Whose Watershed is This? A Decision Case Study of Agricultural Drainage in the Midwestern USA

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ABSTRACT

Every day, individuals make local land management decisions, involving a few hectares or a few square kilometers. These decisions may enhance or degrade local environments, and often are reflected in downstream surface water quality. This case focuses on management decision making in an agricultural watershed in southern Minnesota, USA, and engages participants in making environmental decisions in the context of conflicting values. The case exemplifies a process that is occurring worldwide: people are demanding more local-scale decision making, which often conflicts with broader community and societal goals for integrated management. In using the case, participants are presented with background from the perspective of a local farmer who believed he was making a wise management decision on behalf of his family and his community. He was surprised by the presence and strength of opposition and needed to make difficult decisions about his land and future. There was a well-understood, potential financial gain; he had trouble predicting both the costs (e.g., legal fees) and the probability of success. Participants are presented with the dilemma, asked to make a decision, and then to evaluate their results and process in light of decisions eventually made by the farmer.

Drainage of agricultural land using subsurface tiles and open surface ditches is a common management practice in the midwestern USA (Fig. 1). Its purpose is to remove water from low-lying areas and poorly drained soils to promote higher crop yields. In the early part of the century, many wetlands in Minnesota were drained to make agricultural production possible. As a result, <20% of estimated presettlement wetlands now remain in southern Minnesota (Mulla, 1996). Currently, landowners and managers in the state rarely drain additional wetlands; however, they do maintain and improve existing drainage systems. Drainage offers clear economic benefits to farmers, but there has been growing public concern about its environmental impacts. In this decision case, a group of farmers in southern Minnesota proposes to improve the ditch and tile system on their land, but are met with strong opposition from neighbors and environmental groups. The focus of the case is on the decision of one farmer who weighed the benefits of improved drainage against potential legal fees and impacts on the downstream environment.

THE CASE

Glen Steele’s family had been farming on land near Fairfield, MN, for about 35 yr. In recent years, it had become apparent that the old tile drainage system on their land needed to be replaced. The drainage system was installed in 1915 and its pipes were deteriorating. Neighboring farmers with similar problems had suffered substantial crop loss due to excess water on their fields. Glen understood the scale of the potential losses and the need for change. It had been estimated that inadequate drainage could reduce crop yields in southern Minnesota by 2.8 Mg/ha (45 bushels/acre) of corn (Zea mays L.) or 1.0 Mg/ha (15 bushels/acre) of soybean [Glycine max (L.) Merr.], resulting in a decrease in expected income of $225 to $260/ha ($90 to $104/acre) of cropland (Hachfeld and Theisse, 1997). In addition to removing surface water and increasing crop yield, improved drainage could reduce the time needed to till, plant, and harvest crops. Farmers could plant earlier in the growing season on well-drained land, which allowed crops to mature more completely before harvest, reducing the cost of artificially drying crops.

Glen Steele began talking to his neighbors about the need for better drainage; many agreed that something had to be done to ensure the future viability of croplands in their watershed. They organized meetings to discuss the issue, and decided to hire an engineer to design a drainage improvement project. The project would upgrade the old tile system’s hydraulic capacity and drainage ability. This would minimize the drainage problems the landowners were currently facing and almost certainly would result in increased average income per hectare.

In Minnesota, most actions to change drainage procedures begin with a petition to the county board. A minimum percentage of property owners affected by a proposed project must sign a petition before it can be submitted to the board. For the improvement project proposed by Glen Steele and his neighbors, at least 26% of the affected property owners needed to sign. Steele and 11 neighbors (46% of those affected) agreed on a proposal and signed a petition that was approved by the Northland county board in November 1997. The new system was projected to cost about $830 000. This cost was to be divided among all property owners in the watershed. The 14 property owners who did not sign would be assessed a portion of the cost relative to the benefit they would receive from drainage improvements. Glen saw the project as fairly routine, the type that is typically approved and constructed without a problem. He felt he had made a positive investment in the future of his farm and his community. To his surprise, an organized and determined opposition to the project quickly arose.

Opposition is Voiced

The first opposition to the project came from Linda and Rick Krause, who were assessed a portion of the project cost

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1) While this case represents an actual situation, all names of people have been changed.

Abbreviations: MFE, Minnesota’s Future Environment; DNR, Department of Natural Resources; MnRAP, Minnesota River Assessment Project.

although they did not sign the petition. They claimed that the project threatened to damage a wetland on their property. The Krauses and their two small children had recently moved into a house on land in the watershed. The house overlooked a small wetland that attracted birds and wildlife to the property. Linda’s grandmother owned the land, and to Linda it was a familiar place. “That slough has been there since I was a child,” she said, “To me, it’s home.” The Krause family did not want to cause conflict with their neighbors, but they were worried that the drainage project would damage the wetland, and they decided to file an appeal in district court.

The Krauses contacted lawyers at Minnesota’s Future Environment (MFE), a nonprofit law firm based in Minneapolis, and the firm began to look further into the case. In addition to the wetland issue, MFE discovered that the new system’s outlet was directly upstream of a trout stream that was protected by the Minnesota Department of Natural Resources (DNR) and the change in drainage would increase flows to the stream significantly. Higher peak flows would potentially increase bank erosion, sedimentation, temperature fluctuation, and nutrient inputs to the trout stream, which would degrade its fish habitat and biological integrity. The MFE was concerned about these potential impacts, and before Glen knew it, they had orchestrated a lawsuit to stop the project.

Glen felt that the lawsuit was baseless and unsupportable. “What we did was follow every rule to a T,” he said, “We got the project ready to go, and then somebody steps in and tries to stop us on it.” Glen and the other petitioners had already invested a great deal of time and money into the project, and they had not anticipated the challenges that were now facing them. “The only way the environmentalists could get in was to go piggyback on the Krauses,” said Glen. “The Krauses were pretty much trying to protect their own land; that’s all they were doing. They enjoy wetlands and wildlife, which all of us do, and that was…well, we underestimated them a little bit.”

Regardless of the Krauses’ reasons for becoming involved in the lawsuit, Glen was now facing important decisions. What had begun as a necessary action to maintain his farm’s drainage system and improve the value of his land was now a financially risky situation. Under Minnesota drainage law, if a project is approved but fails to be constructed, each petitioner is liable for all costs incurred, including engineering fees, attorney’s fees, and county auditor’s fees.

As word of the lawsuit spread, public opposition to the project gained momentum. Local and regional environmental groups including Trout Unlimited, Mankato Area Environmentalists, New Ulm Sport Fishermen, and the Coalition for a Clean Minnesota River all voiced opposition. Dennis Coleman, the engineer who designed the drainage project, said it would improve farmland without endangering any wetlands. “The only way that dewatering of a wetland area could occur is if an individual chose to install tiles there, and that could be punishable by law,” he said. But Linda Reister believed that tile drainage could affect a wetland even if tiles did not go directly through it. Coleman agreed, but said that the Natural Resources Conservation Service had established setback distances to guard against such problems. Drainage improvement projects are required to comply with local, state, and federal guidelines intended to protect the state’s wetlands and downstream property owners who may be affected by modifications to an existing system (Assoc. of Minnesota Counties, 1997). Coleman argued that the project was in compliance with all legal guidelines and thought the suit should be dropped. Even after hearing Coleman’s arguments, the Krauses were insistent. They wanted legal documents ensuring the safety of the wetland, and were determined to fight the drainage project in court if necessary.

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**Fig. 1.** Schematic diagram of surface and subsurface flow to tile lines in agricultural areas of the midwestern USA (adapted from Magdalene and Alexander, 1993).
The Trout Stream

The MFE focused their case on the fact that the planned outlet of the drainage project was upstream of the designated trout stream. The stream was designated for protection because it was spring-fed and had trout-supporting habitat. Glen Steele pointed out, however, that the stream did not currently support a trout population. “There’s never been a trout in the stream,” he said. When MFE demanded that the petitioners modify the project to avoid increased flows to the trout stream, Glen said, “Most farmers are pretty practical people, and we looked at that and said you know…[Why should we] concede that to them for something that was never gonna be.” He did not believe that the stream had potential for restoration and did not agree that the drainage project would damage the stream.

The MFE reviewed the engineer’s report of the proposed project, and found that it would involve the construction of nearly 5 km of new open ditch and five new branch lines, which would outlet through a 1.2-m diameter pipe into a ravine approximately 3000 m upstream of the trout stream. The DNR did not have the authority to prevent the project’s construction, because the outlet did not discharge directly into the trout stream. This raised the concerns of officials in the DNR Division of Waters. Leo Griggs, an area hydrologist with the DNR, wrote to the deputy administrator of Northland County saying he thought it would be reasonable to require the project be designed to ensure that runoff did not exceed the current peak stream flow and velocity at the outlet. If that was not possible, then Griggs thought the petition should be denied so that all landowners were treated equitably. “As a society, we can no longer ignore the consequences of our actions with respect to the treatment of water,” he wrote.

“Our responsibility must extend to all landowners, both present and future.”

While the petitioners saw the project as a local, community-based issue, people who opposed the project thought it deserved large-scale public concern. Kenneth May, a petitioner and farmer, was disappointed to see outside groups intervening. “The neighbors are the ones being impacted,” he said, “and it’s their money that’s being used. If we were asking for public dollars it would be another story.” Glen Steele felt that the rights of rural people were being trampled upon. “You can’t expect a farmer,” he said, “on land he’s paying taxes on, to totally fund what urban people want.” But the opposition saw this drainage project as one of the many county- and local-level land use decisions that cumulatively cause larger environmental problems.

The Conflict in a Larger Context

The project watershed is nested within the Minnesota River Basin, a rich agricultural region stretching across most of southern Minnesota (Fig. 2). In 1997, the Minnesota River was named one of the “Twenty Most Threatened Rivers in the United States” (American Rivers, 2000). In recent decades, pollution of the river from agricultural runoff, leaky septic systems, and inadequate treatment of municipal wastewater had caused water quality in the river to decline to levels society was unwilling to accept. In 1989, federal, state, and local agencies undertook the Minnesota River Assessment Project (MnRAP), a comprehensive 4-yr study of pollution in the Minnesota River Basin. The MnRAP showed that agricultural runoff was contributing sediment and phosphorus that damaged water quality and fish habitat, and that ditching and sed-
Implementation were the most significant factors impairing stream biological communities (Minnesota Pollution Control Agency, 1994).

On a larger scale, the cumulative effects of local-level land use decisions in the Minnesota River Basin determine the sediment and nutrient loading at the mouth of the river, where it meets the Mississippi River, which in turn flows to the Gulf of Mexico. In recent years there have been periods of hypoxia in the Gulf of Mexico, in which a lack of oxygen in the water creates a dead zone. Excess nutrients carried in the Mississippi allow prolific growths of algae that consume oxygen as they die and decompose, resulting in oxygen levels too low to support aquatic life in the Gulf. A major cause of hypoxia is the input of nutrients contained in fertilizers and animal manure from thousands of agricultural fields in the Midwest.

The lawyers at MFE believed that the drainage project had the potential to impact downstream environments on a local scale (through direct effects on trout habitat). They also argued that effects were evident at the regional and national scales, through contributions to cumulative water quality impacts in the Minnesota River Basin, the Mississippi River, and the Gulf of Mexico. The lawyers saw the county’s approval of this drainage project as an example of poor environmental management, and were determined to set a precedent in the way drainage decisions are made. Leo Griggs, DNR hydrologist, supported their stance. He wrote to Dennis Coleman, engineer, saying, “Despite our lack of direct jurisdiction with respect to this project, I still have several misgivings concerning the potential for increased erosion, loss of wetlands, and increased flows... As you know, a great amount of effort and expense is being invested toward improving the quality and hydrology of the Minnesota River Basin. The cumulative effects of projects such as this clearly run counter to those efforts.”

Historical Context

When asked why he thought the project was singled out for public scrutiny, Glen Steele said, “We’re just coming to a time now when the hog (Sus scrofa) lots have really been picked on, and all the environmental stuff is coming to the forefront now, and a lot of circumstances came together.” He expressed worry about farmers’ future livelihood and said that many believe a time will come when no new drainage will be allowed. He also noted how people’s views had changed in his own community. “The interesting part of the Krauses,” he pointed out, “is that back in 1915 when this was put in, their dad was the original petitioner to get the drainage system in. So their dad wanted this drainage, and now these people are the ones who are trying to put a stop to it.”

Changing attitudes toward drainage have been reflected in Minnesota’s state drainage policies. In the early part of this century, state policy encouraged the conversion of wetlands to agriculturally productive land through tile drainage. Drainage systems were installed on millions of square kilometers of state land, and the Minnesota River Basin grew into a prosperous farming region that is today a vital limb of the state’s economy. By the late 1960s, however, attitudes toward drainage had begun to shift toward concern for the effects of drainage on the environment and natural resources. Scientists and the public began recognizing that wetlands provide valuable services including water storage, fish and wildlife habitat, and water quality improvement. Policies were implemented to discourage, rather than promote agricultural drainage, and in 1991, Minnesota passed the Wetland Conservation Act, establishing a “no-net-loss” policy to help preserve the state’s existing wetlands.

Many of the old tile systems in the Minnesota River Basin are breaking down, and are not big enough to carry the water flowing to them. Farmers like Glen Steele know that maintaining or improving drainage systems helps guarantee their economic survival in an era when many small farms have been forced out of business. Farmers have spent millions of dollars implementing best management practices to decrease the amount of sediment and nutrients that enter streams. State and federal programs have helped some farmers take erodible or agriculturally marginal lands out of production, but farmers often feel that they are being assessed more than their share of the burden of improving water quality.

Difficult Decisions

Glen Steele and the other petitioners were forced to make a series of important and potentially costly decisions. They hired a lawyer and were determined to defend their case in court. Attorney David Johnson of MFE specified the conditions under which his law firm would agree to a settlement of the case. He said that the project would need to be modified so that it did not drain or otherwise damage any wetlands, did not hurt the designated trout stream, and did not increase the flow of surface water into the Minnesota River. In a letter to Bill Wilkinson, the lawyer representing the petitioners, he wrote, “MFE’s objectives could possibly be met if water was drained at a slower rate over a greater length of time, using an outlet control structure to limit the discharge rate, combined with water storage basins to store excess water until it can be released. Further, if the water storage basins were designed as wetlands, away from the main course of the ditch and the tiling, this could address MFE’s water quality concerns.”

At this point, Glen and the other petitioners were facing estimated costs of approximately $50 000 in lawyers’ fees, $22 000 in court time, and the possibility of $20 000 to $40 000 in costs to make changes to the system that would suit MFE’s demands. These costs ($92 000–$112 000) were in addition to the original $830 000 estimated cost of the project. If they canceled the project at this point, they would lose $72 000 plus engineer’s fees, and would still be left with inadequate drainage. Potential benefits to the farmers if the project were constructed could vary widely, but most research has shown that on average, tile drainage projects will pay for themselves in 3 to 10 yr (Eidman, 1997). Thus, the petitioners faced sure losses by canceling, and increased income after 3 to 10 yr if the project were successful. When he went looking for help and advice, Glen said, “We found out it was a pretty lonely deal and not too many people want to help you. We went to groups that we help fund, like the corn growers and soybean growers. We were really put out that absolutely nobody really seemed to care about helping us a whole lot.”

Some petitioners wanted to fight MFE and some wanted to settle quickly and cut their losses. They asked Glen to lead the group in their decision. There were no guarantees if the case went to court, the direct costs were approaching $930 000, and there were concerns about being a good neigh-
Duration of activity, min

50-min class 90-min class

Introduction, clarification of process 5 5
Meeting of people playing the same role 10 10
Meeting of groups for debate, discussion, and development of consensus statements 25 45
Whole-class discussion, comment on product and process, reflection 10 30

We also lead a debriefing of the process involved, which may take place on the day of the in-class exercise if time allows, or at the next class meeting. This debriefing is an explicit guided reflection in which we discuss the development of the background paper, the initial discussion of character perspective, and the larger negotiation. We find this reflective step to be a critical part of the exercise. It allows students to better understand the pedagogy involved. Also, it allows them to vent about the fact that they had to adopt a position with which they did not agree. That, in turn, can lead to a productive discussion about the role of advocacy and decision-making, or can simply result in students realizing that they now have a greater appreciation for the other side of the argument.

Discussion Questions and Issues in the Case

1. What are some of the environmental, economic, and social issues raised in this decision case?
2. What other options might the petitioners consider that were not explicitly mentioned in the case? What other options might be considered by those opposed to the petition?
3. Environmental decision-makers, especially watershed managers, are currently facing a dilemma: we increasingly see the need to manage whole ecosystems and river basins to protect the integrity of our environment, but there is a simultaneous trend toward decision-making at smaller and more local scales. How do you think the case illustrates this dilemma?

4. What policy alternatives could you frame that would help guarantee the economic and cultural survival of farmers while still addressing environmental problems at the scale of the river basin?

5. What should Glen Steele do? In what way could he and the other petitioners have avoided this conflict in the first place?

Technical Background: Understanding the Effects of Tile Drainage and Channelization on Water Quality, Habitat, and Stream Organisms

Tile drainage and channelization of streams in agricultural landscapes result in increased peak stream flow, habitat degradation, and increased streambank erosion. The combination of increased flows, habitat loss, and associated water quality degradation leads to a loss of biological integrity in local and downstream areas.

Tributaries receiving tile-drainage runoff have higher average streamflow volumes and exhibit greater peakflow after rain events. The difference in flow due to construction or expansion of tile drainage systems can be modeled in an annual hydrograph (Fig. 3). In addition to flow differences, natural (unmodified) and channelized streams differ in water quality and available habitat for stream-dwelling organisms (Fig. 4). Surface runoff to local drainage ditches carries sediment and sediment-bound phosphorus from agricultural fields; subsurface flow through tile drains often carries high loads of nitrogen and pesticides. Some tile drainage systems have open inlets that allow excess surface water to drain vertically from the field into a pipe, then flow laterally through that tile to the local stream. In these situations, tile drains often carry additional loads of sediment and phosphorus. Channelized tributaries are often located upstream of natural stream reaches (e.g., in the present case study, runoff and streamflow from Glen Steele’s watershed drains to a downstream tributary with protected trout habitat). Thus, water is exported from...
channelized streams (drainage ditches) and contributes to the degradation of downstream habitats.

Sediment has a wide range of effects in the receiving stream, including smothering plants and animals and clogging the gills of fish. Higher and less variable water temperatures deprive stream organisms of the thermal cues needed to trigger events such as spawning or emergence to the adult phase. Phosphorus draining from agricultural fields usually is associated with sediments, but can enter the dissolved phase once in the stream. Increases in dissolved or bioavailable phosphorus stimulates nuisance algal growth, which can then cause oxygen depletion in the stream.

Nitrates are a form of nitrogen that is oxidized and dissolved in water. In high concentrations (e.g., >10 mg/L), nitrates can be toxic to mammals; they are especially dangerous to young animals such as calves (Bos taurus) or piglets. Nitrates rarely have a direct effect on plant growth in freshwaters in the temperate zone; however, in marine systems they stimulate large growths of algae that eventually die and decompose. The decomposition process consumes oxygen; the lack of oxygen (i.e., hypoxia) can cause massive fish kills in areas such as the Gulf of Mexico.

Analysis

This case places participants in the role of a local level decision maker (a farmer) who faces a complex decision. The case simulates a common situation, one students and instructors can find in their local communities, and thus it is relevant to their lives. The students become engaged in the case and that stimulates active learning; there is structure in the way they divide and re-divide into groups in the classroom exercise, and we have found that the discussions become heated as students adopt various roles. The issues in the case require a depth of thought in decision making; there are clearly supported arguments that oppose one another. Some of the substantive issues addressed, which might be worthy of further depth of discussion as time allows include:

- Economics of small scale agriculture (e.g., asking a student what he or she would need to know to judge Glen Steele’s decision on economic terms).
- Water quality management (e.g., discussing the anticipated quality of water leaving a tile drain and its probable impact on a trout stream, or hypoxia in the Gulf of Mexico and the potential contribution to that problem by Upper Midwest agriculture).
- Regional and local environmental policy (e.g., contrasting local values versus the values of an adjacent urban population, and questions about cumulative effects).

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REFERENCES