WATER RESOURCES POLICY ISSUES IN ILLINOIS

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Introduction and Environmental Background

Illinois is uniquely blessed with fresh water resources. Hundreds of miles from the sea, it is in Illinois that the Great Lakes-St. Lawrence Seaway connects with the Mississippi-Ohio River system via the Chicago Sanitary and Ship Canal and the Illinois River through the heart of the state. The navigable Wabash, Missouri and Tennessee Rivers also border Illinois or terminate at its borders giving Illinois superb overall water-based transportation access exceeded in tonnage shipped among U.S. states by only Alaska and Louisiana. Notwithstanding the serious drought Illinois is suffering in 2005, Illinois receives abundant and reliable precipitation, under the current climatic regime, with no dry season and a favorable annual range from 35" in the northwest to 45" in the south. This hydrography, combined with the fertile agricultural soils left by the Illinois and Wisconsin glaciations, gives Illinois one of the most favored geographies in the world.

Yet Illinois and its neighboring Midwestern states face substantial water resources problems that form policy challenges and dilemmas. These stem primarily from the complex interplay between agriculture and water quantity and quality, but also involve other water uses such as cooling of thermoelectric power plants, how to meet the growing water needs of metropolitan Chicago, and how to handle the substantial risk of damages from floods that goes hand-in-hand with living along major navigable rivers.

Water Uses in Illinois

If we consider only water withdrawn from rivers, lakes and aquifers, cooling water for thermoelectric power plants is by far the largest use of water in Illinois with 84 percent of all withdrawals. This is contrary to many drier western states in which irrigation constitutes the largest portion of water withdrawals. Most of Illinois' power plants are located on Lake Michigan, the Mississippi, Ohio, or Illinois rivers and employ once-through cooling systems that take advantage of these abundant water sources and return nearly all the water withdrawn, albeit at an elevated temperature. Power plants not located on these sources employ more expensive cooling towers to reduce their water withdrawals (Yang, 2003), but at the expense of increased evaporation and less water returned to the source. Water supplies for cities, towns and rural areas constitute most of the remaining withdrawals through public water supply systems, or self-supplied commercial, industrial or domestic systems. The majority of water withdrawn for these uses is returned to waterways via wastewater treatment plants. Total withdrawals in Illinois are expected to increase by 28 percent from 2000 to 2025 (Dziegielewski, 2005). Interestingly, direct withdrawals is the part of the water cycle that has been most carefully measured.

A broader view of water uses based on the work of Swedish hydrologist Malin Falkenmark gives a substantially different picture (Figure 1). Of all the precipitation falling on Illinois, the largest portion is rainfall falling on crops such as corn and soybeans during the growing season of April-October. This water is transpired to the atmosphere by those crops as a necessary part of their growth process. The total amount of water used annually for rain-fed agriculture is roughly 14 *trillion* gallons or 148 million cubic meters per day (one m^3 is equal to 264.2 gallons), more than twice all water withdrawals and many times all water consumed (i.e. evaporated or transpired to the atmosphere and removed from the state) for all other human uses. This water is "embedded" in the crops that rely upon it, crops that are a foundation of the Illinois economy. Importantly, rain falling on agricultural fields that is not transpired by crops runs off to streams or percolates to aquifers carrying with it sediments, nutrients and pesticides – Illinois's largest water quality problem. High rates of runoff from impervious urban areas also contribute to non-point source pollution, better termed "polluted runoff." The remainder of precipitation falling in Illinois is either transpired by non-agricultural ecosystems, recharges aquifers, or flows to streams and rivers. All of these are essential ecological uses of water, especially because runoff and recharge from non-agricultural rural lands such as forest or less intensively farmed areas such as pasture tends to be of much higher quality than water from cropped fields and urban landscapes.

<u>Virtual Water</u>

Tony Allan's (Kings College, London) concept of "virtual water" helps us understand Illinois' role in the global water balance. Consider that the average person requires about 1 m^3 of water per year for drinking, 50-100 m^3 for other domestic purposes, but over 1000 m^3 to produce the food that they eat (Allan, 2001). World average per capita water use is 1243 m^3 in the 1997-2001 period; the U.S. average is 2482 m^3 with the difference primarily due to American's high consumption of industrial goods and, especially, meat (Chapagain and Hoekstra, 2004). Given these water needs, several Middle Eastern and North African countries ran out of water decades ago. How then do they survive and continue to grow in population? In general, they do not import water, which is very expensive given water's low value per unit volume and most countries' unwillingness to export water directly. Rather, they import food derived from crops that require large quantities of "green" soil water -- concentrated over 1000-fold in grain and other commodities. As world averages, paddy rice requires 2291 metric tons (equivalent to a cubic meter) of water per ton of grain produced, wheat 1394 m^3, soybeans 1789 m^3, corn 909 m^3, cotton lint 8242 m^3, coffee 20,682 m^3, chicken meat 3918 m^3, and beef 15,497 m^3 (Chapagain and Hoekstra, 2004). It has been through rapidly increasing imports of basic foodstuffs such as grain grown in more humid regions that Middle Eastern and other water-short countries have managed to survive domestic water deficits. Israel imports 87 percent, Jordan 91 percent and Saudi Arabia 50 percent of their grain supply (Lomborg, 2001). Japan and several European countries are also large net virtual water importers through imports of grain and manufactured goods.

Illinois, uniquely among the world's regions, represents the other end of this global water inter-dependency. In 2001, 1625 cubic kilometers of virtual water were traded internationally, 58 percent embedded in crops, 18 percent in livestock products, and 24 percent in industrial goods (Chapagain and Hoekstra, 2004). For this paper, I did a *rough* calculation of Illinois agricultural virtual water exports. Illinois farm sales in 2002 were $7.68 billion, and exports were $3.14 billion; exports were therefore 41 percent of production. Of the 54 million m^3 that are transpired annually by crops grown in Illinois, roughly 24 million m^3 is Illinois' virtual water exports from crops alone. This is equivalent to 24 cubic kilometers per year of virtual water exports, about 16 percent of all precipitation falling in the state, or the mean flow of the Illinois River. The U.S. leads all nations of the world by exporting 229 cubic kilometers per year; Illinois crops then account for 11 percent of U.S. virtual water exports. Illinois' 24 km^3/yr is at least half that of any other nation except Canada (95 km^3/yr), Australia (73 km^3/yr), Brazil (68 km^3/yr), or Argentina (51 km^3/yr) (Chapagain and Hoekstra, 2004). Rainfed agriculture and virtual water exports thus dominate the human use of water in Illinois and are a foundation of the state's economy as well as a major component of its hydrology.

Illinois Watersheds and Illinois Agriculture

Due to the simple fact that water runs downhill, surface water is organized into readily identifiable river basins, whose sub-components are termed watersheds. The quantity and quality of water in streams and rivers is determined by the climatic conditions and land uses within its watershed or basin (Table 2). Therefore, water quality, as well as water quantity, is largely a land use issue that is analyzed at a watershed scale. In Illinois, only a slim sector bordering Lake Michigan is in the St. Lawrence River Basin, while 99 percent of Illinois lies in the Mississippi River Basin – either its Ohio or Upper Mississippi sub-basins. The Wabash (to which flow the Little Wabash and Embarrass Rivers) and Cache River watersheds are subsets of the Ohio River Basin, while the Rock, Kaskaskia and Big Muddy watersheds are subsets of the Upper Mississippi Basin. The Illinois River forms a large basin within the Upper Mississippi and contains eight major tributary watersheds (Sangamon, Kankakee, Des Plaines, Fox, Mackinaw, Vermilion, Spoon and LaMoine watersheds) (Figure 2) and over 90 percent of Illinois' population.

Watersheds can be usefully conceived as geographic units of natural capital and of the production of ecosystem services from this natural capital. Ecosystem services are the non-market benefits humans derive from ecosystems such as the processing of waste, the production of soil, oxygen, and wildlife, and maintenance of the hydrologic cycle, nutrient cycles, and climate. Costanza et al. (1997) have conservatively estimated the global value of ecosystem services as US $16-54 trillion; the estimated global gross product in 1997 was $25 trillion. Landscape elements within watersheds, such as wetlands, produce a range of ecosystem services. Wetlands provide wildlife habitat, store flood waters and sediment, sequester atmospheric carbon, and denitrify runoff. However, of the approximately 8 million acres of wetlands in Illinois during pre-settlement times, covering 23 percent of the state, less than 1 million acres, or 10 percent of the original area, remain. While the marshes of eastern Illinois were once the dominant wetland type, the majority of remaining wetlands are bottomland forest with the greatest concentration in southern Illinois (Suloway and Hubbell, 1994). A century ago, wetland drainage was a mission driven by malaria control and the development of agricultural land. Illinois enacted legislation authorizing the formation of drainage districts in 1878. By 1959, 5,661,468 acres were included in drainage districts with a peak of 1.5 million acres drained in the decade 1900-1909. Over 9 million acres of Illinois farmland, 31 percent of the total, are drained by tiles and ditches (McCorvie and Lant, 1993) and 90 percent of Illinois' wetlands have been lost, primarily to agricultural drainage (Lant et al., 1995).

A second arena in which the interface between agriculture and water forms a policy challenge is the case of large-scale livestock production. U.S. livestock generate 1.8 billion tons of waste annually, a dozen times what humans produce. Between 1997 and 2002, the number of pigs, the most important livestock animal in Illinois, declined from 4,677,231 to 4,094,706 but the number of pigs in confinements of 1000 head or greater increased from 3,227,938 to 3,352,399 (USDA, 2005). The percentage of Illinois pigs being raised in large confinements thus increased from 69.0 percent to 81.9 percent in just these five years. This trend of increasing concentration of livestock also holds for cattle and chickens. Beyond considerations of animal welfare, raising livestock in close quarters requires routine use of antibiotics whose effectiveness in fighting human diseases is facing increased bacterial resistance. Confined animal feedlot operations (CAFOs) also concentrate animal manure and the nutrients it contains relatively far from crop fields that require these nutrients. Crop farmers instead rely increasingly on chemical fertilizers. In this way, the on-farm cycling of nitrogen and phosphorus from field to crop to livestock to manure and back to field has been broken with an increasing overall load of nutrients in aquatic ecosystems from the combined effects of fertilizer and manure run-off in addition to natural sources.

The run-off and infiltration to groundwater of agrichemicals forms a third policy challenge. Illinois and Iowa lead all states in application of herbicides, insecticides, nitrogen, and phorphorus, four of the leading water pollutants in the U.S. (U.S. Geological Survey, 1999). Resulting high levels of nitrates in groundwater have been associated with methemoglobinemia, or blue-baby syndrome. Far downstream, over the past two decades the northern Gulf of Mexico has developed a New Jersey-sized "hypoxic" zone in which low oxygen concentrations reduce or eliminate fish and shrimp life. Hypoxia is a form of marine eutrophication where excess nitrogen loads from the Mississippi River Basin cause high rates of algae growth, which then consume oxygen when they decompose. Runoff from fertilizers and concentrated livestock manure in Illinois, Iowa, and parts of Indiana, Ohio and Minnesota are the primary sources of nitrogen (National Science and Technology Council, 2000). Increased nitrogen flux to the Mississippi has been found to be associated with wetland drainage, high rates of fertilizer application, and concentration of livestock manure. The NSTC study found that nitrogen management on farms, where farmers would reduce "insurance" rates of fertilizer application, credit sources of nitrogen other than fertilizer, and improve management of runoff from feedlots, has the greatest potential to reduce nitrogen flux from farms to waterways. Along with wetland restoration, on-farm nitrogen management was also found to be the most cost-effective means to reduce nitrogen delivery to the Gulf.

The Current Policy Landscape

Agricultural Policy and Illinois Water Resources

Because of the interplay between agriculture and water resources, Federal agricultural policy is a particularly important political arena for water resources issues in Illinois. On May 13, 2002 President Bush signed the Farm Security and Rural Investment Act of 2002 – the 2002 Farm Bill. From the 1930s through 1996, the U.S. Department of Agriculture (USDA) administered a program of price supports. Under this policy, USDA sets a target price that is designed to prop-up prices that farmers receive for key commodities during times when prices are low as a means to support farm income. In Federal Fiscal Year 2002, for example, USDA distributed $7.3 billion in farm program payments, (http://www.fsa.usda.gov/pas/farmbill/fb2002_ anniversary.asp). Price supports affected Illinois water resources in a number of ways through their effect on farmers' land use decisions. In order to maintain base acreage eligible for subsidy programs, farmers maintain fields in rotations that include program crops (corn, wheat, barley, and since 2002, soybeans) rather than experimenting with alternative uses of their land. Since the profit-maximizing level of fertilizer application increases when the price farmers receive for crops increases, price supports encouraged high levels of fertilization. Finally, high outputs of basic feed grains such as corn lower the price paid for these inputs by livestock producers, thereby decreasing the price of meat, increasing market demand and production of beef, pork, and chicken and, therefore, of livestock manure.

Given these and other concerns, Congress in the 1996 Farm Bill modified the price support system into a system of market transition payments that was designed to "decouple" subsidies from the production of specific crops on specific lands. Congress based this action on an assumption that decoupling would lead to farmers following market trends more carefully when choosing crops to produce, possibly leading to a significant shift in cropping patterns, a reduction in long-standing program crops such as corn and wheat, and also a possible reduction in agrichemical applications. Transition payments would ultimately be phased out as farmers found profitable alternatives. However, none of these anticipated responses manifested and Congress partially retreated in the 2002 Farm Bill to reestablish the base acreages and yields from the pre-1996 price support system. The manner in which the federal government supports farm incomes thus remains a key water resources policy lever in Illinois.

Since the 1985 Farm Bill, agricultural conservation policy has also been a critical component of the policy framework governing water resources in Illinois. In 1986 the Conservation Reserve Program (CRP) began accepting bids from farmers to retire highly erodible lands from crop production for ten years. By 1988, over 30 million acres were enrolled nationwide at an average annual rental rate of a little over $50/acre. The CRP has been evaluated as a success because it has substantially reduced soil erosion nationwide, has supported farm income and has generated economic benefits far in excess of program costs when the environmental benefits of the program are included along with the effect the CRP has on decreasing crop surpluses, increasing crop prices, and thus decreasing price support payments (Ribaudo et al., 1990). However, the targeting of lands for CRP enrollment has been a matter for political contests in Congress. Initially, with both Senate and House leaders coming from Great Plains states, CRP rental rates in those states were very competitive with rental rates that landowners charge farm operators. As a result, the majority of CRP enrollments occurring in Great Plains states and the program targeted cost-effective erosion reduction rather than other environmental objectives such as reduction of non-point source water pollution. In the 1990 Farm Bill, wetlands and filter strips along streams were added as eligible land, and in 1997 special incentives under the continuous CRP were granted for water quality buffers resulting in 1.72 million acres or, at a width of 66 feet, over 200,000 linear miles of streamside land being enrolled.

The USDA now uses an Environmental Benefit Index (EBI) in determining which bids will be accepted. The EBI is a key element in the USDA rules-making process because it encapsulates the environmental priorities of the program and the structure of the EBI largely determines the proportion of the $1.7 billion in annual CRP payments each state and Congressional District will receive. East-of-the-Mississippi and water quality-oriented interests have thus far made only minor gains in the cost-effective erosion control emphasis that has locked 74 percent of CRP acres and 68 percent of CRP payments in states between the Mississippi River and the Rocky Mountains.

Illinois has joined several states in dovetailing state-based conservation programs to the CRP. The Conservation Reserve Enhancement Program (CREP) adds additional state incentives to CRP payments in order to encourage farmers to bid lands with defined environmental characteristics into the CRP. With over 100,000 acres, Illinois is second only to Pennsylvania in CREP enrollments. In this manner, state investments in conservation have successfully leveraged and targeted federal dollars.

The Wetland Reserve Program (WRP), initiated in the 1990 Farm Bill, is also a positive economic incentive program, but rather than annual payments, the WRP pays farmers a lump sum, averaging about $1400 nationwide, for 30-year or permanent easements. Congress initially set a one million acre limit on WRP, but bids from farmers have far exceeded this amount. Thus enrollments in both CRP and WRP are limited by Congressional appropriations and USDA rulemaking rather than by farmer demand for these conservation programs.

In the 2002 Farm Bill, the Comprehensive Conservation Enhancement Program maintained a 39.2 million acre Conservation Reserve Program (CRP) and makes water quality and wildlife enhancement co-equal with erosion control in considering enrollments. As of this writing, 34.8 million acres in 687,000 contracts were enrolled nationwide at an average annual rental rate of $48. Illinois has just over one million acres enrolled, concentrated in western Illinois counties, at an average annual rental rate of $102/acre (the difference reflecting the high productivity of Illinois croplands) for a total of $104 million/year in federal CRP payments. It expands the Wetlands Reserve Program (WRP) acreage cap to 2.275 million; 1.47 million acres are currently enrolled. It provides $4.6 billion in additional funding for the Environmental Quality Incentives Program (EQIP). The greatly expanded EQIP adds surface and groundwater conservation to the purposes of the program providing $600 million for water conservation and incentive payments for comprehensive nutrient management plans. The new EQIP targets 60 percent of funding to livestock water quality concerns and removes prohibition against cost-sharing for waste storage facilities for large confined animal feedlot operations (CAFOs) with a $450,000 limit per producer. From a water resources perspective, the increase in federal subsidization for practices that improve water quality is laudable; however, EQIP in particular raises issues of whether the U.S. taxpayer should be paying for solutions to pollution in livestock rearing or whether this should be the responsibility of industry as is generally the case outside of the agricultural realm.

The 1985 Farm Bill also set new standards with cross-compliance -- environmental criteria that must be met if farmers are to remain eligible for USDA benefit programs. Sodbuster requires that farmers not plow new highly erodible lands without an approved soil conservation plan. Swampbuster requires that farmers not drain additional wetlands. Conservation compliance requires that farmers adopt a soil conservation plan approved by the Natural Resources Conservation Service (NRCS). These programs have been controversial with the farm community that sees itself as environmentally responsible and dependent on USDA subsidy programs and therefore regulated if strings are attached to benefits. The NRCS has also viewed itself as a disseminator of technical information and as a facilitator in the implementation of practices such as conservation tillage and not as an environmental regulatory agency like EPA. Given this, the strictness with which these conservation compliance programs have been applied has varied over both time and space reflecting local political and environmental circumstances (Kraft, 2003). Conservation Compliance is thus not currently an important policy tool for improving water quality.

In Illinois, Soil and Water Conservation Districts (SWCDs), largely county-based institutions authorized by the state, were charged with the task of reducing sediment loss from all crop fields to a “tolerable” level (T) by the year 2000. Tolerable soil loss (T) is defined as the maximum amount of topsoil that can be eroded per acre without a reduction in long-term soil productivity (Walker and Pope, 1983). Illinois adopted a step-by-step program in 1980 to make all farmland comply with the T-value restriction by the year 2000 (Illinois Dept. of Agriculture, 1980). The major milestones in this program set goals of 4T by 1983, 2T by 1988, 1.5T by 1994 and T by 2000. Similar programs have also been implemented in other Midwestern states with mixed success.

Environmental Policy and Illinois Watersheds

The Clean Water Act is, of course, critical in governing Illinois’ water resources. The relationship between this landmark legislation and the quality of water in Illinois is, however, not straightforward. By requiring that the best available technology be used in improving the quality of effluents, and by providing cost-share funding for the construction of sewage treatment plants for American cities and towns, the Clean Water Act has been an environmental success story in reducing point-source water pollution. For Illinois, the Ohio and Illinois Rivers and Lake Michigan have particularly benefited.

Unfortunately, most water pollution in the U.S., and especially in Illinois, is non-point (storm runoff from urban and cropped areas that is contaminated with sediment, nutrients and other pollutants). Non-point source pollution constitutes one of the most formidable environmental policy challenges in Illinois and throughout the Midwest. Section 303(d) of the Clean Water Act contains a provision for Total Maximum Daily Load (TMDL) that requires states to identify watersheds that fail to meet “designated uses” and to develop and implement watershed-scale management plans for reducing pollution loads to within TMDL levels. TMDL has been the subject of a great deal of political activity since environmental groups began filing lawsuits in the mid-1990s against EPA for ignoring section 303(d) as the Clean Water Act’s primary regulatory approach to non-point source water pollution. In 2002, Illinois reported to the U.S. EPA on watersheds and water bodies requiring TMDLs. Nutrients and sediment, classic problems of agricultural run-off, lead the list of 3480 TMDLs, along with heavy metal runoff from mining and industrial areas and habitat alterations stemming from dams, levees, navigational structures, wetland drainage, and other engineering interventions in the hydrologic system (Table 3).

The political future of TMDLs as the primary regulatory approach to non-point source water pollution control in the U.S. is uncertain. Few TMDLs have been implemented to date. The approach has faced scientific problems because polluted run-off is associated with heavy precipitation events and is therefore episodic and not “daily” as described in the Act. It is difficult to attribute pollutants to specific areas of land within a watershed. The effect on pollution loads of implementing Best Management Practices (BMPs) such as conservation tillage or streamside filter strips on specific lands is difficult to ascertain, and computer simulation models must often be used despite suffering from a lack of data for calibration and validation. These issues only begin to illustrate the scientific challenges described in the 2001 report commissioned by the National Research Council (Committee to Assess the Scientific Basis of the Total Maximum Daily Load Approach to Water Pollution Reduction, 2001). While most scientific analysis is fraught with uncertainty, the level of uncertainty in establishing these relationships makes it difficult for regulatory bodies to defend their actions in implementing TMDLs against legal challenges from landowners, farm operators, developers, and others whose profits could be diminished by TMDL plans. As of this writing, this author's best guess is that few TMDLs, as they are currently conceived, will ever be implemented, despite the fact that non-point source pollution is a leading environmental problem. The reason for this lies in the lack of public acceptance of, and political machinery for, land-use control outside of urban zoning contexts, the strength of agricultural lobbies to block controls on agricultural land-use, and the weakness of state and local institutions for governing watersheds in most U.S. states, including Illinois.

A second point of contact between the Clean Water Act and agriculture, the leading source of water pollutants in the U.S. and in Illinois, is regulation of confined animal feedlot operations (CAFOs) as point sources similar to sewage treatment plants. The 100-page EPA final rule on CAFOs, NPDES Permit Regulation and Effluent Limitation Guidelines and Standards for CAFOs, was published Feb 12, 2003 after considering 11,000 comments submitted by the public (Federal Register, 2003). There are over 15,000 CAFOs in the U.S. producing 300 million tons of livestock manure annually, plus an additional 200 million tons produced by smaller scale animal feedlot operations. These 500 million tons per year of confined livestock manure can be compared to 150 million tons of human waste managed through sewage treatment plants, septic systems and other means that are the core of the NPDES system for point sources.

The CAFO rule focuses on the spatial problem of concentrating manure-borne nutrients in the Atlantic coast region from PA south to GA where there is insufficient cropland to utilize them, and solving this problem through comprehensive nutrient management plans and regulations governing the land application of manure. Under the rule, CAFOs are obligated to apply for an NPDES permit as point sources. The rule emphasizes cooperation between EPA and USDA and the critical role of states in managing the NPDES system. Currently, 45 of the 50 states have acquired the authority to manage NPDES permits and 18 have authorized the formation of tradable pollution permit systems, although few water pollution trades of any kind have occurred to date (Anebo, 2005). EPA officials drafting permits also have a degree of autonomy in using "best professional judgment" in the development of nutrient management plans.

The CAFO rule was long overdue and represents the "low-hanging fruit" of agricultural impacts on water quality. It addresses the issue through the traditional regulatory machinery of the Clean Water Act, but does not address the economic driving forces that have led to the rapid concentration of livestock and the uncoupling of centuries-old agricultural nutrient cycles. Economic incentives such as taxes on nutrients and credits for carbon sequestration may be needed in combination with the CAFO rule to manage an environmental challenge of this magnitude, but more fundamental issues remain. Should livestock manure be transported interstate from CAFO-rich regions to crop-growing areas? Even more fundamentally, should the concentration of livestock in large confinements in order to gain small economies of scale be reversed? Would economic forces generate this result if all external environmental costs in livestock production were internalized, that is if feedlot operators had to pay for waste management?

A third point of contact is section 404 of the Clean Water Act that regulates the conversion of wetlands to other uses, while granting exemptions for agricultural and forestry activities. Several cases in the 1990s involving section 404 found their way into the U.S. Supreme Court in a classic environmental conflict. The arguments on the side supporting restrictions on wetland conversion cited:

(a) an abundance of scientific evidence emphasizing the critical role of wetlands in regulating and supporting ecological and hydrological functions,

(b) the constitutional police powers of government to protect the public welfare (including the public trust doctrine, navigation servitude, and commerce clause), and

(c) the political acceptance of existing environmental regulations and local zoning ordinances, regulations that are legally similar to wetland protection laws.

However, strong resistance was mustered from landowning interests who cited:

(a) the economic costs of wetland protection, and

(b) the Fifth Amendment of the Constitution protecting private property from public confiscation (the "takings" doctrine).

At the core of this conflict is a question of property rights -- does the owner of a wetland have the right to alter that wetland for his or her own purposes? Or does the public have the right to the ecosystem services of the wetland? This struggle over ecosystem services found its way into a struggle over the legal definition of wetlands when the first Bush administration's attempts to change the criteria used to map wetlands resulted in a greater number of public comments than any federal rulemaking event to date (Hays, 1997). Landowners claiming that "regulatory takings" so diminish the profitable uses of their property, without physically confiscating it, that government has violated the Fifth Amendment continue to play a role in wetlands, as well as in endangered species, and other environmental laws.

Importantly, the rate at which wetlands were drained for agricultural production dropped 87 percent from 237,000 acres/year in the decade 1974-1983 to 30,900 acres/year in the decade 1983-1992 (Wiebe et al., 1996) and have remained low. The reasons for this remain obscure, but candidate hypotheses include (1) the Swampbuster provisions of the 1985 and subsequent farm bills, (2) the section 404 program, (3) low prices for crops that could be grown on drained wetlands, (4) the lack of remaining wetlands in agricultural areas, (5) changes in farmer attitudes and knowledge, and (6) different combinations of these in different places. Together with WRP, wetland mitigation banks, and other programs, the goal of "no net loss" of wetlands embraced by the 1998 Wetland Policy Forum has been nearly achieved nationally and may have been achieved in Illinois.

Finding Joint Solutions through Innovative Policies

In painting the mosaic that constitutes the policy arena for water resources in Illinois, it is clear that there is a lack of policy coordination. Federal policies are sometimes inconsistent with those at the state and local level; agricultural policy is at odds with environmental policy. In this section I will explore opportunities for realigning policies in ways that would help resolve Illinois' water resources challenges. These opportunities lie primarily in three areas: (1) agricultural subsidization and conservation policy, (2) recognizing the importance of virtual water, and (3) watershed governance.

Agricultural Subsidy-Shifting and Tax-Shifting

A different approach to farm policy that could better address water resources issues could be termed "subsidy shifting." Since the 1996 Farm Bill, federal subsidies have averaged $14.8 billion per year with a peak of $27.8 billion in Federal Fiscal Year (FFY) 2000 (www.aes.purdue.edu/aganswrs/2000/11-17%20Farm_Bill.html, 11/17/2000). The 2002 Farm Bill calls for over $100 million over six years in a return to price supports. In FFY2002, USDA distributed $7.3 billion in farm program payments, $1.6 billion in conservation funding, and $2 billion in loan funds (http://www.fsa.usda.gov/pas/farmbill/fb2002_anniversary.asp). Subsidization of European farmers is also at very high levels, and the issue of transforming their subsidies to the benefit of the environment is also at issue. Recent reforms in the Common Agricultural Policy (CAP) decouple farm subsidies from the production of specific crops and emphasize stringent cross-compliance along with expanded subsidies for environmental services, thus moving these subsidies from the "Blue Box" to the more flexible "Green Box" in WTO negotiations (http://europa.eu.int/comm/agriculture/envir/index_en.htm).

Agricultural subsidization at these high levels makes relevant the issue of shifting from crop-based subsidies to ecosystem service-based subsidies for a number of reasons.

(1) These subsidies establish that markets for most primary agricultural commodities suffer from surplus supply causing low prices that undermine profitability. The reduction in output of subsidized agricultural commodities that may occur with a reallocation of farmland from commodity production to co-production of ecosystem services would lead to reduced surpluses and increased market prices. In this way the need for crop-based subsidies would be reduced by ecosystem service payments.

(2) Some ecosystem service payments are legitimate under the Uruguay Round of the General Agreement on Tariffs and Trade/World Trade Organization negotiations whereas direct crop subsidies are viewed as protectionist.

(3) Taxpayers would obtain greater public benefits from the subsidies tied to the production of public benefits in the form of ecosystem services.

(4) Within the U.S., the willingness of Congress to allocate crop subsidies at an annual rate equivalent to over $50 per U.S. citizen establishes the willingness of taxpayers to allocate public funds to the agricultural sector of the economy.

Tilman et al. (2002), in their excellent synthesis in *Nature* on "Agricultural sustainability and intensive production practices" also conclude that "Sustainable agriculture will require that society appropriately rewards ranchers, farmers, and other agriculturalists for the production of both food and ecosystem services. One major step would be achieved were agricultural subsidies in the United States, EU and Japan redirected to reward sustainable practices. (p.676)" States can dovetail on federal initiatives as is currently the case with CREP programs.

A second approach at the state level is "tax shifting." In 2004, Governor Blagojevich proposed to eliminate the sales tax waiver on fertilizers and some other farm inputs in order to help stabilize the state budget. However, since fertilizers are a primary source of ground and surface water pollution, a major external cost of crop production, there is justification not just for applying sales tax, but for an additional excise tax on fertilizers, similar to that on gasoline or alcohol, as an inducement to limit application, within the confines of relatively inelastic demand for fertilizers that makes farmers' response to fertilizer price increases fairly limited. This approach would also create a fund for policies such as wetland restoration or CREP that are the best means to combat polluted runoff, and thereby also recycle tax funds into the Illinois farm economy. Flood-prone lands could also be purchased from willing sellers. The argument against this approach would be that fertilizer taxes would disadvantage Illinois farmers, but ecosystem service payments of various kinds can counter-balance the effect of regulations and negative economic incentives on farm incomes. For example, Lant et al. (2005) found that regulations limiting soil erosion rates to T do not diminish farm income so long as the CRP is available as an alternative income source.

Policies that incorporate the notion that farms can be "multi-functional" producers of not only food commodities, but also ecosystem services such as cleaner water and wildlife habitat will help achieve multiple goals rather than maximizing food production at the expense of other goals. An important example is the role of farmland as a storehouse for carbon that would otherwise accumulate as carbon dioxide and methane in the atmosphere. Lal et al. (1998) estimate that agricultural lands currently emit 7 percent of the U.S. total for greenhouse gases, but could sequester a net 5-14 percent with reasonable changes in farming practices that restore soil organic carbon with side benefits in the form of improved soil productivity and flood water retention. Land-based carbon sequestration is allowable without a cap under the specifications agreed to in Bonn in 2001 on implementation of the 1997 Kyoto Protocol. The key to achieving multi-functionality is to redesign the economic incentives appurtenant to farmers' decisions on how to use the land they own or manage in favor of ecosystem service production. While the growing number of organic farmers are exemplars of this principle, a shift is also needed in the vast majority of conventional farms.

<u>Appreciating Virtual Water</u>. The rough calculations presented above demonstrate the quantitative importance of Illinois' virtual water exports, both to the state's economy and to the nations and regions purchasing water-intensive products such as corn, soybeans, pork, and beef from Illinois. Yet, like many issues that lie embedded in the inter-dependent processes and material and energy fluxes of natural, agricultural and industrial ecologies, virtual water is not an active policy issue because it is not directly observable and does not provide fuel for journalists' reports. In what way is it politically relevant that Illinois stands out as a virtual water exporter as much as Israel and Saudi Arabia stand out as virtual water importers? First is the recognition that soil and climate have geographically favored Illinois in ways that are of tremendous economic and political importance. Climate change and soil conservation are therefore foundational issues in sustaining these comparative advantages. Second is the manner in which

Illinois' bounty of rainfed crop production is utilized as food for domestic human consumption, for export, for meat production, or marginally reduced in order to better facilitate ecosystem service production through organic farming or re-conversion of crop land to wetlands, riparian filter strips and other land uses that produce water quality, wildlife habitat, and carbon sequestration rather than crops. By and large, Illinois is maximizing meat production and the export of corn and soybeans, largely as livestock feeds. Is this the highest and best use of Illinois' unique natural resources, especially when red meat consumption has been associated with heart disease (Willett and Stamp, 2003) resulting in a major change in USDA dietary recommendations? Or could environmental quality in Illinois be considerably enhanced by marginally reducing cropped land in favor of ecosystem service production, especially at the water's edge, and reducing use of agrichemicals? Or could food for direct human consumption be increased, whether for export to hungry nations or for a healthier diet in the U.S.?

Governing Watersheds. Twenty-First Century water resources management challenges in the United States are shifting to management of land uses to prevent polluted runoff and groundwater contamination, restoration of the physical integrity of rivers to reverse declines in aquatic ecosystems, and protection of the natural capital assets of watersheds in order to promote delivery of ecosystem services. This shift in management challenges also requires a shift in institutional structures from a system of Congressional appropriations for largely federal civil and environmental engineering projects, as described by Reisner (1993) in *Cadillac Desert*, to a system of state-facilitated, locally-led watershed management. Watersheds are politically passive as compared to the private sector land owners within them as well as state and federal agencies (Figure 3). Herein lies the heart of the problem of watershed governance, a problem similar to that faced by unplanned suburbs. Watersheds define critical physical geographic units of the landscape, but landscape patterns at watershed scales reflect an aggregation of decisions made by individual landowners responding largely to economic and technological imperatives that manifest at national to global scales. Therefore, the primary factors that determine the ecosystem services produced by a watershed can barely be influenced by, no less controlled by, watershed managers.

Given this dilemma, the process of integrating watershed governance into concrete policy objectives has finally begun. The most recent Army Corps of Engineers Strategic Plan identifies environmental restoration on a watershed basis as one of its primary goals (Department of the Army, 2002). The U.S. EPA has recently committed itself to a "watershed or 'place-based' approach." At least 20 states have also adopted some form of statewide watershed management policy for purposes of managing at least some aspects of water quality protection. The National Research Council recently concluded that "many factors are converging to cause citizens, scientists, resource managers, and government decision-makers to look increasingly to watershed management as an approach for addressing a wide range of water-related problems" (National Research Council, 1999).

Over 1000 watershed-scale planning initiatives were started in the U.S. in the 1990s. Similar efforts have also appeared in Brazil and Australia. In 1991, New Zealand restructured environmental management along watershed lines. The modern watershed management movement represents numerous unique local efforts that seek to address on-going problems with non-point source pollution and aquatic ecosystem decline in an era of increasing local participation in natural resource management. With little funding or political authority, however, these groups face an uphill battle. Watersheds do not normally constitute formal, organized political jurisdictions. Hence resource planning groups, their planning processes, and their plans face the challenge of acquiring political legitimacy and legal authority. Adams et al. (in press) addresses these issues directly in a recent case study focused on the Cache River restoration efforts. In-depth interviews with participants in the planning process revealed that the process lacked legitimacy for many of the farmers involved. This view stemmed from two factors. First, not only were participants hand-picked rather than elected by SWCD districts, local elected officials were not involved at all. Second, TNC and NRCS defined the problem as concerning "resource management." Government agencies and TNC used the plan to enhance local federal expenditures on CRP, WRP, and land acquisition for the Cypress Creek National Wildlife Refuge, to considerable positive environmental effect, but local social issues were deliberately left out of the discussion, even though the Cache lies within the Mississippi Delta region where poverty rates and attendant social problems are among the highest in the U.S.

So how are watershed-based institutions to be empowered to tackle the steep challenges of watershed management while also building their local legitimacy to do so, keeping in mind that watershed-based political institutions must coexist with an amalgam of current local governmental institutions. In tackling this issue, Ruhl et al. (2004) identify five characteristics that a watershed-based institution must possess.

1. The institutional structure for watershed management must enjoy the type of power and authority generally associated with state government, but must also be capable of establishing democratically based legitimacy at local levels where many regulatory actions are implemented. Emphasizing the role of states inevitably results in 50 different solutions, but herein lies a tremendous opportunity to learn from the successes and failures among the states, ranging from Florida's powerful Water Management Districts to promising initiatives in Maryland, Nebraska, Oregon, Pennsylvania, Washington, Wisconsin, and other states.

2. The institutional structure must have the authority and the responsibility to manage watershed issues "holistically" on a system level (see Figure 1).

3. The institutional structure must rely on financing mechanisms (e.g., taxes, fees, surcharges, bonds) and compliance instruments (e.g. regulatory, incentives, reporting requirements) in addition to voluntary measures.

4. The structure must have the institutional capacity (i.e. budget, staff, and expertise) to carry out complex scientific, economic, and social analysis functions, and the responsibility to make policy and regulatory decisions through public, transparent procedures.

5. The institutional structure should be generalizable across watershed types, scales (see Figure 2), and political units, and the information gathering capacity and protocols should be standardized so as to allow sharing of information in both hierarchies (e.g., from watershed districts to the state) and networks (e.g., among states, local districts, the scientific community and the public).

The Illinois River Basin is currently Illinois' most important test of many of the issues raised in this paper. In 1908, the Illinois River supported more than 2,000 commercial fishing operations harvesting nearly 25 million pounds of fish, second only to the Columbia River as a river-based commercial fishery in the U.S. However, agricultural and industrial impacts and the introduction of invasive species have resulted in a loss of 67 percent of the fish species present in 1850 in what Karr et al. (1985) describe as “a history of degradation.” Sediment loads have multiplied and have become the most important environmental challenge in the basin (Demissie et al. 2004). Partly as a consequence, aquatic vegetation has been nearly eliminated (Illinois River Strategy Team, 1997). In 1996, Lieutenant Governor Bob Kustra Chaired a committee of over 100 people to develop an Integrated Management Plan that contains 34 recommendations containing a total of 121 action items covering issues in the riparian corridor, soil and water movement, agricultural practices, economic development, local action, and education. Illinois Rivers 2020 was subsequently developed in 1999 in order to develop new technologies and approaches to: 1) enhance navigation, 2) improve water quality, 3) protect farmland and open space, 4) implement land-use BMPs, 5) enhance habitat, and 6) increase economic opportunities (Illinois Department of Natural Resources, 2002).

With the backing of Republican Congressman Ray LaHood and Speaker of the House Dennis Hastert, the 2002 Water Resources Development Act provided $100 million over three years to fund the Illinois Rivers 2020 program. Participating groups included the Nature Conservancy, the Illinois Farm Bureau, Prairie Rivers Network, the Illinois Dept. of Agriculture, IDNR and IEPA, showing that politics does make strange bedfellows when a common enemy or, in this case, a chance to collaborate for federal funding arises. Among the projects made possible by this Act is the Illinois Rivers Decision Support System (IRDSS) developed by the Illinois State Water Survey (ISWS) and other state agencies. IRDSS includes GIS databases, simulation models, user interfaces, and a processing system for integrating these various components (Illinois Department of Natural Resources, 2002) placing it alongside work being done in the Everglades and Chesapeake Bay as among the most sophisticated scientific initiatives in watershed and river basin analysis in the U.S. Time will tell whether the Illinois Rivers initiative can surpass the very partial successes achieve to date by its sister endeavors in large-scale river basin restoration.

Conclusion

Illinois’ abundant and reliable water resources are a foundation of the state’s economy and its environment. Nevertheless, the difficult relationship between the Illinois economy and its water resources, and especially between water quality and agricultural production, generates several policy issues that manifest in different political arenas, from local-level watershed management, to state-level programs, to federal agricultural and environmental policy arenas. Given this kind of fragmentation, reforming policies governing Illinois’ water resources is complex, yet in this fragmentation also lies an opportunity to find reforms that are mutually beneficial to the varies parties involved.

At a deeper level, however, lies a recognition that water resources and other forms of natural capital are among the state’s greatest assets and that to protect and even augment those assets, policies need to provide signals and incentives that encourage investment in, not depreciation of, these assets. Unfortunately, there is a narrow range of circumstances under which resource managers are willing to make substantial personal investments in the present to achieve even more substantial public benefits in the future. Agricultural subsidy-shifting such as that now being carried out in Europe and state-level programs such as CREP that allow states to leverage federal programs to the accomplishment of state goals are just two examples of policies that fall within that narrow range to the benefit of Illinois water resources and its citizens.

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Table 1. Water withdrawals and uses in Illinois in millions of cubic meters per year; 2000 and predictions for 2025. Conversions to millions of gallons per day are shown in parentheses below for comparison to other studies. Rounding reflects the accuracy of the estimates.

Water Use Sector	**Estimated 2000 withdrawals m^3/y (Mgd)**	**Percent of withdrawals**	**Percent of human use**	**Percent of human and ecological use**	**Predicted withdrawals in 2025 m^3/y (Mgd)**
Thermoelectric generation	18,336 (13,272)	84.0	24.1	13.8	23,332 (16,889)
Public Supply	2,318 (1,678)	10.6	3.1	1.7	3,048 (2,206)
Self-supplied C&I	681 (493)	3.1	0.9	0.5	757 (548)
Irrigation	213 (154)	1.0	0.3	0.2	399 (289)
Self-supplied domestic	187 (135)	0.9	0.2	0.1	218 (158)
Livestock	52 (38)	0.2	0.1	0.0	58 (42)
Mining	32 (23)	0.1	0.0	0.0	94 (68)
Total withdrawals	**21,819 (15,793)**	**100**	**28.7**	**16.5**	**27,906 (20,200)**
Rain-fed agriculture*	54,000 (39,000)		70.9	40.6	-
Total human use	**76,000 (55,000)**		**100**	**57.3**	**-**
Ecological use**	57,000 (41,000)			42.7	-
Total precipitation	133,000 (96,000)				
Ecological re-use***	19,000 (14,000)				
Total use	**152,000 (110,000)**				**-**

Sources: Bennett and Hazinski, 1993; Dziegielewski et al., 2005; USDA, 2005.

* In making a rough and conservative estimate of water use in rain-fed agriculture, I used the lesser of rainfall or evapo-transpiration (the total amount of water transported to the atmosphere by a combination of plant transpiration and water surface evaporation) in each month in Springfield, IL from April to October when most crops are in the field. This estimate of 23.04 inches, water that drier states would need for irrigation, was then multiplied by 22.56 million acres of crops harvested in Illinois in 2002.

** Run-off to streams, percolation to aquifers and transpiration by ecosystems other than crops. Estimated as mean annual rainfall in Springfield less total human use.

*** Estimated as 14,000 Mgd return flows from withdrawals. This is equivalent to a consumption rate (due to evaporation) of 11% of withdrawals.

Table 2. Land uses in Major Illinois River Basins and for all of Illinois 1800 and 2005.

River Basin	**Area (km^2)**	**Agricultural**	**Forest**	**Urban**	**Prairie**[2]	**Other**[3]
Upper Illinois	17,607	73.4	4.8	18.6	0.0	3.2
Lower Illinois	46,393	85.9	7.8	3.7	0.0	2.6
Wabash	22,496	86.8	10.0	2.4	0.0	0.8
Lower Ohio	6,322	68.3	25.5	0.2	0.0	6.0
Kaskaskia-Big Muddy	26,020	76.4	16.5	0.3	0.0	6.8
Rock	13,840	90.9	3.9	4.1	0.0	1.1
Illinois Total[1]	145,741	81.9	10.1	5.2	0.0	2.8
Illinois in 1800[4]	145,741	0.0	38.2	0.0	61.2	0.6

[1]Includes several small basins not listed above. Excludes Lake Michigan.
[2]Includes substantial areas of wetland (marsh).
[3]Includes wetlands, water, rangeland and barren land.
[4] Source: Iverson et al. (1989).

Table 3. Causes of Water Quality Impairments in Illinois Waters (source: USEPA, 2003).

Impairment	**Number**	**% of Total**
Nutrients & Ammonia N	1149	33.0
Sedimentation & suspended solids	446	12.8
Metals	349	10.0
Low dissolved oxygen	296	8.5
Habitat alterations	240	6.9
PCBs	191	5.5
Algal growth	140	4.0
Other	509	14.6
Total	3480	100

Figure 1. Water flows and uses in Illinois showing the hydrological context of policy issues discussed in this paper. The width of flow lines is shown as approximately proportionate to the volume of water on an annual basis. Colors are consistent with Falkenmark's "green water" for rainfall transpired by plants, "brown water" for polluted runoff, "blue water" for clean runoff and water withdrawals and "gray water" for industrial return flows.

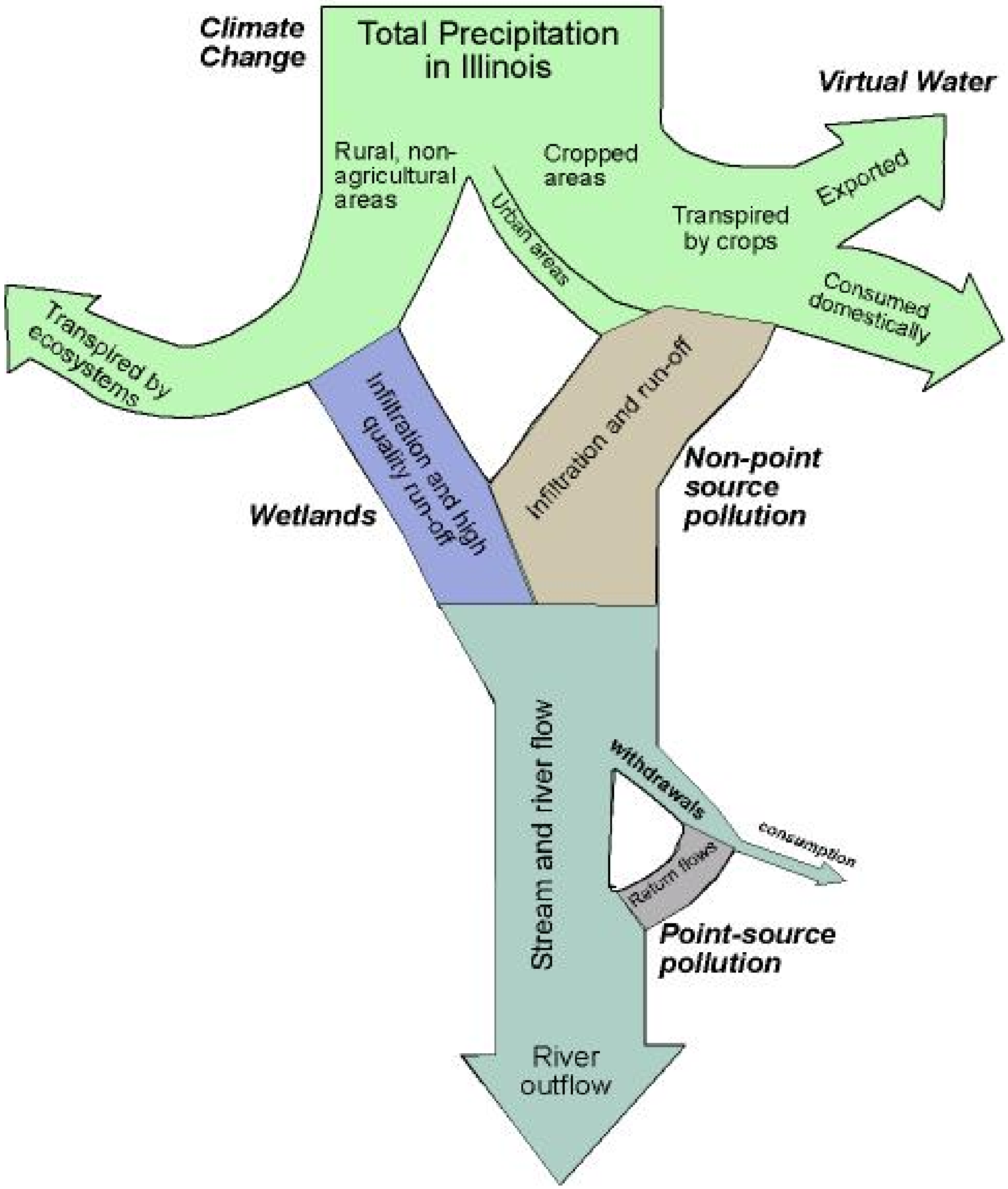

Figure 2. Hierarchical spatial arrangement of river basins and selected watersheds in Illinois.

Figure 3. The relationship among global, national, watershed and land ownership scales in governing watersheds. Source: Lant, et al., 2001.