Sustainable Use of the West's Water (Summer Conference, June 12-14) 1995

6-12-1995

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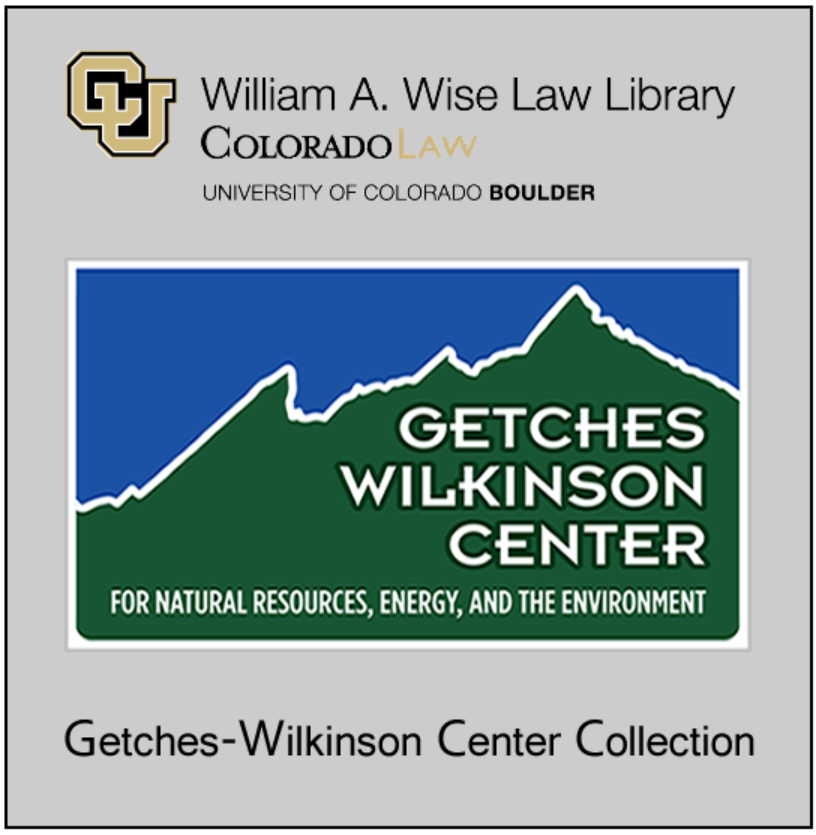

John Opie, *Is Sustainable Agriculture Possible in the Arid West?: The Example of the Ogallala Aquifer*, *in* SUSTAINABLE USE OF THE WEST'S WATER (Natural Res. Law Ctr., Univ. of Colo. Sch. of Law 1995).

IS SUSTAINABLE AGRICULTURE POSSIBLE IN THE ARID WEST? THE EXAMPLE OF THE OGALLALA AQUIFER

John Opie
Director of Graduate Environmental Policy Studies
New Jersey Institute of Technology

Sustainable Use of the West's Water
Natural Resources Law Center
University of Colorado School of Law
Jun 12-14, 1995

The enormous Ogallala aquifer is groundwater trapped below 174,000 square miles of fertile but otherwise dry Plains farmland. This territory covers large parts of Texas, Oklahoma, Kansas, and Nebraska, and extends into New Mexico, Colorado and South Dakota. It is the largest underground body of water in the United States. More than 3 billion acre feet (an acre foot is a foot of water across one square acre, or 325,851 gallons) were deposited under the Plains. Unlike most of the world's underground water supplies, Ogallala groundwater is mostly irreplaceable "fossil water" because its sources were cut off thousands of years ago. In my study area of the old Dust Bowl region of southwest Kansas and the Texas-Oklahoma panhandle, it is being depleted three to ten times the few inches of annual trickle of any recharge. (Opie, 1993) Optimists give irrigation-dependent farmers until the year 2020 before they will be with inadequate supplies of water while pessimists predict no more than ten more years of water.

My focus is not directly upon the remaining two billion acre feet, but upon the water's consumer, the modern irrigation farmer. The Ogallala aquifer--fresh water in beds of gravel 50 to 300 feet below the surface--is not intimately connected to events taking place on the surface. It was not a major feature of the grasslands ecology before the arrival of white European settlers. Nor did Ogallala groundwater affect the monoculture farming of the first 70 years of settlement; Ogallala water was not accessible during the Dust Bowl era. The underground supply began to influence surface events only when it came on line for irrigation through a combination of new pumping technologies and energy resources after World War Two, mostly beginning in the 1960s.

But once reached, Ogallala groundwater profoundly did affect surface events. The modern Plains farmer, on his typical 1280 to 1920 irrigated acres--eight to twelve quarter sections--is now bound to a gushing steel umbilical, 6 to 8 inches wide, plugging down 100 to 250 feet to the water supply. At the top end, another finite resource, natural gas, fires up the four cylinders of an new International 605 or Minneapolis-Moline engine or a used auto engine. The engine's shaft, rotating at 1,200 rpm, runs to a reduction gearbox that also shifts the torque from horizontal to vertical, and powers a Johnson or Peerless impeller pump. The aquifer water rushes up the steel umbilical and into aluminum pipes at 800 to 1,200 gallons per minute, ready to be soaked up by nearby fields overloaded with wheat or corn or sorghum. In 1990, a center-pivot sprinkler system, from drilling the well to watering the milo, would cost a farmer $70,000 to $100,000 per 160 acres, depending on well depth and field needs. Most irrigators

need 8 to 12 units for efficiencies of size. (Interviews, 1988-90) To pay for it, the irrigator needs good wheat or sorghum prices, which in the late 1980s were half of what they were ten years before. Alternative incomes are employment off the farm, sometimes natural gas leases, and in particular, government subsidies. From any rational perspective, irrigation is a marvellous technology, and alternatives to irrigation are gloomy.

Decades of Unsustainable Consumption are Now Coming to a Close.

Most consumers of High Plains groundwater treat it as a "free good" from the commons, available to the first taker at no cost for the water itself. Hence it has been generously consumed on profligate levels. It takes only $15 to pump an acre foot using natural gas and $30 using electricity. It seemed to farmers that they could schedule rain because they could irrigate their crops by the start of a pump. At the edges of the aquifer, irrigation has taken all but five or ten feet of useable Ogallala water, and some farmers are reverting to dryland farming with questionable results. There are combinations of forces at work that encourage excessive use. Pierre R. Crosson and Norman J. Rosenberg of the think-tank, Resources for the Future, write that "markets are not well equipped to protect resources such as water...in which it is difficult to establish property rights." (Crosson and Rosenberg, 1989) Policy analysts A. Maass and R.L. Anderson write that "farmers typically refuse to treat water as a regular economic good, like fertilizer, for example. It is, they say, a special product and should be removed from ordinary market transactions so that farmers can control conflict, maintain popular influence and control, and realize equity and social justice." (Maass and Anderson, 1978) Irrigation water thus carries a heavy load, not only for agricultural production, but also as a social, legal, economic, political, and even ethical issue.

The list of problems created by historical choices seems endless. The region is planted in the wrong crops for a semi-arid zone with less than 20 inches of normal rain a year. Corn demands the most water during the season, an astonishing 900,000 gallons laid on 130 acres of a 160 acre quarter-section, wheat and sorghum half that amount. In one growing season, a single acre of alfalfa needs up to thirty inches of water, equivalent to 2-1/2 acre feet or almost a million gallons. Between 1960 and 1990, about one billion acre feet of Ogallala water were consumed by irrigation farmers, mostly in southwest Kansas, the Oklahoma panhandle, and west Texas. (Interviews, 1988) (Western Nebraska holds more than sixty percent of the remaining aquifer water. It is mostly cattle country.) Another billion is inaccessible and the

remaining billion is coming under stress. Nothing can accelerate Ogallala flow and artificial replacement remains unlikely. It is far too costly to pipe water onto the Plains from the Mississippi or Missouri rivers, and grandiose plans to transfer water from the great rivers and lakes of Canada would run hundreds of billions of dollars. Farmers can afford up to $70 (1990 dollars) an acre foot; such imported water would cost conservatively $500 to $800 an acre foot.

There are other quagmires. Most major irrigators on the Plains are now older men and their sons and daughters left the farm ("It was too many hours at too much hard work.") and became lawyers in New York City. The equipment is also getting old; costs have skyrocketed to $75,000 (1990 dollars) to replace equipment for a quarter section when the farmer needs eight to twelve quarter sections to stay in business. Overall, consumption of Ogallala water can soon double or triple to compensate for such problems. Aging less-efficient equipment wastes water. Reduced government supports means a farmer has to plant more crops, which he has to water. An eroding soil produces lower yields on the same amount of water. In the last decade, a vertically integrated agribusiness in wheat or beef or pork became the most profitable operation in my study region. (Interviews, 1988-90) It needs copious water to serve its demand for high yields. The threat of the next drought (possibly intensified by the Greenhouse Effect) would triple water consumption.

Local irrigators are highly sensitive to the threat of less water. They have not stood around wringing their hands. Back in 1970, farmers around Sublette, Kansas, concluded they had 300 years of water left in the aquifer, based on current pumping and known supplies. By 1980 their estimate had fallen to 70 years as pumping rose dramatically, and by 1990 their estimate dropped to less than a 30 year supply. When Plains farmers found their groundwater levels in continuous decline they applied a variety of conservation strategies that mix traditional and innovative ideas--converting to specialized drip irrigation, heavily managed irrigation scheduling to water a crop at an ideal growth period, planting genetically-engineered drought tolerant crops, and special tillage procedures. Efficiency can rise dramatically under ideal conditions, from the miserable 45 percent in flood-the-furrow irrigation to 75 percent with scheduled center-pivot sprinkling. Expensive drip irrigation directly to the roots of plants claims 90 percent efficiency. Today, using current techniques, many local irrigators say they will be happy to hold on for another decade. More than half of the useable water is gone and levels continue to drop as much as two feet a year.

Not the least, irrigation farmers also joined new regional water management districts in Kansas and Texas, or formed their own independent associations, as in Oklahoma, to control the number and spacing of wells and pumps, to meter consumption, and to foster conservation and fight waste. (Opie, 1993) The pathbreaking Texas Groundwater Management District No. 1 opened its doors in Lubbock in 1952. Its mission was to promote controlled development of Ogallala water. It has now shifted policies to protect the remaining supply for "beneficial use" only. This realization that when the aquifer is set aside for farming, it serves a fundamental social good that benefits society is also stated in the legislative act that created the Oklahoma State Water Board in 1963. But Oklahoma has no local districts, and local citizens' groups in the panhandle often find themselves in conflict with the state board, which they see as dominated by big business. As to Kansas, a local vote in 1976 created the Kansas Groundwater Management District No. 3 headquartered in Garden City. While Kansas has a state water engineer, groundwater policies and actions in Kansas belong to local boards of irrigators and local district officials. But to guarantee beneficial use has been extraordinarily difficult. Nor has water "mining" been reduced significantly. A new development bears watching. The Northwest Kansas Groundwater Management District Four, established in 1977, and overseeing more than 3,600 wells, set in 1990 a zero-depletion goal to be reached in as little as 10 years. To quote one district official, "the declining levels meant zero depletion anyway, so why not opt to reach the same goal earlier while retaining an acceptable quantity of water for future management options." (Lowe, 1990) But the district is experiencing great difficulty in matching this draconian goal with the immediate need by local farmers to irrigate for their survival.

Sustainability, But Whose?

For over 30 years the irrigated High Plains have served important outside interests. They provided food for world markets, aided in overcoming the trade deficit with grain exports, produced the surpluses which allowed foreign policy flexibility, benefited both the independent family farmer and agribusiness, and sustained historically-low American food prices. But can the Ogallala waters serve all these masters? Seen in the best possible light, should it be used (1) to maximize profits, which is the "American way"? (2) Should it maximize yield "to feed the world"? (3) Or should it minimize risk--short or long term--to shield the family farmer and keep him on the land? Where does sustainability fit into this picture?

Conventional agriculture continues to mine the resource base of the High Plains. The combined negative impacts of less groundwater, low commodity prices, farmer removal, and environmental degradation can require a major shift in our thinking. A changed perspective may be revolutionary since today's definition of successful agriculture is so deeply commited to flawed practices that now threaten wholesale failure. Not only are water levels declining at 3 to 10 times recharge, but we are losing 5 feet of topsoil each year when it takes three to six thousand years to replace a foot. Now we can add Ogallala groundwater to the list of cheap and exploited resources like land and manpower. We include manpower because local farmers appear to be continually vulnerable based on climate and prices. (High energy consumption threatens the rosy picture as well.) In 1950 the Ogallala had irrigated 3.5 million acres of farmland. (Opie, 1989) Today it is 16 million acres (down from 17 million in 1970) because the lack of rain could be ignored, and the farmland transformed into today's fabled "breadbasket [and feedbag] of the world."

Government subsidies encourage "transitional unsustainability" by inducing farmers to use excessive amounts of pesticides and fertilizers and to waste underground and surface waters in irrigation. It is clear that vast food surpluses are being created at great economic cost not passed on to the consumer, grain trader, or foreign buyer. Less clear is the hidden ecological cost since lost water, soil, and bankrupt farmers are not easy to measure in dollars. These policies counter sustainable development. Grain surpluses have also promoted an expanding beef industry, in which six pounds of grain produce one pound of beef. It also takes several hundred gallons of water to produce that pound of beef when on the hoof. While Americans today are consuming less beef, over the long sweep of human history, higher meat consumption has been seen as a sign of a better living standards; this is true globally. Third World peoples get their protein from beans, rice and grains, but to them a higher standard of living includes meat in the dinner pot, and beef is still the ideal. Today the Plains are locked into high water consumption to grow the wheat and water the beef.

Sustainable development offers a useful perspective by which to examine irrigation's golden age from 1960 to 1990 on the High Plains, and the extreme difficulties that farmers are now having in their attempts to switch away from high consumption. (MacNeill, 1989) But can changes be made at the very last minute, as the region comes close to depleting its ecological capital and moves (once again in this Dust Bowl country) to the brink of environmental bankruptcy? But is there anything wrong with this scenario? Why not exploit the resource to economic exhaustion and

then depopulate the farmland? Should the integrity of an environment be maintained while assuring development to serve human aspirations? What is the balance between human needs and the "carrying capacity" of a geographical region? Instead of sacrificing land, water, and energy to serve market value alone, sustainability lays emphasis upon the drastic reduction of soil erosion, non-point pollution, and improved water quality.

Sustainability gives priority to (1) preservation and improvement of fertile soils; (2) maintenance and expansion of supplies of clean water; and (3) protection and regeneration of a satisfying quality of life for the work force. The goals of high yield production are the source of needless soil depletion, pollution, and disruption of natural and human resources. This viewpoint worries that conventional agriculture, according to Paul B. Thompson, isolates humanity "from the feedback mechanisms that inform us when we are increasing our vulnerability to a breakdown in the environmental system that supports agricultural practices." (Thompson, 1986) Even some USDA researchers in the 1980s admitted that the 2% annual increase in production that seemed reachable in the decades after World War Two, has not been attained since the early 1970s because of depleted land and water, the lack of continuously improving technological fixes (better seeds, pesticides, fertilizers and equipment), and a depressed farm population.

Sustainability seeks the inclusion of the Worldwatch Institute's principle of "ecological deflation" that takes into account soil and water mining, nonpoint pollution, exploitation of human groups, and intergenerational needs, all of which would significantly reduce the claimed efficiency and profitability of actual production to more realistic levels. Emphasis is placed on the on-site balance between agriculture and nature, in Congressman George Brown's words, using "stable, self-maintaining ecological systems [of farming] tailored to suit local variations in knowledge, climate, soils, and biological diversity." Critics of the sustainability approach argue that its production levels would not match global population growth.

The Future of the Family Farm on the Plains: What is the Highest Priority?

Sustainability that keeps the Ogallala water intact for its own sake is probably an inadequate objective. Sustainability to keep the small farmer in place is equally dubious. The independent farmer became idealized into a mythic hero early in the Republic's history, and this mythification continued with his presence on the High Plains, despite his continuous difficulties.

Regional Environmental Conditions

When, in the 1880s, large numbers of energetic and ambitious white European farmers appeared on North America's unplowed High Plains, they accelerated the pace of nature's events and narrowed nature's intentions to suit human needs. The early struggle of frontiersmen on the Plains has not led to comfortable settlement, but only to more struggle. The series of failures on the High Plains demonstrated that America's ability to fufill its dream of truly conquering the continent had its limits. One unfortunate result became the Dust Bowl of the 1930s when fertile soil, no longer protected by native grasses, blew away. Not until the 1960s would these Dust Bowl conditions be mastered, for a time, by the use of groundwater pumping and irrigation technologies that brought a boom in farming in wheat, corn, alfalfa, and sorghums. The problem of the Plains seemed solved, and the Plains entered the American mainstream. But this fabricated environment appears to be nearing its end because the water is running out. Drought is still the dominant feature of the region after a hundred and thirty years of human migration on and off the Plains.

One of America's premier geographers, Carl Ortwin Sauer, argued that the midcontinent grasslands was where the nation's frontier history really began because Americans had to solve new environmental problems. On the semi-arid High Plains, the frontier is not yet over because the environment has not been mastered; in the long run the Plains environment, because of its climate, may never be conquered. Despite the coming of irrigation, between 1950 and 1970 half the people left the region, and between 1980 and 2000 it is expected that half again will have departed, leaving half a million farmers across the entire High Plains compared to two million in 1950. The history of the High Plains has not changed from the days of its first white settlement. Its history is a series of crisis situations accelerated by repeated drought. As a result, the old Dust Bowl region has been an inadvertent "experiment station" in crisis management. Because of environmental conditions, when the High Plains was settled as an agricultural region it also went on permanent alert, experiencing crisis with no solution and no end. This is particularly true if one sees today's dependency on declining Ogallala water levels as a mere brief blip in time--1960-1990--compared to long-term forces at work.

A Confused Picture--Sustain the Family Farm, or Not?

Since the 1930s, at least, government policy has been biased toward protection of the family farm. This reflected society's judgment that the resulting benefits (cheap food, surplus food, highest profits, the farming way of life, historic values) outweigh the unfair cost imbalance. Now, a shift away from farmer protection is taking place as the public sees agriculture as a special interest group rather than as a source of traditional values. Back in 1980, for example, the U. S. Department of Agriculture, after working through volumes of data, identified 575,000 "primary farmers." (Penn, 1981) Primary farms were those operations that produced almost 80 percent of the nation's food and fibre although they made up less than 20 percent of all farms. The USDA then targeted a more select group of 115,000 farms that produced almost three-quarters of all the nation's strategic foods: wheat, corn, and soybeans. These 115,000 farms alone could each year supply the nation's basic grain needs, support overseas exports, and still maintain a surplus. What should not have caused surprise was that the USDA's "primary farmer" was not necessarily the historic family farmer. Half the number of High Plains farmers worked the same amount land in 1980 compared to 1950, while the regional economy grew. Local farmers expect the number to be halved again by the year 2000.

Some argue for the preservation of the independent family farm, others argue it should have died out with the horse and buggy. According to two congressional researchers, (Zinn and Blodgett, 1989) conventional agriculture "is losing its special status as the bastion of traditional values as the public recognizes that the small-scale family farm no longer dominates agriculture. People now view agriculture as just another large business that should not be excepted from the environmental quality requirements placed on other businesses. People also realize that agriculture is an important source of environmental problems."

No one, especially not politically sensitive congressmen and USDA officials, openly advocates abandonment of the family farm. The family farm has been characterized by on-site ownership, family labor, agrarian values, land stewardship, and generational continuity, where "household members own the land, perform the labor, control the capital, and make the important economic decisions." Cochrane called it the "single enterprise farm firm." (Cochrane, 1979) More important than income off the farm from working at the local plastics factory were *ownership of land* and *lifestyle,* remembering that frontier farmers also hunted game and collected wild foods away from the place they plowed and harvested. A 1979 definition produced by a Nebraska conference concluded, "the family farm carries with it a commitment to certain values which include conservation, frugality, responsibility, honesty, dignity in

work, belief in community, caring for future generations, neighborliness, and self-reliance."

High Plains Family Farmer as Government Client

High Plains farming persists as a high risk occupation; in this sense it is still flavored by the frontier experience. Despite the romance, it is historically clear that the family farmer was never heroically independent or sustainable on the High Plains. Abundant land was his first free good. He survived and enjoyed a false prosperity by mining the land. It eroded and blew away in the 1930s, with even worst droughts in the 1950s and 1970s. As land costs rose, Ogallala water became the farmer's current free good. Here he prospered (still too rarely) because he could exploit abundant inexpensive water.

This on-site American family farmer has also been the long-term recipient of special privilege that involves large sums of federal money to protect him from natural disasters and market forces. (Symposium, 1985) Over the last 50 years, as the government attempted to buffer farmers from natural disasters like the Dust Bowl and human mistakes like the Depression, it turned independent farmers into dependent clients. As a result of this government protection, American family farming has continued as a decentralized "cottage industry" in an increasingly industrialized world. It is inherently site-specific. So insulated, it may always have been an excessively vulnerable workplace artificially isolated from harsh reality, instead of the free and spirited career widely admired in congressional rhetoric, newspaper editorials, and the public eye.

There are many historical parallels. The shift from family farm toward large-scale centralized agribusiness operations can be compared to the demise of "ma-and-pa" neighborhood grocery stores after World War Two as supermarkets became commonplace. The small farmer became a long term government client. He or she became "frozen" in time--the parity years of 1911-1914--out of sync with the system, insulated from the world while the rest of the world changed. Once having created its clients, the federal government may be obligated to protect them as federal wards. Federal protection from the risks of drought also introduced new forms of high risk. The family farmer became dependent upon costly equipment, chemical pesticides, and heavy energy needs. All these threw him heavily into debt. He shifted from labor-intensive to capital-intensive farming.

To Keep the Nonsustainable Plains Farmer on the Land

Philosopher and policy analyst Mark Sagoff (1988) describes "important shared values" to which the public will sacrifice prices and efficiency. As long as the public remains sympathetic to the needs and services of the family farm, it will subsidize it. Social committment expresses not simply individual self-interest but public values we choose collectively. The role of government is not merely to correct market errors, but to reflect a sense of national well-being. In American history, so-called "benevolent" goals, such as the Marshall Plan, open immigration, urban welfare, and environmental protection accurately reflect, it is claimed, not primarily self-interest and market efficiency, but widely-held national values. Americans are willing to support policies not tied to the profit motive, nor to recent expansionist growth patterns. Material wealth and the good society may not be the same.

It is hard to argue against the productivity of the Plains, despite the price paid in depletion of water and soil. Industrial farming plays a major role in the ability of each American farmer today to feed, local signboards claim, a whopping eight dozen other people, compared to four others when the nation began. This success story, perhaps the most important in all of modern history, does much to define American prosperity. Kenneth A. Cook, of the Center for Resource Economics (1989), calls for "a new social contract between farmers and society. For its part, society will have to recognize the enormous cost farmers already bear to conserve natural resources and protect the environment. Taxpayers will have to be willing to share more of that burden--probably a great deal more--as external costs of agricultural production becomes internalized." It is remarkable that less than two percent of Americans work on the farm, compared to thirty or forty percent of a nation's population elsewhere in the world. Half of America's farmers, about a million, live on the Plains. The loss of Ogallala water would not be significant except that it currently irrigates almost fifteen million acres of productive farmland on the Plains. Over the next two decades, this farmland could decline to two million acres.

Another View on Plains Sustainability

There is a far broader general environmental model--biocentrism--that gives nature great autonomy and argues that humanity is best understood as it is enclosed within nature. This turns on its head the historic Western view that nature is humanity's raw material, which is the way nature is usually treated in most studies of the agricultural revolution and today's industrial agriculture. To accept the general environmental worldview requires a new understanding of the function of agriculture.

Agriculture's traditional bondage to the web of the marketplace must be challenged and alternatively expanded into an entire lifestyle, given a global framework, and subsumed under an overall humanity-nature philosophy. According to a biocentric viewpoint, farming cannot be like any other industry. North Dakota farmer Fred Kirschenmann (1991) observed that "A farm is not a factory--it is an organism made up of numerous suborganisms, each alive and interdependent, each affected in numerous, complex ways" by outside forces--money, chemicals, technology, market prices--that are invariably disruptive. "A cow is not a production unit but a biological organism." In their use of insecticides, for example, farmers have incorrectly measured success by "economic thresholds" that are "based on mathematical calculations. It causes us to ignore that fact that we may be creating the very problem we are trying to solve by killing off beneficial insects and natural predators and by creating resistant strains of the target pest."

The joker in this poker game is global warming. The High Plains is inescapably threatened by the world's changing climate due to greater quantities of industrial and automobile carbon dioxide, methane and other substances pumped into the upper atmosphere. According to computerized global climate modelling at Princeton, New Jersey, and Boulder, Colorado, the U.S. High Plains is one of several regions around the world that will turn into a major desert if the predicted CO2-induced greenhouse effect takes place. (Opie, 1993) Farmers will have a harder time preventing this "desertification" because they would need to take three times more water than today's rate to compensate for global warming. This would seriously harm most strategies for survival on the High Plains. Since agricultural yields are three times higher today than in the 1930s, the stakes are far greater. A long history of capital investment, and government subsidies, would be lost. For example, today's all-important cattle feedlot operations would be halted by sun, wind, and temperature extremes. The arid climate of the High Plains, newly intensified by global warming, may once again have the direct impact it has not had for fifty years.

Irrigation on the Plains is still in a self-destruct mode and the Ogallala aquifer is still a non-renewable resource. As such, the Ogallala region today is a representative microcosm of the difficult global search for sustainable development.

The Ogallala belongs to the world because humanity today is a globally-dominant species whose needs spin a web of mastery across the earth. When food from a radius of thousands of miles enters a single shopping cart, or when bags of grain stamped USAID avert starvation in Africa's Sahel, the whole world depends

upon the Ogallala. As a result, the clear fresh waters of the Ogallala are being unnaturally gulped up at 10 times their trickling pace of replacement. Over the next 50 years, when the world's food needs multiply 5 or 10 times, the Ogallala waters, fulfilling Adam Smith's 18th century prediction, will be as precious as diamonds.

> How is it that water, which is so very useful that life is impossible without it, has such a low price--while diamonds, which are quite unnecessary have such a high price?

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