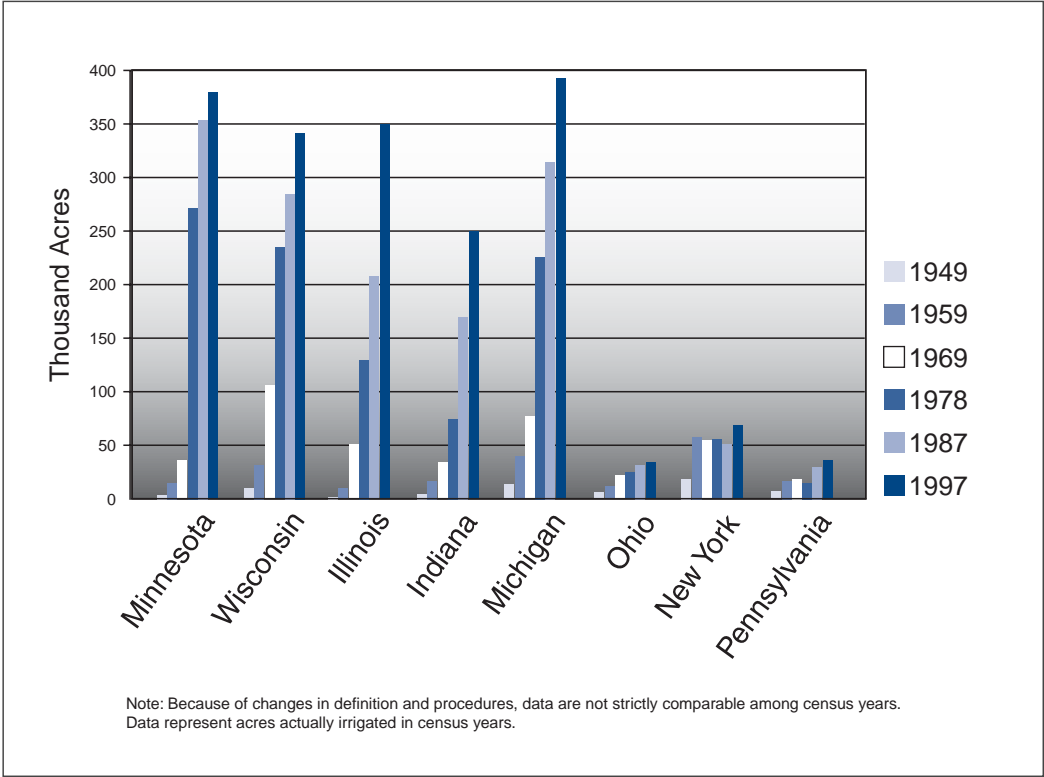
Recreated by: Institute for Agriculture and Trade Policy

**Irrigation for agriculture accounts for 70 percent of the water withdrawn from lakes, rivers, and underground sources worldwide (shown left). Agriculture accounts for more than 90 percent of all water consumed (shown right).**

In the Great Lakes region, irrigation has been increasing steadily over the last 40 years, and is expected to continue to grow.<sup>7</sup> The Great Lakes Provinces account for nearly 40 percent of total Canadian agricultural production (in dollars) while the Great Lakes States make up almost 20 percent of U.S. agricultural production (in dollars).<sup>8</sup> Despite a significant decline in overall land in farms in the Great Lakes region from 1949-1997 (almost 30 percent in Great Lakes states), the amount of farmland that is irrigated has increased a staggering

25 times over the same time period. Production over the same period also increased, which is due to various factors, such as the use of higher yielding hybrids, increased fertilizer usage, and better crop and pest management. However, it is the profound increase in irrigation that is most striking. Irrigated land produces between two and three times greater yield than rain-fed land, however requires proportionately more water and higher input costs (equipment, energy, etc.). In both the U.S. and Canada, the total area of irrigated land is projected to continue to grow.

IRRIGATED LAND IN FARMS:  
GREAT LAKES STATES, 1949-1997



Created by: Institute for Agriculture and Trade Policy.  
Data Source: USDA, 1997

Although measurable impacts from increasing water usage to Great Lakes surface water levels are difficult to determine due to the size of the ecosystem, local impacts to groundwater aquifers may be more obvious, as groundwater supplies, like surface water, are becoming increasingly depleted. Of the freshwater used for irrigation and livestock in Great Lakes states, more than half comes from groundwater sources.<sup>9</sup> As irrigation in the region continues to grow, reservoirs and groundwater levels will be reduced, leading to an increasing pressure on groundwater aquifers and potential conflicts with other water uses.<sup>10</sup> Already there have been several instances of residential wells going dry during high withdrawal periods for municipal, industrial, and irrigation uses in Michigan.<sup>11</sup>

The total amount of irrigated land in farms in Great Lakes states has increased a staggering 25 times over the last 50 years (1949-1997), and by almost 30 percent, on average, in the last decade (1987-1997).



## WATER USES IN THE GREAT LAKES BASIN

**Thermoelectric Power Use.** At thermoelectric power plants, water is used principally for condenser and reactor cooling. In the United States, thermoelectric withdrawals have remained relatively constant since 1985 and are expected to remain near their current levels for the next few decades. In Canada, modest increases are expected to continue along with population and economic growth.

**Agricultural Use.** In the United States, water use for agriculture in the Great Lakes region increased fairly steadily from 1960 to 1995 and is expected to continue to grow. In Canada, the rate of increase was somewhat greater. Combined projections indicate a significant increase by 2020. Climate change could increase even further the competitive advantage the basin has in agriculture from of its relative abundance of water.

**Industrial and Commercial Use.** In the United States, industrial and commercial water use has declined in response to

environmental pollution legislation, technological advances, and a change in the industrial mix from heavy metal production to more service-oriented sectors. A similar trend is evident in Ontario, so combined use is expected to gradually decline through 2020.

**Domestic and Public Use.** In the United States, water use for domestic and public purposes in the Great Lakes Basin generally increased from 1960 to 1995 and is expected to climb gradually through 2020. In Ontario, however, the modest downward trend established in recent years because of water conservation efforts is expected to continue.

**Total Water Use.** There is agreement that water withdrawal will increase in the future, although it is impossible to know just how much the increase will be.

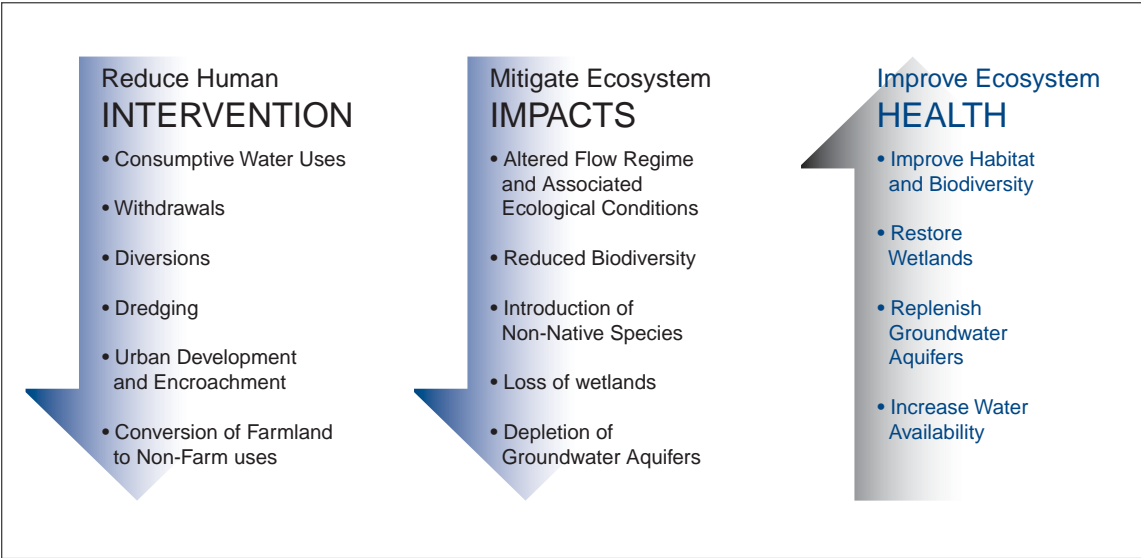
Source: International Joint Commission, 2000

# CUMULATIVE IMPACTS OF INCREASING WATER USE

Although the impact of localized, small-scale activities may be difficult to measure on an individual basis, collectively, they can significantly alter the level and flow regime and associated ecological conditions.<sup>12</sup> Research shows that cumulatively, human activities and decreasing water levels have had many impacts to the Great Lakes ecosystem and habitat, including changes to the hydroperiod (the length of one wet and dry cycle), reductions to water flow variability and ecological niches, depletion of groundwater aquifers, loss of wetlands, reduced biodiversity to coastal wetlands, introduction of non-native species, and potential disruptions in breeding of fish populations. In order to improve the overall health of the Great Lakes ecosystem, steps must be taken to mitigate such activities and their negative impacts.

Cumulatively, human activities have had significant impacts to the Great Lakes ecosystem and habitat. Although it is extremely difficult to quantify precise ecological impacts of most water withdrawals and consumptive uses, steps must be taken to mitigate the negative impacts of such activities in order to improve Great Lakes ecosystem health.

## HUMAN ACTIVITIES AND ECOSYSTEM HEALTH



Source: Institute for Agriculture and Trade Policy, 2002



# POLICY CONTEXT: GREAT LAKES PROTECTION THROUGH IMPROVED WATER USE POLICY AND SOUND CONSERVATION

Over the last century, there have been repeated policy initiatives by Great Lakes leaders to create a reliable legal framework to conserve, protect, and effectively manage Great Lakes water resources. Most of these attempts have been insufficient to fully protect the Great Lakes ecosystem due to such issues as the non-binding legal nature of the policy, the inability to implement regionally consistent decision-making standards regarding diversions, inconsistent methods of monitoring, permitting and understanding of state/provincial surfacewater and groundwater uses, and the lack of a basinwide conservation strategy. The recent decision to update the 1985 Great Lakes Charter, termed “Annex 2001,” represents the most current proposal to address these issues and to strengthen regional water policy.

In signing Annex 2001, Great Lakes leaders have consented to regional collaboration to strengthen the protection of Great Lakes water resources by reforming state and provincial water use law to protect the environment, rather than only represent the interests of human water users. The next step is for the basin’s governments to incorporate the conservation principles of Annex 2001 into state and provincial law. Although this crucial stage of the Annex process faces many challenges, the basinwide commitment to necessary water conservation goals as set forth in the Annex is fundamental to achieving what earlier water policy initiatives could not: fully protecting Great Lakes resources from bulk water exports and diversions, improving the Great Lakes ecosystem, and establishing a precautionary principle regarding Great Lakes water use and management.

## ANNEX 2001

The purpose of Annex 2001, a new provision of the 1985 Great Lakes Charter, is to forge a binding agreement to manage Great Lakes waters, to develop a new standard for new or increased water withdrawals, and to make further commitments to improve the Great Lakes water management system. In December 2000, the Council of Great Lakes Governors, acting on behalf of the Great Lakes governors and premiers, released a draft amendment to the Great Lakes Charter called Annex 2001, for public

review and comment. On June 18, 2001, the Annex document was signed by all of the Great Lakes governors and premiers to protect the Great Lakes against bulk water exports and large-scale diversions. In the Annex, the governors and premiers reaffirm their commitment to the Charter principles and also “commit to develop and implement a new common, resource-based conservation standard and apply it to proposed new or added increased capacity withdrawals of Great Lakes water.”<sup>13</sup>

# INTERNATIONAL TRADE IMPLICATIONS

Water resources are not protected under current international trade agreements. The development of free trade in water has the potential to seriously hamper or eliminate effective Great Lakes water protection.<sup>14</sup> Under current trade agreements such as NAFTA (North American Free Trade Agreement between the U.S., Canada and Mexico) and GATT/WTO (General Agreements on Tariffs and Trade/World Trade Organization), the primary guiding principle is that governments cannot act in ways that give economic advantage to their own people over people in other countries who wish to trade with them.<sup>15</sup>

Water resources are not protected under current international trade agreements. The development of free trade in water has the potential to seriously hamper or eliminate effective Great Lakes water protection.

Although general exceptions to trade obligations regarding health and environmental concerns officially exist, “in all the cases before the WTO involving issues of protecting environmental or natural resource interests, the WTO had ruled against those interests.”<sup>16</sup> Only recently has the first public health measure successfully been granted exception by the WTO. According to the Sierra Club of Canada and Great Lakes United (GLU), if this result represents the baseline necessary before a general exception to trade obligations can succeed, “there remains serious doubt that (trade exceptions relative to water) have developed adequately to ensure the observance of legitimate domestic objectives, including Great Lakes water protection.”<sup>17</sup>

Citing the need to protect the Great Lakes ecological integrity, the International Joint



Minnesota Extension Service, Don Breneman

Commission’s (IJC) final report to the governments of Canada and the United States recommended that the Canadian and United States federal, provincial, and state governments not permit the removal of water from the Great Lakes.<sup>18</sup> Relying on the GATT/WTO general exceptions, the IJC concluded: “the achievement of a coherent and consistent approach to water conservation and management in the Great Lakes Basin — an approach clearly grounded in environmental policy — would be an important step in addressing any trade-related concerns with respect to the use of Basin waters.”<sup>19</sup> This recommendation has been acknowledged by Great Lakes leaders and environmental groups in the development of a common standard on water use and removals that focuses on the environmental aspects of water conservation in the hope of falling within the WTO/NAFTA general exceptions.<sup>20</sup>

# FUTURE CONDITIONS INFLUENCING GREAT LAKES WATER QUANTITY

As fresh water becomes more and more scarce, the need to revise certain aspects of water policy and management in the Great Lakes-St. Lawrence River Basin will be necessary. The drivers that will or may likely impact Great Lakes water availability in the

future include not only population growth, climate change, and land use changes, but also such potential factors as further bulk water removal/export, water conservation practices and policies, and the possibility of international trade in water.

## FUTURE CONDITIONS IMPACTING GREAT LAKES WATER QUANTITY

**Population growth.** Many of the risks to the world's lakes stem from a growing global demand for water. The population in the Great Lakes Basin has been growing significantly over the last century, most extensively near Lakes Erie, Michigan, and Ontario.

**Climate change.** Research is showing that the impacts of potential climate change to Great Lakes water levels could be dramatic, including: an average temperature rise of 15 degrees Fahrenheit; basinwide lake level decreases of over three feet; further loss of wetlands, forests, and essential habitat; and increased human health problems.<sup>21</sup>

**Land use change.** Changes in land use occurring over the last century have resulted in significant habitat loss in the lower basin. One of the most significant land use changes is the increasing conversion of farmland to non-farm use, particularly around metropolitan areas, resulting in dramatic impacts on natural resources.<sup>22</sup>

**Bulk water removal/export.** Although the U.S. and Canada currently oppose bulk export of Great Lakes water, future conditions such as limited water availability in regions outside the Great Lakes Basin, stresses from natural disasters, drought, and other crisis situations will likely lead to continued consideration of bulk water export.

**Water conservation.** Water conservation efforts in the Great Lakes region have been limited by a widespread sentiment that there is an almost limitless supply of water. Research and education efforts that target water quality as opposed to water quantity issues, as well as low water pricing in both countries have resulted in minimal water conservation measures. The degree of future water conservation likely will not improve dramatically without changes to current water use policies, clear economic incentives, appropriate water valuation, and sensible water pricing that encourages conservation.

**International trade in water.** The development of free trade in water has potentially serious implications for Great Lakes water protection. Under current trade agreements (NAFTA, GATT), the primary guiding principle is that governments cannot act in ways that give economic advantage to their own people over people in other countries who wish to trade with them. Without effective legislation that would protect the Great Lakes (as discussed above) from being treated as a general commodity, this could place the Great Lakes water resources at risk.<sup>23</sup>

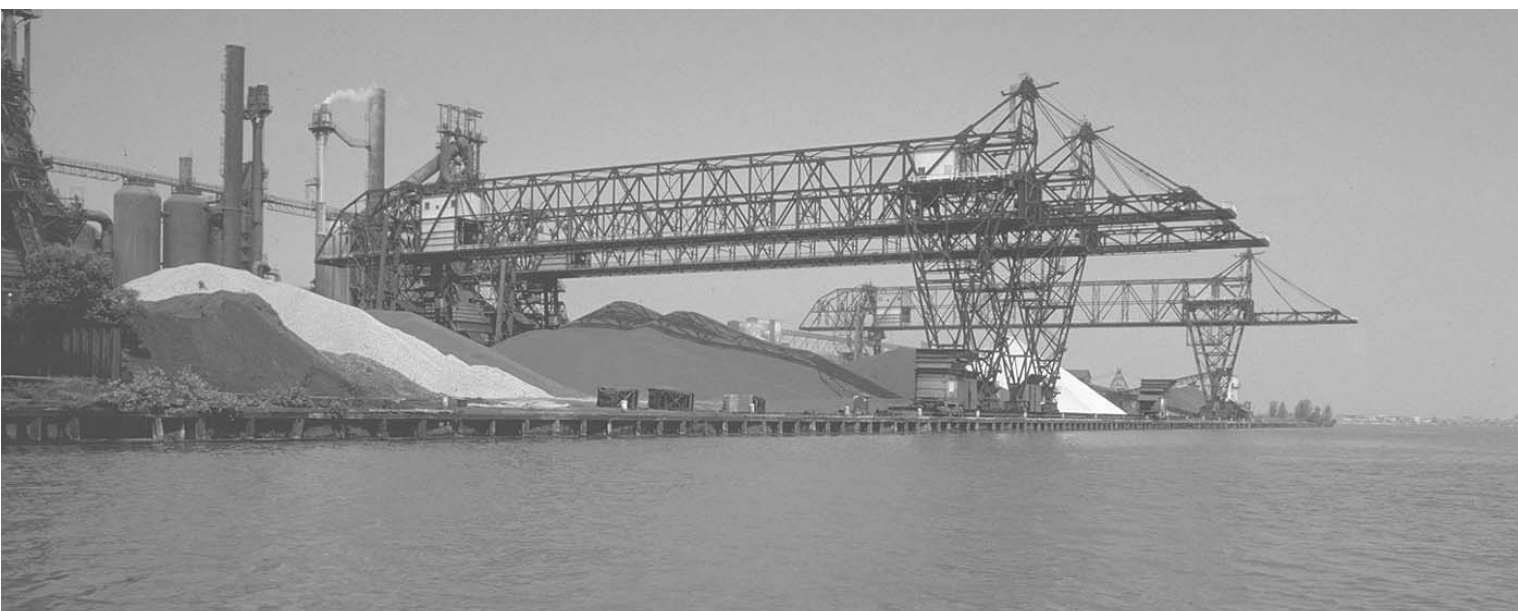
Source: Institute for Agriculture and Trade Policy, 2002

# RESEARCH PRIORITIES: WHAT ARE THE IMPACTS OF FOOD PRODUCTION ON WATER AVAILABILITY?

Despite critical connections between agriculture and ecosystem health, not enough is known regarding the impacts of agriculture on water budgets in the Great Lakes Basin. Although the cumulative impacts of increasing water use are not fully understood, ecological impacts in the basin have already been severe. In a future environment of increasing population and decreasing water availability, policy options that may have seemed too costly or politically impossible to implement in the past may need to be reconsidered. In order to do so effectively, considerable research is necessary. Until key questions regarding the relationship between agriculture and water quantity can be answered, strong conservation strategies and a precautionary approach to water quantity management is needed to protect and enhance the Great Lakes for years to come.

To better understand the implications of potential policy decisions, numerous research gaps and data needs must be addressed, including:

- the need to define the current and future role of agriculture as related to water quantity in the basin;
- the need for multi-scale, geography-specific analyses which include both macro (watershed/region) and micro-levels (sub-region/local); and
- the need for improved data to develop alternative future agriculture, environment, trade, and water quantity scenarios to better understand the implications of potential policy decisions and to improve overall management of the system.



# RECOMMENDATIONS FOR IMPROVED WATER QUANTITY MANAGEMENT



Agriculture dominates land use and consumes more water than any other consumptive use in the Great Lakes Basin. The use of considerable amounts of freshwater for irrigation and livestock production, more than half of which comes from groundwater sources, is weakening nature's ability to replenish the lakes, placing both ecological and human communities at risk. Population growth, land use and climate change, and the ongoing threat of water exports, diversions, and trading all pose enormous threats to the resources and ecological integrity of the Great Lakes.

## RECOMMENDATIONS FOR IMPROVED OVERALL MANAGEMENT OF THE GREAT LAKES ECOSYSTEM INCLUDE:

- developing an integrated basinwide water quantity management strategy, based on sound conservation principles (as outlined in Annex 2001), that accounts for the role of agriculture;
- implementing a targeted research agenda for agriculture, trade, and water quantity management;
- improving data quality, monitoring, availability, and presentation (for example: expanded utilization of geographic information systems for improved decision-making, analysis, and Web-based data sharing);
- improving public outreach, communication, and education regarding the state of the Great Lakes environment;
- improving product development (for example: providing all Great Lakes water quantity information via one bi-national, centralized Web site; creating a geographically-based Great Lakes Water Atlas); and
- establishing water quantity issues as an agricultural policy priority.

## NEXT STEPS

The Institute for Agriculture and Trade Policy is leading a project to increase overall understanding of the relationship of agriculture, the environment, and trade to surface and groundwater management in the Great Lakes Basin. The objectives of the project are:

- to assess the current state of research;
- to identify gaps in knowledge;
- to begin addressing these knowledge gaps by commissioning new research; and
- to disseminate accumulated information through briefings and publications.

By conducting research, holding workshops, and communicating with water quantity professionals, IATP has begun to collect relevant research, identify data gaps, and increase dialogue on these issues, some of which is highlighted in the enclosed report. IATP is interested in furthering dialogues between and among agricultural and other stakeholders of the Great Lakes Basin about water quantity, availability, and conservation issues. If interested in these discussions or further information on this project, please contact Jim Kleinschmit at [jim@iatp.org](mailto:jim@iatp.org).

## REFERENCES

See: Impacts of Food Production to Water Quantity in the Great Lakes-St. Lawrence River Basin: Outlining a Research Agenda for Agriculture, Trade, and Water Quantity Management. Bibliography, Part XIV. [CD attached].

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