Agric Hum Values (2008) 25:469–486
DOI 10.1007/s10460-008-9137-x

Agricultural transitions in the context of growing environmental pressure over water

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Accepted: 10 September 2007 / Published online: 10 April 2008

Abstract Conventional agriculture, while nested in nature, has expanded production at the expense of water in the Midwest and through the diversion of water resources in the western United States. With the growth of population pressure and concern about water quality and quantity, demands are growing to alter the relationship of agriculture to water in both these locations. To illuminate the process of change in this relationship, the author builds on Buttel's (*Research in Rural Sociology and Development* 6: 1–21, 1995) assertion that agriculture is transitioning to a post "green revolution" period where farmers are paid for conservation, and employs actor network theory (Latour and Woolgar *Laboratory life: The construction of scientific facts*. Princeton, NJ: Princeton University Press, 1986) and the advocacy coalition framework (Sabatier and Jenkins-Smith, *Policy change and learning: An advocacy coalition approach*, 1–56. Boulder, CO: Westview Press, 1993) to frame discussions of water and agriculture in the upper Mississippi River watershed, particularly Iowa. The author concludes that contested views of agriculture and countryside, as well as differing views of how agriculture must change to adapt to growing water concerns, will shape coalitions that will ultimately play a significant role in shaping the future of agriculture.

Keywords Actor network theory · Advocacy coalition framework · Agricultural change · Agricultural policy · Conservation policy · Structure of agriculture · Water policy · Water quality and agriculture

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Abbreviations

ACF	Advocacy coalition framework
ANT	Actor network theory
BMP	Best management practice
CAFO	Confined animal feeding operation
CAST	Council for Agricultural Science and Technology
CRP	Conservation Reserve Program
CSP	Conservation Security Program
DMU	Des Moines Municipal Utility
EPA	Environmental Protection Agency
FSA	Farm Services Agency
IDALS	Iowa Department of Agriculture and Land Stewardship
IDNR	Iowa Department of Natural Resources
NRCS	Natural Resources Conservation Service
RRWP	Raccoon River Watershed Partnership
USDA	United States Department of Agriculture

> It is impossible to talk about the history of human civilization without talking about water.
>
> (Postel 1999, p. 3)

> The importance of water for life on earth can hardly be underestimated. Too much water at the same place is a problem, often a disaster. The same goes for too little water. Water management is one of the oldest tasks to be taken on by government.
>
> (Schrama 1998, p. 3)

> It is a paradox of modern democratic societies that the state is considered both the cause and the cure of injustice.
>
> (Walton 1992, p. 1)

> [T]he social organization of agricultural production is *centered in nature* as its name implies: *agri* (meaning "field") and culture.
>
> (Mann 1990, p. 28, italics in original)

Introduction

The agricultural industry is unique as it is absolutely nested in nature (Mann 1990). US agriculture has been built on technologies designed to transform nature to maximize commodity production. In many cases, these technologies aimed to control water. As Schrama observed (see above), water is at once our nemesis and savior. In different parts of the United States, society has employed technology to make water conform to production demands—to harness nature and control it. In the Midwest, vast wetlands have been tiled and drained to become some of the world's most productive farmland in corn and soybeans (McCorvie and Lant 1993). Great rivers have been dammed and diverted for flood control and irrigation—altering soil composition as well as hydrology for the sake of agricultural production. Now social concern over issues of water quality and quantity are demanding change in the very agricultural systems that emerged out of the technological reconfiguration of hydrologic systems.

Given that social pressure, a literature is emerging to map the scientific and economic variants of how that change might occur (Santelmann et al. 2004). This paper will build on that literature by nesting the movements towards a changing structure of agriculture due to concern about water quality in broader social processes. Rather than focusing on questions of feasibility and adoption of conservation technologies at the individual level, this paper aims to answer the question "how do social processes at multiple scales combine to influence changes in the practice and structure of agriculture." In so doing I will demonstrate the roles of actors, coalitions of actors, and information in that process.

Water is the centerpiece of any ecosystem. The concept of the watershed attempts to capture the notion of the ecosystem (including humans) as it surrounds the water body. Interactions within that watershed are constantly changing, adapting, but hopefully achieving a balance that sustains the components of the ecosystem—humans, other mammals, birds, amphibians, fish, insects, etc. Certain components of the system will respond in a way that is perceived as negative by certain human groups when the system is out of balance. Examples are species die-off or deformation or the eutrophication of water bodies from nitrogen and phosphate loading (Cortner and Moot 1999; De Leo and Levin 1997). We can call these actions "signals" (Holling 1995; Holling et al. 2002). Social actors record the signals, interpret their meaning, and advocate for action based on that meaning (Sabatier 1999; Sabatier et al. 2005).

I combine Latour and Woolgar's (1986) actor network theory (ANT) and Sabatier and Jenkins-Smith's (Jenkins-Smith and Sabatier 1993; Sabatier and Jenkins-Smith 1999; Sabatier et al. 2005) advocacy coalition framework (ACF) in attempting to understand the current concern about water quality and quantity and its implications for agriculture in the upper Mississippi River watershed, specifically Iowa. ACF and ANT provide frameworks for looking at the roles of different actors and coalitions in creating the policies and administrative constraints that condition future agricultural activity. I hope to shed light on the strength of the water-quality lobby within society; the extent to which local agricultural production is being impacted by larger societal trends and local-, state-, and national-level social movements; the role of technical information in shaping the discussion; and the role of culture in shaping these discussions.

Whether agriculture is practiced in the form of large capitalist, industrial production systems, or smaller, family held, traditional production systems, social mobilization around issues of water quality and quantity are changing the context for agriculture. Environmental concerns have been part of the rhetorical landscape in agriculture since the 1930s, first in the form of soil conservation, then in the form of broader debates about the impacts of agricultural inputs (such as pesticides). New concerns about the quality of water in the Midwest and quantity of water in the West have the possibility of dramatically changing the constraints on agricultural production. The drama of how this will play out is unfolding before us. I will apply the ANT and ACF frameworks to look at the issues of Gulf of Mexico hypoxia and chronic water nitrification problems locally in Iowa.

Iowa was chosen for this study because it is a significant agricultural state (among the nation's leaders in corn, soybean, and hog production). Efforts to address agricultural pollution of water have occurred in the context of a generalized support of farming. Iowans tend generally to legitimate farming—even as they seek to find ways to minimize the negative impacts on water quality (Market to Market 2002).

An undercurrent in this paper is Buttel's (1995, 1997) argument that agriculture is in a transition period from the "green revolution" era of agricultural modernization to an emerging "environmental-agriculture" era, where farmers are compensated for maintaining the ecosystem as well as producing crops. I will describe two trends that foretell of both directions of agricultural development. As Thompson (1997) argues, these visions of the agricultural system might well exist simultaneously on the agricultural landscape of the future.

Background and context

It is not new to argue that agriculture in the US is undergoing dramatic change. In the Midwest, the demographic

farm structure has dramatically narrowed since the 1970s,[1] with farm concentration increasing and fewer farmers owning more land (Albrecht 1997). Agricultural production data show as well that the range of crops grown by farmers has diminished significantly since the 1970s. In the Midwestern "corn belt" the percent of wheat and oats, for instance, has diminished significantly (Duffy 2006). The 1999 Iowa Farm and Rural Life Poll found that more farmers are pessimistic than optimistic about both present and future quality of life (Lasley et al. 1999).[2]

In all cases, competing demands for water, because of expanding urban interests as well as growing concern about water quality and habitat, are creating a new level of debate over the resources available to and the direction of agriculture. This debate is unfolding before us. The participants include everyone from government agencies to environmentalists, urban municipalities, and farmers. These actors plus self-proclaimed sustainable farmers, conventional farmers, and farm interests are playing a role in the reshaping of agriculture through changing the relationship of agriculture to water. All sides in the debate are employing scientists and scientific assessments and the rhetoric of rights and cultural heritage. These debates unfold in the context of changing technology, both for delivery of water resources and farming, and are contingent on changing economics, markets, and a changing (and often internally contradictory) role for government.

These changes likewise take place in the context of history. Thus, I will begin with a brief overview of the history of agriculture in the Midwest—tracing the development of conventional, industrial agriculture as it exists today. In addition to alluding to the "facts," I will focus on the perceptions of agriculture over time, as this as much as anything shapes the debate as it stands now. I will then look at the growth of environmental interest in agriculture. This context will set the stage for a brief outline of the actor networks and advocacy coalitions engaging in the debates over agriculture and their activities in the context of growing concern about water quality and availability.

A brief overview of the history of agriculture and US society

Danbom's (1997) summary of the history of American agriculture and the agrarian image describes an important dualism that he argues has existed since the colonial era. On the one hand, American society has always viewed agriculture as a social enterprise, sustaining a way of life and a set of values. While ignoring the realities of class stratification and power that were very apparent on the American rural landscape, Jefferson was most prominent among these, envisioning the US as a land of hard-working small farmers, "family-oriented freeholders." On the other hand, Jefferson, Hamilton, and many of the other founding fathers were agrarian businessmen, in the tradition of the early Anglo colonists of Virginia, North Carolina, and South Carolina. They saw the importance of exploitation of natural resources to pay off the significant debts that the US owed—and measures such as the 1785 Basic Land Ordinance and the Northwest Ordinance of 1787 sought to encourage agricultural expansion by selling off federal land to farmers and to extend this power into the frontier areas west of the Appalachian Mountains. With the Louisiana Purchase, the systematic expulsion of the Indians from land as America expanded westward, and the distribution of land to settlers, American farmers moved to the Midwest as new settler/farmer entrepreneurs. The government provided military protection and the transport infrastructure (first by water including the famous Erie Canal, later also by train) and eventually passed laws intended to pull farmers around the country into the capitalist economy.

Starting in the middle of the 19th century, the US government underwrote increasing numbers of projects aimed at the expansion of settlement and agricultural production through changing nature. Systematic efforts were made, starting in the 1870s and culminating in the 1930s, to drain the wetlands of the Midwest so that they could be planted in grains.[3] In addition, starting in the early part of the 20th century, an array of government subsidies, from price deficiency payments to Acreage Reserve Programs, encouraged farmers to focus on the production of a few commodities (Becker 1986; Jagger and Harwood 1997). As Heffernan (1998), Bonanno et al. (1994), and Friedmann and McMichael (1989) point out, this process has led to concentration in the food-processing sector, with an associated increasing control of these conglomerates over the food production process, either through contracting or actual ownership.

While government research, extension, and infrastructure encouraged farmers to grow and industrialize to fit into the US capitalist system, rhetoric, both by farmers and social/political leaders, continued to convey the agrarian image of the independent, hard-working small farmer. It is indicative of this that William Jennings Bryant's Prairie

[1] As Paul Lasley pointed out in the Bultena lecture at Iowa State University in October 1999, this just represents a steepening, rather than a change in a trend that dates back at least to the 1930s.

[2] This same question has not been repeated in later summaries of the Iowa Farm and Rural Life Poll.

[3] The draining of wetlands remained an important part of the Iowa farmer's interaction with nature through the 1970s and 1980s. Only with the passage of wetland protection components of the 1990 Farm Bill did farmers have an incentive to reverse this trend.

Populism (1900–1910) shunned the sectors of the farm movement which called for a restructuring of the farming system along socialist lines. His movement was aimed more at reform—particularly government curbs on the monopoly control of the railroad robber barons so that farmers could more fairly compete in the capitalist system (Danbom 1997).

The role of environmental and conservation concerns

Environmental concerns

The 1970s saw a growing environmental movement concerned about the negative impacts of the modernization of agriculture, especially the impacts of agricultural chemicals, and called for a change in the direction of development. This stood in contrast to the early environmental movements of the 1930s through the 1950s, which sought to set aside wilderness for the sake of conservation, without interfering with progressive farming practices or modern development. Rachel Carson's (1963) *Silent Spring*, the fire on the Cuyahoga River outside of Cleveland, and an upsurge in reported incidence of and mortality from cancer led to broader concerns about the health of the environment among an urbanizing (or, more correctly, suburbanizing) and increasingly wealthy US population.

The mainstreaming of these concerns culminated with the passage of legislation such as the National Environmental Protection Act (1972), which established the Environmental Protection Agency (EPA), the Clean Water Act (1972), and the Safe Drinking Water Act (1974). These pieces of legislation at first had little impact on agriculture. Rather, this legislation and the agencies that implemented it mirrored public concerns at the time and focused first and foremost on regulation of major industrial polluters (Dunlap and Mertig 1992.

Environmental awareness gained prominence during the Carter administration and public concern about the impact of farming on the environment grew. Initially this concern centered around health, as studies emerged on the dangers of overconsumption of red meat, the dangers of pesticides to human health, and the potential negative impact of agriculture on water quality. Increasingly, agency representatives talked about the importance of addressing non-point-source pollution.[4]

[4] Water-quality professionals have divided water pollution into two types: point-source pollution, that is pollution that can be traced to a pipe leading from a municipal sewage disposal facility or an industry; and non-point-source pollution, which is pollution that when aggregated is significant, but comes from multiple, hard-to-identify sources.

Conservation concerns

As Foster and Magdoff (1998) point out, issues of soil fertility have been a recurring part of capitalist agriculture since the 1800s. As production systems became more efficient in the economic sense, farmers abandoned the crop rotations and fallow periods necessary for more sustainable agricultural production.

In reaction to the Dust Bowl of the 1930s, the federal government established programs to protect farmland from erosion preemptively. In most of these projects, the government either leased or bought marginal land from farmers to keep it from being farmed. The government also undertook land rehabilitation through planting trees, reseeding grasslands, and constructing erosion control structures, all as part of the New Deal Public Works Association. The Soil Conservation Service (later the Natural Resources Conservation Service [NRCS]) was established during this period to advise farmers and to manage marginal lands.

Forty years later in the 1970s, high farm prices and a favorable export market led to the expansion of land under cultivation. Farming was increasingly dominated by mechanization, inputs, and production incentives and supports provided by government.

By the early 1980s, erosion on these lands sparked concern among scientists and agricultural activists about environmental damage and future productivity. The commodity establishment and key congressional representatives (most notably the late Congressman Jamie Whitten from Mississippi) initially responded with intransigence. Some agricultural producers, exemplified by Robert Rodale, began adopting alternative models of agriculture (Batie 1985).

Using discourse analysis of testimony from the Agriculture Committee hearings on the 1985 Farm Bill, Glenna (1999) demonstrates how members of the alliance that pushed the conservation provisions of the 1985 Farm Bill through Congress operated from fundamentally different rationalities. Agricultural scientists, environmental activists, and sustainable farming advocates initially proposed legislation aimed at addressing the systematic problems of soil fertility by replacing commodity-based productivity requirements with conservation-based incentives. This alliance included small farm advocates, who were interested in Congress taking actions to preserve the family farm and agrarian society—operating on what Glenna calls a *socialistic rationality*. It also included environmentalists, who aimed through the legislation to achieve a better balance between humans and nature—an *ecological rationality*. Many of the commodity groups, the Reagan administration Agriculture Department representatives, and aligned congressional members focused exclusively on

maintaining production—an *instrumental rationality*. Glenna asserts that an additional substantive rationality existed among many of the members of Congress participating in the debate. These members recognized the need for environmental and social change in the farming system but lacked political will to challenge the basic assumptions of those upholding instrumental rationality. In the end, despite adequate political backing for meaningful conservation, the conservation legislation that passed retained production and profit as the major goals of farming.

The conservation components of the 1985 Farm Bill added new layers of conservation incentives to the already existing system that rewarded monocrop (or simple rotation) production (Becker 1986). Other incentives to serve environmental goals were inserted into the 1990 Farm Bill. These included the so-called Swampbuster and other wetland restoration funds, and the establishment of the Low External Input Sustainable Agriculture program, later to be transformed into the Sustainable Agriculture Research and Education fund and office within the US Department of Agriculture (USDA) (Jagger and Harwood 1997). But the legislation that finally passed the Senate and was implemented upheld the basic assumption that yields were to be maintained and conservation inserted as a way of maintaining productivity and controlling negative externalities.

While the legislation failed in transforming the incentives for farmers so that they better matched the ecological and social rationalities that so desperately needed attention, it did not end public pressure for a change in the direction of farming in the US. The farm crisis of the 1980s provided fuel for a growing popular and institutional[5] environmental movement have steadily moved toward presenting an alternative vision of agriculture in the 1990s.

In *Paying the Farm Bill*, Faeth et al. (1991) demonstrate that the existing commodity support programs (even including the instrumental conservation provisions mentioned above) were ultimately bad for the environment, economically inefficient, and unfairly beneficial to large farmers. Stauber et al. (1995) demonstrate the social as well as production side of sustainability by describing sustainability as marrying the goals of community, agricultural, and ecosystem health. Ecological agriculture researchers such as Altieri (1998) and Gliessmann (1998) have worked to document the inefficiencies of the industrial mode of agricultural production from an ecological perspective. Buttel (1995) describes the emerging environmental transition of agriculture. From the ill-formed definitions of sustainability at the time of the 1985 Farm Bill, research and experience have sharpened the critique of, and clarified alternatives to, conventional agriculture.

Others have demonstrated the extent to which the conventional, industrial systems are dependent on external (internationally derived) inputs that are only available through continued imperial domination and the ability to import input and to export waste to others. Foster and Magdoff (1998) link the search for phosphate fertilizers by industrial agriculture suppliers to colonization of Africa during the late 1800s and early 1900s.[6] Goolsby and Battaglin (1994) and Rabalais et al. (1994) link farming in the Midwest to significant nitrate buildups in the Mississippi River basin and assert that these nitrate buildups are a major contributor to the hypoxia problem in the Gulf of Mexico. So, while Africans may have in the past borne (and may continue to bear) the brunt of industrial agriculture's need for external inputs, fishers in the Gulf have had to bear the brunt of industrial agriculture's externalities. In some ways we may see agriculture as the epitome of what Catton (1980) calls the "ghost acres" that have maintained well-being in industrial countries through production dependent not only on importing inputs normally derived from fossil fuels, but also on the ability to export excess water and waste products through a tiling network (as in Iowa).[7]

Both concern about drinking water and initiatives that look at water from a watershed perspective present the possibility for redefining acceptable practices and priorities. These openings are further complicated by a liberalizing state that has drawn conventional agriculture ever further away from locality, placing it squarely in the uncertainties of the international market and allowing the market to eliminate what linkages exist to communities.[8] Urbanizing populations, both in the Midwest and the West, have developed into specific political interest groups—both environmental and simply urban—who do not see their interests in increasing agricultural production or in an agrarian lifestyle that does not involve connections to ecology.

[5] By this I mean a growing number of institutions (organizations, institutes, and agencies) formed in the late 1980s and early 1990s to address environmental issues and integrate them into policy analysis.

[6] Grubler (1998) and Grisar-Kasse(1997) describe the continued battles for foreign domination over phosphate mining in the context of the Pacific Islands, specifically Nauru, and West Africa, specifically Senegal.

[7] Farming in the upper Midwest is possible largely because of tiling systems that make the natural prairie wetlands cultivable. These systems also export the waste in the form of excess nitrogen and phosphorous that runs off of the farm land and ultimately ends up in the Gulf. For more information, see Schilling (2006).

[8] Here, I am drawing on Marcuse's (1964) concept of "technological rationality," from *One Dimensional Man*, which describes the development an industrial treadmill of production and progress that continues defining progress as industrial modernization regardless of signals of major system weaknesses.

Theoretical framework for the case analysis

To look at the emerging influence of changing water priorities in the US on agriculture, I draw on two theoretical frameworks for understanding the role of actors in creating action paradigms in natural resources. The first is actor network theory, as defined by Marsden et al. (1993), Latour and Woolgar (1986), Callon (1986), Goodman and Watts (1997), and de Soussa and Busch (1998). The second is the notion of the advocacy coalition framework, as outlined by Jenkins-Smith and Sabatier (1993) and Sabatier and Jenkins-Smith (1999), and augmented by Sabatier et al. (2005).

Latour and Woolgar (1986) developed actor network theory (ANT) while studying the scientific method. By tracing the various information networks and influences, they convincingly debunked the perception of science as a purely objective enterprise, demonstrating that scientists were subject to a variety of political and cultural influences that they carried into the laboratory and which formed the lenses through which they interpreted results. Under the theory, science and the diffusion of scientific innovations for development are carried out by actors, these actors are defined by interests, and we can better understand the technoscientific process of development by systematically following those actors and their "actants," (those acted upon) (Latour and Woolgar 1986).

Marsden et al. (1993) use ANT to analyze the changing rural countryside in Europe. Various interests were involved in defining of "rural" in the context of the emerging European Union. Locality, Marsden et al. argue, is where these interests met and battled for positions within specified frameworks. They argued that various images of the countryside were being reshaped to meet specified interests as they conducted their research; the processes of enrollment and mobilization occurred as they watched. Developers, agribusiness firms, agricultural scientists, social scientists, farmers, rural residents, and environmentalists were all part of the evolving mosaic. The authors outline how rural sociologists participated in this definition process by describing and advocating for rural communities. Marsden (1999) describes the development of rural life in the context of globalization, focusing on the simultaneously emerging social and spatial trends that are leading to an increasing interest both in understanding and working with social diversity, and to a growing concern about environmental health and well-being. Each of these interests has different actors associated with it, and they are all acting as globalization sets a context of change in rural areas and expands the potential networks for all actors at the level of the locality.

Like Marsden, I will apply ANT to an emerging process—the negotiation of government policy relating to agriculture. Furthermore, I am interested in understanding not just the actors, but the tools they use to build their networks. These tools could include actions they implement to draw other actors into their network, regulatory frameworks that enable or hinder the establishment of the network, and information that builds the network. I am interested in the application of ANT in the analysis of a situation that is unfolding, not ex post facto.

Marsden et al. (1993) and Marsden (1999) provide a useful framework for analysis of rural change as it is taking place. These works focused on the locality, assuming that the major choices would be made at the local level, and that local-level actors would only react to globalization. ANT describes the networks that form and their power relationships, but does not describe the mobilizing process. To get at the larger context of influencing policy decisions by connections between local actors and state- or national-level actors, it is necessary to build in another framework.

The advocacy coalition framework (ACF) of Sabatier and Jenkins-Smith (1999) allows a better understanding of mobilization and the development of political networks and policies. Jenkins-Smith and Sabatier (1993) move beyond the traditional political science "iron triangle" of interactions between the legislative arena (Congress), the administrative arena (federal agencies), and special interest groups by bringing market and private sector actors, different levels of state actors,[9] and, later, civil-society actors to the analysis (Sabatier et al. 2005).

ACF focuses on the competing advocacy coalitions within a policy system as it moves from the legislative process to the implementation process. The advocacy coalitions generally form around broad core values, such as believing that the world is a better place because of technology or that the free market is the best regulator of society. These core values generally represent the prevailing frame alignment of the coalition (Snow et al. 1992). A researcher identifies coalitions and actors within each coalition that share a set of basic beliefs (policy goals, worldview, etc.) and seek to manipulate the rules, budget, or personnel of government institutions in order to achieve goals over time.

ACF focuses on the process of "policy-oriented learning," in other words the process of collecting information, discussing strategies, dialoguing about issues, and mobilizing for action. ACF theorizes that policy oriented learning can help actors to see different options in the policy process. As with ANT (Callon 1989; de Soussa and Busch 1998; Marsden 1993), scientists and their technical

[9] Thinking about civil society, the private sector, and the market sector is not new for sociologists, of course, but the application to the traditional policy-making models of political science provides us with a new conceptual tool for understanding the role of these actors in the policy context.

information are key actors in ACF. In ACF, however, their role is not as autonomous actors, but rather as actors within the context of an advocacy coalition. Scientific information in this framework may be and often is employed by multiple and sometimes opposing coalitions. Scientific information must, however, be advocated with an existing policy framework.

Sabatier and Jenkins-Smith (1999) applied ACF to the San Francisco Bay water-quality initiative. The identified coalitions that formed around preserving (1) the ecological heritage of the bay, (2) fish stocks for commercial and recreational fishers, and (3) economic on-shore interests. Ultimately scientists joined the ecological heritage and protection coalitions, who aligned with the fishing coalition. Technical information from the scientists then was used to advocate for protection actions to local, state, and federal agency representatives who, in turn and to varying degrees, eventually joined the aligned coalition. Ultimately, without legislation, a combination of federal and state sources funded local-level initiatives to curtail and monitor point- and non-point-source pollution entering the bay.

Jenkins-Smith and Sabatier (1993) hypothesize that advocacy coalitions might be unable to impact core structures, like a national constitution or key cultural elements in society, without the input of larger external forces. Sabatier et al. (2005, pp. 174–199) subsequently argued that, by combining ACF with alternative dispute resolution, one can understand how in the case of water issues in particular, even longtime "warring factions" can come together. They cite cases of estuary management programs in California and Washington where environmentalists, government agencies, and fishing interests joined forces to protect water quality because all parties recognized that water-quality disturbance as a "wicked" problem necessitating changes in behavior and actions by multiple parts of society.

In a similar manner, ANT and ACF can be combined to provide a framework for analyzing the actors in ongoing disputes over water and the role of agriculture in Iowa. ANT provides the framework for identifying the different actors, both human and biological, that are creating the context that is changing agriculture. These actors have formed important coalitions that are advocating for certain policy changes. ACF then provides a framework for understanding how the coalitions are being mobilized to advocate for change within current the policy structure. Within both of these theoretical frameworks I can overlay the larger policy and economic contexts, which are ultimately affecting local-level action and policy development. The following analysis of the case study is based on content analysis of website, newspaper, other media, and agency reports. This information has been supplemented with interviews with key informants in Iowa.

Iowa, water quality, and hypoxia

During the 1990s and the first part of the 21st century, Iowa has increasingly been confronted with a need to address water-quality concerns. These concerns have been manifested at local, regional, national, and ultimately international levels. The cause of concerns and the reaction have been the result of coalitions that have impacted both the flows of information and the shape of efforts to address these concerns. The efforts to protect water quality and mitigate water-quality concerns have, ultimately, led to a discussion about the structure and practice of farming. In some cases, water quality has become subsumed within generalized concern about the industrialization of agriculture. In others, it has been paramount—and the discussion has been about the ways to address water-quality issues resulting from agricultural practice. Within these discussions, we see the formation of actor networks that implement technologies and practices to respond to water-quality concerns. The networks emerge out of advocacy coalitions that impact policy options and implementation.

Context

Iowa sits in the middle of the US, and is a state that is perceived to exemplify the agrarian tradition. Seventy-five percent of land use is agricultural, and agriculture continues to contribute significantly to the state's economy. Iowa has experienced the same trends as the rest of American agriculture, with increasing acres per farmer and decreasing numbers of farmers. Between 1997 and 2002, the number of farms declined by more than 6,000 and the number of farm acres fell from 32.3 to 31.7 million. The acreage per farmer still remains relatively low (352 acres per farmer compared to 411 throughout the US and 377 in neighboring Illinois, for instance). Iowa's agriculture is dominated by corn and soybean row-crop production, along with hog production, mostly in confined animal feeding operations (CAFOs).[10]

The portion of the population engaged directly in farming in Iowa has also diminished steadily over time. As of 2002, 127,166 Iowans listed their primary occupation as farm operator, out of a total population in the 2000 Census of 2,926,324, or only 4.3% (US Census 2000). Additionally, between 1988 and 1998, 314,719 acres were converted from farmland to other uses. Fifty-two percent of that change was to residential or commercial uses. This trend has continued into the new century (Cosner 2001). At the same time, Iowa's population grew by only 5.4% from

[10] Information derived from the National Agriculture Statistics Service (NASS; http://www.nass.usda.gov) and the Iowa Department of Agriculture and Land Stewardship (IDALS n.d.).

1990 to 2000, less than half the national rate of growth of 13.2% and less than all Iowa's immediate neighboring states (OSETA 2004).

Much of Iowa's productive farmland is actually land converted from prairie and seasonal wetlands. To make this land productive, it was necessary to move water off of the land using tiling systems that channel water into canals. This process started in the mid-1800s, but picked up dramatically in the 1890s, 1930s, and 1950s through 1970s (Bogue 1994). These canals then feed or create[11] waterways that ultimately flow to the Mississippi or Missouri rivers.

The context of farming is also important. The farm crisis of the 1980s led to an accelerated concentration of farmland owned by a decreasing number of farmers. Additionally, a combination of environmental advocates, neo-liberal economic conservatives, and budget-conscious policy forces from nonfarm states, undercut the traditional US government support for farm subsidies. The resulting 1995 Freedom to Farm Act purported to cut subsidies to farmers, allowing them to compete on the open market. While the rationale of the legislation seemed to work in 1996, when farmers had a bumper crop, flooding and periodic drought led to a crisis for many farmers by the end of that year. In response, Congress, pushed through a farm bill in 1997 that provided a patchwork of emergency subsidies that amounted to higher transfer payments than had existed prior to the 1995 Freedom to Farm Act. Because of the design of subsidies, however, this legislation exacerbated the existing trends of concentration in agriculture—with middle-size farmers either going out of business or turning to livestock or other contract operations to stay in business (Kirschenmann and Duffy 2004). The transformation of row-crop or mixed livestock and row-crop farms to CAFOs has led to tensions between small-community residents and neighboring farmers. A growing number of communities confronted odor and other problems associated with a growing number concentrated swine facilities (Flora et al. 2002).

Goolsby and Battaglin (1994) and Rabalais et al. (1994) document a link between the emerging hypoxic dead zone in the Gulf of Mexico and nitrogen and phosphorous loading. Tracing the nutrient loads upstream on the Mississippi River, they indicate that this load in all probability came from the heavy row-crop farming states, namely Missouri, Iowa, Illinois, and Minnesota (the upper Mississippi River basin). This revelation led to national-level interest by environmentalists as well as the Clinton administration in addressing problems of nutrient loading. The findings added critical information as well as a platform that was mobilized by sustainable agriculture advocates both within and outside Iowa to call for changes in the commodity production system. Much of the commodity agriculture establishment (such as the National Farm Bureau) resisted the notion of responsibility for the hypoxic dead zone.

At the same time, natural events were shaping Iowans' concerns about water issues. The 1993 flood led not only to flooding of the Iowa communities on the banks of the Mississippi River, but also to flooding of inland farmers and communities, including the capital city of Des Moines. Adding to this initial catastrophic event, Iowa suffered seven federally declared disasters from flooding between 1994 and 2002 (FEMA n.d.). Additionally, the Des Moines Municipal Utility (DMU) water works, which draws from the Des Moines River and the Raccoon River, exceeded the Safe Drinking Water Act maximum contaminant levels for nitrate in 1989 and 1990. The efforts to come into compliance involved millions of dollars in investment in ion-exchange treatment facilities, but also led the utility to actively work with watershed efforts aimed at reducing effluent of nitrate from farms, as well as other sources (DMWW n.d.). Others in Iowa were regularly reporting problems with algae blooms and beach closures in recreational lakes and reservoirs and fish kills resulting from farm spills of chemicals or manure. Flora et al. (2006) used Iowa Department of Natural Resources (IDNR) data to show that two-thirds of counties had suffered manure spills between 1986 and 2003. They also found that 29% of Iowa counties had reported fish kills of 10,000 or more fish. Iowa Environmental Council analysis, based on IDNR 2002 data, indicated where CAFOs were most concentrated, the watersheds were impaired. Flora et al. (2006) found a moderately strong relationship between production of hog manure and impaired watersheds in Iowa. An association between agricultural practices and water quality, combined with generalized concern about the future of farming, has led to processes designed to renegotiate the relationship between water and the production of agricultural products.

Mobilization process

Many of the depictions of response to the pressures for Iowa agriculture to adapt to increasing concern for water quality have focused on the application of practices by farmers (Dinnes et al. 2002), on new opportunities available through policies or programs (Hey et al. 2005), or on local initiatives, such as the strategies and workings of

[11] A study by the Iowa Water Survey in 1999 demonstrated that the majority of flowing streams and rivers in the state did not exist in 1850. Through investigation of tiling networks, they determined that many these formed through water channeled off of Iowa's farmland. A report by Iowa DNR, Geologic Survey concluded that runoff from this process increased nitrate and nitrogen losses from the agricultural Midwest. (See Schilling 2006.)

watershed organizations (Wright-Morton 2006). While these are all important, this analysis will depict the larger institutional framework and structural relationships within which these actions and policies have taken place. ANT allows me to look at the actors that have led to actions on the ground and the relationships among those actors.

Iowa state government actions

From the mid-1980s through 1999, the government of Iowa, under the Branstad administration, was limited in actions to protect water quality. While administering federal programs, such as the EPA 319 local watershed initiative grants, the government of Iowa was unwilling to take an active role in mitigating water-quality problems if that meant implicating agriculture as the polluter. The state bristled at allegations that the hypoxic dead zone was related to Iowa farming. A memo from the Upper Mississippi River Basin Association, to the National Oceanic and Atmospheric Administration (NOAA) Hypoxia Task Force, co-chaired by then IDNR chair Kevin Szcodronski, exemplifies this position: they called, effectively, for no action due to insufficient scientific evidence (reminiscent of similar reactions by some to calls for curbing of fossil-fuel use in reaction to global warming) (Wegwart and Szcodronski 1999).

Since 1999, when centrist Democrat Tom Vilsack was elected governor, the Iowa state government has played a more active role in encouraging the growth of initiatives related to water quality, specifically through the IDNR and the Iowa Department of Agriculture and Land Stewardship (IDALS). In particular, late in 1999, the legislature funded the Iowa Watershed Taskforce (which was in part funded by the state emergency management agencies as part of flood prevention) and an Iowa Wetlands Initiative, both of which produced reports in 2001 (Iowa Watershed Task Force 2001). Other key actors in these efforts are the Iowa employees of the Federal Emergency Management Agency, who see watershed work as flood prevention and approve funding for water-quality work in that context. Most of the actions of these two initiatives target agricultural areas. It is important to note, however, that a number of agency employees remain skeptical, at best, about local-level water-quality efforts. Threats by federal agencies to take over state water-quality functions have been useful in forcing these agents to implement certain policy changes.[12] However, arguments among IDNR and IDALS agents about the real impact of conservation practices on water quality are evidence of continuing divisions surrounding the issue.

In 2006, the Iowa legislature established the Watershed Quality Planning Task Force, made up of legislators as well as representatives of commercial farming interests (Iowa Farm Bureau and Pork Producers Association), conservation districts, small-community water-system interests (Iowa Rural Water Association), wastewater-system interests (Iowa Water Pollution Control Association), and the Iowa League of Cities. The goal of the task force is to discuss the establishment of a voluntary statewide water-quality program. The task force was asked to make recommendations on the following issues: improving water quality creating economic incentives for environmental compliance; facilitating implementation efforts; developing quantifiable protocols and procedures; and providing greater flexibility through community-based, nonregulatory, performance-driven watershed management planning (IDNR n.d).

These concerns add to existing concerns about the future of farming in Iowa—which is the result of fluctuation of corn, bean, and hog prices; increasing corporate control of the farming sector, through contract production; and concentration of agriculture, leading to a growing proportion of the Iowa population without a direct link to agriculture.

It is worth noting that there is still a significant coalition against change in the state. This coalition includes the commodity organizations and large farmers, who utilize other scientific analysis. It is interesting to note that institutions that have traditionally supported the interests of large farmers have commissioned studies that do cite agriculture as a significant cause of hypoxia in the Gulf, a reversal of earlier assertions (CAST 1999). This might explain an increasing willingness among conventional farmers and commodity agriculture advocates to dialogue with watershed groups. They have stated a willingness to adopt best management practices (BMPs) to protect water quality. They discuss the potential of new technologies (such as computerized precision farming technologies) to be better stewards of the land even as the production paradigm stays the same (Wolf and Wood 1997). Their goal, however, is to ensure production, but the price crisis currently affecting farmers is no doubt having an important impact on their interest in considering conservation incentives. Their coalition includes scientists and academics who promote the current modernization trends. It also includes key government actors at USDA, IDALS, and the level of the state economic development offices. While employing agrarian rhetoric, in an example of the classic American dualism mentioned earlier, economic and agronomy scientists and agency representatives in this coalition use scientific data to argue that there is no alternative to the conventional paradigm. They argue that BMPs

[12] The state's chronic water-quality issues were a driving force behind Governor Tom Vilsack's water-quality initiative. See IDNR (2003).

can be put in place to mitigate negative environmental consequences.[13]

Iowa Farm Bureau Federation and other commodity groups have supported an increasing number of watershed groups and initiatives in recent years, in an effort to build support for the notion that it is possible to maximize commodity production while protecting water quality.[14] Initiatives by the governor and congressional representatives to secure resources for programs that appeal to production farmers encourage adoption of conservation practices and arguably protect water quality, but do nothing to encourage alternative agricultural production.

Federal Government actions

The federal government actions are implemented by federal agencies, but also by initiatives directed by Congress. It is here that the actors and actions at the state level can influence congressional members. Iowa's senators have both been in the Senate for more than 20 years and hold senior positions on Senate committees. Iowa Senator Tom Harkin used his senior status on the Senate Agriculture Committee to propose a reorientation in the 2002 Farm Bill through the Conservation Security Act, which would have largely replaced production incentives with wide-ranging incentives for soil conservation and water-quality protection practices. Much as Glenna (1999), above, describes with the conservation amendments in the 1986 Farm Bill, the political processes of negotiating the farm bill in 2002 transformed the concept of a Conservation Security Act into the Conservation Security Program (CSP) within the overall Farm Bill, to be implemented through the USDA Farm Services Agency as an add-on to the existing crop support and conservation programs (FFAS n.d.). There has been considerable frustration as the implementation of the CSP in the 2002 Farm Bill, as finally approved, only targeted particular watersheds. Additionally, the Republican-controlled Congress was slow to appropriate resources and the Bush administration was slow to implement the program—which would allow farmers to implement practices to protect water quality without the commodity-based restrictions of programs such as the Conservation Reserve Program (CRP) and the Conservation Reserve Enhancement Program (Perkins 2005). The CSP was finally fully implemented only in 2006.

Representatives from the federal government such as the EPA, the USDA NRCS, and the US Geologic Survey are all instrumental in funding conservation initiatives and encouraging local water-quality action. Through the EPA, the Clinton administration launched the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force. This initiative was charged with finding consensus on actions that could be taken to reduce nutrient loading in the upper Mississippi River watershed. The initiative involved technical experts from inside and outside government as well as key stakeholders from agriculture and other sectors in the upper Mississippi River watershed. They developed plans for limiting nutrient inputs to the watershed that were deemed to benefit farmers as well as the watershed, such as nutrient trading and a wide range of conservation practices (US EPA n.d.a).

Cooperative Extension, supported by technical information and networking through the USDA Cooperative State Research, Education, and Extension Service, provides technical assistance to farmers. These actions are nested in the context of federal initiatives and national research that are likely to mandate changes in agricultural practice. These include the interagency guidelines on animal feeding operations, the Mississippi River Basin Initiative, the interagency working group on hypoxia, and other national watershed initiatives.

Local activists use the knowledge of these initiatives in the attempt to expand their coalition. Scientific and technical information provides a key backdrop for federal action by EPA and USDA. Both agencies are involved in encouraging locally based, voluntary water-quality initiatives. A difference however is that EPA has tended to ally itself with small farmers and the water-quality initiative above. USDA, on the other hand, has tended to ally with the instrumental rationality of the large producer coalitions that I will describe below. There is increasing support within both agencies for pollutant trading as a way of minimizing off-farm nutrient emissions. There are increasingly agency-sponsored initiatives to develop nutrient markets that would allow other potential polluters to pay farmers for actions to reduce nitrogen and phosphorus runoff. A growing number of farmers seek to "farm nitrogen" (Hey et al. 2005) in lieu of maximizing row-crop production (Hey et al. 2005). Iowa Farm Bureau reports that there is significant interest by farmers in implementing water-quality protection and soil conservation practices, as evidenced by the fact that there are far more farmers wanting to sign up for government conservation and wetland restoration programs than resources available to enroll farmers (Iowa Farm Bureau 2006).

Local-level actions

At the local level, there is an increase in the number of watershed organizations and an expected increase in the

[13] Portions of the Private Lands Summit, held at Iowa State University on 7 December 1999, contained this rationale. See Beeman (1999).

[14] Iowa Farm Bureau has launched a range of programs to assist farmers in addressing water quality issues. These include both programs unique to Farm Bureau and collaborative programs with other nonprofits such as Trees Forever. See, for instance, Iowa Farm Bureau (n.d.).

number of acres under conservation programs. There has also been an increase in the number of farmers using alternative production methods (small vegetable and horticulture farms selling to local markets), and the number reporting use of alternative practices, even as the number of acres producing corn and soybeans has increased in the last couple of years. In 2005, for instance, Iowa led the nation in the production of hogs, corn, and soybeans, but also had 450 certified organic operations (on approximately 100,000 acres) and led the nation in per capita farmers' markets with 172 (IDALS n.d.).

Still, farmers have also been involved across the state in stream-bank restoration projects and watershed efforts. Local citizen watershed groups are playing an increasing role in these activities. For example, the number of citizen-based water-quality or watershed groups grew from under 10 in 1992 to about 42 in 1998[15] (Seaman 1998). While many of these groups formed out of local interest, there is increasing interest in larger issues of ecosystem health and agricultural policy as well. These groups often have links to Midwestern environmental activists, who provide information that ties local action to broader policy issues. They are also in most cases well nested in the community. They have used their community embeddedness along with their networks to the larger environmental movement to advocate for better programs to help farmers operate in ways less harmful to water quality. For instance, watershed groups have been key activists for the state-level reauthorization of the Rural Enhancement and Protection funds that provide local farmers and communities with conservation assistance.[16]

Watershed and water-quality groups also generally have links to scientists and academics at the various universities in Iowa—and in turn scientists (specifically from the social, biological, and ecological sciences) tend to be part of this coalition. Thus while watershed groups develop information through monitoring and linkages, they also utilize information to promote change in farming practices and development initiatives. Moreover, they utilize this information and local memory of water-based crises (for instance of the 1993 flood) to enroll other actors. This coalition includes, and generally supports, small farmers who advocate for a more diverse agricultural production paradigm. As evidence, note that the Leopold Center for Sustainable Agriculture has been a key institutional member and advocate of both water quality and alternative farming coalitions in the state, and it explicitly draws a link between the two.[17]

Actors, networks, and coalitions

Framing this process from the perspective of ANT and ACF, one can map out the relationship between individual and institutional actors, actants, and actions in the form of agriculture in Iowa vis-à-vis water. At the beginning of the 1990s, conventional farmers in Iowa produced corn and soybeans on a growing number of acres per farmer, increasingly using techniques such as no-till, which substituted chemical herbicides for manual or mechanical labor. A growing number of farmers (actor 1) were either contracting or investing in CAFOs, viewed as a wise investment given readily available corn and soybeans as well as sufficient feed and cropland for the disposal of manure. Commodity organizations (actor 2), such as the Corn Growers Association, Soybean Growers Association, and Farm Bureau (actor 16) actively endorsed and defended these production trends as good for farmers and the environment. Farm creditors and input suppliers (actor 3) likewise supported this production system. Conventional agriculture researchers and agricultural extension at Iowa State University (actor 4) supported this system through targeted research to support this production system. The former organizations also used their lobbying power to influence the agencies of the government of Iowa (IDALS and IDNR) (actor 5), which avoided setting water-quality guidelines, and implicating agriculture in non-point-source water-quality problems. Ultimately, the system was supported by federal government (USDA) price-support systems administered by the Farm Services Agency (actor 6).

An alternative coalition concerned with water quality within Iowa also existed. This coalition involved a growing alternative agriculture movement, embodied by the Practical Farmers of Iowa (actor 7). They were working to demonstrate that conventional farming could be carried out on smaller acreages and involve more diverse production (Bell 2004). This resistance was supported by a growing movement at Iowa State University, embodied by researchers affiliated with the Leopold Center for Sustainable Agriculture as well as other academics (actor 8), who produced work demonstrating the inefficiencies of the conventional agriculture system and possible alternatives in returning to more diverse cropping patterns.

[15] I know of three new groups that have formed in the last year as well, adding to this number.

[16] See, for instance, advocacy by the Iowa Environmental Council.

[17] Note that the Leopold Center carries out research and programs explicitly aiming to demonstrate the viability of alternative agriculture *and* the ecological imperative of adjusting the conventional agricultural paradigm (Leopold Center 2007). It is also considered to be a partner to Iowa State University Extension in improving water quality (ISU Extension 2004).

Outside of alternative agriculture, a growing environmental civil society movement (actor 9), including the Iowa Environmental Council and the Iowa Natural Heritage Association, called for the development of farming systems that involved greater landscape diversity—including restoration of prairie and seasonal wetlands. This movement was encouraged by ongoing concerns about drinking-water quality, coming specifically from the Des Moines Municipal Utility (DMU) (actor 10), who in the early 1990s faced violation of EPA health regulations because of high nitrate levels in their drinking source water (the Des Moines and Raccoon Rivers). They, in turn, began to call for the state to assist in the development of watershed approaches to mitigate the impacts of agriculture, as well as other land use, on water quality.

Researchers focused on soil conservation and water quality at Iowa State University (actor 11), along with associated colleagues in government agencies such as US Geologic Survey and moderate non-governmental organizations (NGOs), such as the Soil and Water Conservation Society (SWCS) (actor 12), worked at documenting BMPs that farmers could implement to protect soil and water quality.

In the mid-1990s, national academic researchers (actor 13) developed models that linked nitrogen and phosphorus in the upper Mississippi River to the hypoxic dead zone in the Gulf of Mexico. The federal government under the Clinton administration responded by developing the Mississippi River Basin and Gulf of Mexico Hypoxia Task Force (actor 14) to look at ways to diminish nitrogen and phosphorus loading from the upper Mississippi River basin.

The initial response by the conventional agriculture coalition and the Iowa government (IDALS and IDNR) under Governor Branstad (actor 5) was to argue that there was insufficient scientific evidence to implicate agriculture in the hypoxic dead zone. Several events led to an opening of the possibility of a middle ground for action around water quality in the context of farming. First, the report by the Council on Agricultural Science and Technology (CAST) (actor 15), a research body trusted by and generally supportive of conventional agriculture, convened a task force the findings of which admitted that agriculture in the upper Mississippi River watershed was responsible for a disproportionate amount of nitrogen and phosphorus that fueled the Gulf of Mexico hypoxic dead zone. Second, the DMU (actor 10), began to work with the commodity organizations (actor 2), and specifically the Farm Bureau (actor 16) and civil society environmental organizations (actor 9), to the form the Raccoon River Watershed Partnership (RRWP) (actor 17). The RRWP was designed as a collaborative watershed initiative to develop mechanisms for water-quality protection in the Raccoon River and Des Moines Rivers.

Second, the administration of Iowa governor Vilsack (actor 14), elected in 1999, developed initiatives aimed at addressing water-quality concerns from agriculture. While there existed a level of resistance within the bureaucracy, the election of Vilsack shifted the posture of IDALS and IDNR from stalling to action to address a wide range of agriculture related water quality concerns.

Third, through initiative of Iowa Democratic Senator Tom Harkin (actor 19), Congress (actor 20) ultimately passed the CSP as part of the 2002 Farm Bill. While slow to implement the CSP, the USDA has now appropriated resources to support farmer activities aimed at improving soil conservation and water quality in particular watersheds.

At the same time, there were critical actions at the local level. Large watershed initiatives such as the RRWP (actor 17), which was supported by commodity organizations and the DMU (actor 10), aimed to address water-quality issues, such as nitrogen loading in drinking source water, through landscape mitigation efforts such as buffer strips. These efforts were supported by USDA NRCS, and agroecology researchers at Iowa State University. The commodity organizations (Farm Bureau, for instance) (actor 16) dramatically increased their support of watershed initiatives to carry out this work over the last several years.

ACF provides a framework for analysis in pinpointing the mobilization of knowledge in these processes. As is depicted in Fig. 1, the actors above group into three identifiable coalitions. The *commodity production coalition* (conventional agriculture producers, commodity and industrial agriculture organizations, and government representatives aligned with these groups) has a core value that commodity productivity is the critical concern. They reacted initially to Gulf of Mexico hypoxic dead zone and other water-quality concerns by arguing that other sectors should be targeted in protecting water quality before agriculture. Major actors within this coalition eventually supported and provided funding for initiatives to mitigate water-quality impacts even as they continued assert a production orientation.

An *environmental coalition* holds a core value that the commodity system was indeed responsible for water quality and other environmental and social problems. They embraced the dead zone reports and internal water-quality reports as further evidence of a bankrupt system and evidence that the conventional paradigm needed changing toward the production of alternative cropping systems.

A *mitigation coalition* holds a core value that the current production system, while responsible for water quality, must be accepted as a given. The impacts, however, could be mitigated through land amendments, such as conservation buffers, and changes in cultivation practices. Over time, we see the accumulation of evidence, such as the

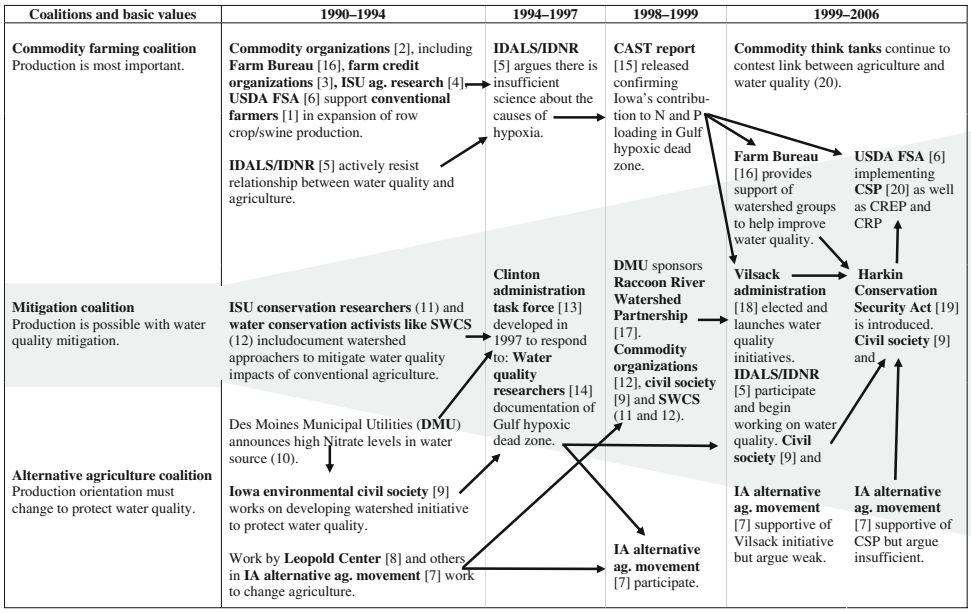

Fig. 1 The relationship of coalitions and actors to water-quality policies and actions. Note the growth between 1990–2006 of a mitigation coalition which worked to ameliorate the impacts of production agriculture on water quality through incentives for conservation practices, with some support for alternative agriculture

CAST (1999) report, and stakeholder efforts such as the RRWP, expand the mitigation coalition to encompass many of the actors from conventional agriculture. This is evidenced by support from Farm Bureau and other commodity groups for watershed initiatives and from federal government in the form of the CSP.

Impacts

On the surface, little has changed in terms of agriculture and water in Iowa. Iowa still leads the US in production of corn, soybeans, and hogs, as cited above. This reality, however, is offset by the fact that there are more than 450 certified organic operations[18] and 172 farmers' markets. Iowan farmers also had 514,680 acres enrolled in these conservation programs as of 2006 and were first in the nation in the number of acres set aside as riparian buffers, grassed waterways, contour buffer strips, field borders, and other buffers on private farmlands—reducing soil erosion, protecting water quality, and stabilizing stream banks (IDALS n.d.). Iowa's farmers were also first in the US, as of 2002, with land under conservation tillage, no-till, and mulch-till. Evidence is that this has held steady through 2006, although there is some concern about the forecast of increased corn production because of record high prices due largely to ethanol support (NRCS 2003; Nickel 2007). This sobering prognosis is coupled with statistics that show the number of acres in CRP having declined between 1997 and 2003 from roughly 17 million acres to an estimated 14,806,000 acres. Further, some evidence suggests that soil erosion has also increased since 1992, after falling from 1986 to 1992 (Miller and Tidman 2000). Iowa's politicians provide further evidence of stasis; they have led efforts to promote agricultural biotechnology and corn- and soybean-based ethanol as alternative fuel sources.

At the same time, Fig. 1 demonstrates that there is widening awareness and support for actions to protect water quality. Iowa has 40 local-level watershed organizations (some affiliated with larger state or national organizations) listed on the EPA Adopt-A-Watershed Catalogue of Watershed Groups (US EPA n.d.b). Anecdotal evidence suggests that this catalogue misses many of the watersheds organizations that exist. This may be partly because many of these watershed organizations are associated with Farm Bureau—and are thus unwilling to provide their name to the EPA. Former Governor Tom Vilsack's water-quality initiative has apparent, continued support from the new governor of Iowa, Chet Culver. These combined efforts seem to support a growing number of local actions dedicated to improved watershed and water-quality management. Such local initiatives are capable of mobilizing state and national resources to develop nutrient and land management plans that can have

[18] This figure is up from 353 certified organic operations in 2000. Iowa is 10th in overall certified organic acres, second in organic corn, and first in organic soybeans acres (USDA ERS 2005).

the impact of simultaneously prescribing methods for minimizing water-quality impairment and increasing awareness of the relationships between agriculture and water quality (Corey et al. 2006). The net effect is that more attention is being paid to water quality in Iowa. Indeed the Governor of Iowa's "Leadership Agenda" has stated of eliminating all impaired waterways in Iowa by 2010, and established indicators to track progress toward meeting this goal (Results Iowa n.d.).

The sobering projections are that the expansion of corn production to fuel the ethanol boom will lead to a reversal of many of these gains in the coming years. Some project that the amount of nitrogen dumped into the Gulf of Mexico will lead to a significant expansion of the hypoxic dead zone.[19] Others project that farmers will begin to move into the production of perennials, such as switchgrass, as part of the ethanol boom, which may have a positive effect on water quality (Jordan et al. 2007). One implication of Fig. 1 is that the last 15 years in Iowa have created inertia for water-quality protection initiatives, regardless of market forces. This, in part, explains the simultaneous interest in expanding corn production acres to fuel ethanol initiatives, increasing acres in alternative farming, and pursuing water-quality initiatives.

Conclusion

I am building here on Buttel's (1995) assertion that agriculture is transforming. Like him, and similar to the assertion of Thompson (1997), I believe that it could go in two directions: increasing industrialization of the conventional model or an alternative model that is environment and community friendly. I argue that these transitions are shaped by coalitions that form around issues, such as water quality. The point here is that social processes that link local to state, national, and international actors determine which direction agriculture is likely to take in response to concerns about water quality. I have used a combination of ANT and ACF to tease out the emerging water-policy coalitions in Iowa.

The first direction is that agriculture will continue to develop along conventional, industrial lines. In the case of Iowa, this would involve greater utilization of expensive technologies, such as precision farming, so that farmers on ever-larger acreage will be able to manage it to meet specified practices and water-quality goals. CAFOs would also have to develop ever-more expensive technologies for production and management of waste. This option is tacitly supported as the "only option" by commodity organizations and the leadership at USDA. Innovation is seen in the creation of markets and trading of emissions credits, so that farmers could be paid for forgoing production to protect water quality (Hey et al. 2005). These options might take care of the immediate water problems, but would not address the core issues. The case in point may be the ethanol boom of 2007, which has resulted high projected corn prices and an expansion of row-crop corn acres onto land that may well have been traded for emissions credits or enrolled in conservation acres in years past.

The second direction would involve the development of agricultural systems that are more in keeping with the ecosystem and community goals. In Iowa, this would mean increasing the options for farmers to produce higher value crops, to sell locally, and to make entrepreneurial community linkages. An important underpinning of this option is a new conception of the countryside focused less on production of commodities than on protection of culture and environment, as Marsden (1999) and Marsden et al. (1993) describe in Europe and Hinrichs (1998) describes in Vermont. It worth considering whether this reverses what Williams (1990) described as country culture masking increasingly industrialized production. Increasingly, European farmers are using a veneer of production to mask what they are really selling: culture (Marsden 1993).

As we see in Fig. 1, two competing coalitions represent these viewpoints. An alternative agriculture coalition used concern about water quality as further evidence of the need for alternatives to the conventional row-crop and animal confinement system. A conventional agriculture coalition initially resisted the association of agriculture with water-quality impairment both within Iowa and in the Gulf of Mexico. Information produced by trusted institutes softened their position, as did the change of the Iowa governorship. Important actors in this coalition instead shifted focus to conservation measures to mitigate impacts of existing production practices on water quality while not interfering with the basic production system or structure.

The consensus position revolved around programs that decoupled water quality and conservation payments from commodity production. This took life in the form of the proposed Conservation Security Act of 2002. Yet, like Glenna's (1999) findings about the soil conservation provisions of earlier farm bills, the Conservation Security Act was ultimately subsumed as a program under the conservation portion of the 2002 Farm Bill, which favored more conventional production (Zinn 2003). The Bush Administration and a Republican Congress, who failed to request or fund CSP once authorized until 2005, exacerbated this situation. In following this process, one can see the role of national actors in creating the incentives that influence the options available for individual farmers.

[19] This is based on NOAA supported modeling efforts by scientists at Louisiana State University and the Louisiana Universities Marine Consortium (NOAA 2007).

Clearly, ideology, regardless of the strength of local coalitions, is important—as evidenced by the reticence of Republican administrations (Branstad in Iowa and Bush in the US) to support new actions to protect water quality. ACF helps us to understand this, as an important part of the theoretical framework expects there to be core values that are unlikely to be changed through marshalling information (Sabatier and Jenkins-Smith 1999). In this case, the core value amounts to a belief in the primacy of agricultural commodity production. Thus, one can understand willingness to support measures to mitigate the impacts of conventional production, but not measures that challenge that production paradigm.

On the other hand, while severely underfunded, the CSP has been implemented since 2005, and shows some promise of being expanded in the 2007 Farm Bill. Further, there is greater acceptance in society for alternative agricultural production models. Even as the statistics show continued concentration in conventional agricultural production in Iowa, they also show an increasing presence of alternative production systems. While still in the minority, as Dunlap and Mertig's (1992) study of environmental movements shows, the voice for the alternative has become very mainstream. Universities, government, civil society and the private sector have actors who are part of the "alternative agriculture coalition." They are compiling, gathering, and creating information that is moving into the public realm. The mobilization and enrollment are ongoing at the national, regional, state, and local levels. The question is not just about efficiency of farming practices, but rather about farming options in the context of changing demographics and ecology. The question is how agriculture will fit into the broader mosaic of environmental concerns that surround water, and the extent to which social movements and market signals allow farmers the opportunities to take actions that enhance water quality.

Combining ANT and ACF allows us to trace not only the networks that lead to the implementation of a particular production scenario, but to understand how the development of advocacy coalitions leads to policy options that produce production *scenarios*. This paper has demonstrated how, in Iowa, the response to local, state, national, and international water concerns resulting from agriculture led to the simultaneous implementation of conservation programs meant to mitigate environmental impacts while accepting a conventional agricultural paradigm *and* in growing support for alternative agriculture scenarios. Even as broader market forces related to corn-based ethanol production seem to be encouraging a conventional production orientation not seen since the 1970s, a growing number of watershed organizations and the continued presence of an alternative agriculture coalition are providing mitigation measures and alternative frameworks. In other words, the competing coalitions at the extremes balance each other, and the mitigation coalition is increasingly empowered to mobilize farmers and others to mitigate production impacts on water quality at the watershed, state, and regional level. The drama of how this balance plays out continues to unfold. Water concerns are bound to impact agriculture; actor networks and coalitions will determine how.

Acknowledgements I would like to thank Clare Hinrichs under whose tutelage this paper originally took shape back in the late 1990s. I would also like to thank Catherine Grosso and Stephanie Nevins for their valuable editing assistance. I would be remiss in not also giving thanks to the numerous Iowans who assisted me in developing an understanding water quality in their state.

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