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Developing Participatory Models of Watershed Management in the Sugar Creek Watershed (Ohio, USA)

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ABSTRACT: The US Environmental Protection Agency (USEPA) has historically used an expert-driven approach to water and watershed management. In an effort to create regulatory limits for pollution-loading to streams in the USA, the USEPA is establishing limits to the daily loading of nutrients specific to each watershed, which will affect many communities in America. As a part of this process, the Ohio Environmental Protection Agency ranked the Sugar Creek Watershed as the second "most-impaired" watershed in the State of Ohio. This article addresses an alternative approach to watershed management and that emphasises a partnership of farmers and researchers, using community participation in the Sugar Creek to establish a time-frame with goals for water quality remediation. Of interest are the collaborative efforts of a team of farmers, researchers, and agents from multiple levels of government who established this participatory, rather than expert-driven, programme. This new approach created an innovative and adaptive model of non-point source pollution remediation, incorporating strategies to address farmer needs and household decision making, while accounting for local and regional farm structures. In addition, this model has been adapted for point source pollution remediation that creates collaboration among local farmers and a discharge-permitted business that involves nutrient trading.

KEYWORDS: Agriculture, conservation, culture, participatory, watershed

INTRODUCTION

Koontz et al. (2004) state that government institutions in the United States, such as the US Environmental Protection Agency (USEPA),[1] have recently moved toward a more collaborative approach to solving non-point source water problems. Yet, as this article discusses, the experiences of many farmers in the Sugar Creek Watershed of Northeast Ohio reveal that agency success often relies on the individual personalities of agents working in local communities, rather than on an inherent quality of the institution. Nonetheless, this changing paradigm of community and agency interaction has created an opportunity for farmers of the Sugar Creek Watershed to partner with researchers at the Ohio Agricultural Research and Development Center (OARDC) in designing and implementing a unique water quality remediation programme attuned to the needs of residents and the specific characteristics of each subwatershed.

Historically, the USEPA has used an expert-driven approach to watershed management. In an effort to regulate pollution-loading to streams in the USA, the USEPA is establishing non-point source limits to

[1] The USEPA is an institution of the United States Government charged with the protection of the physical environment.

the daily loading of nutrients specific to each watershed. This process, referred to as the Total Maximum Daily Loading (TMDL) regulation, will affect many communities in America. In 1998, the Ohio Environmental Protection Agency (OEPA) cited the Sugar Creek Watershed as the second "most-impaired" watershed in the State due to sedimentation, excess nutrient loading of phosphorus, nitrates, and ammonium (P, NO_3-N, NH_4-N), low dissolved oxygen, high temperature, habitat loss, and bacteria, which are mostly attributed to agriculture (USEPA, 2000).

While Koontz et al. (2004) differentiate among multiple roles for government in watershed management, from a farmer's perspective Midwestern farming communities are disproportionately blamed for pollution problems. Concurrent with this assessment is the perceived problem that local input to government-sponsored conservation program development begins at the 'adoption stage' in which local agents find volunteers to participate after programme development has already occurred. This devaluation of local human resources and knowledge puts many potential participants at odds with a programme that emerges in the public mind from a centralised bureaucratic agency that entangles participants in the red tape of administrative rules and conservation programme guidelines. Additionally, Best Management Practice (BMP) specifications are perceived by farmers as narrowly developed and creating unnecessary spending that is not only unnecessary but incommensurable with the problem.

Furthermore, the voluntary nature of government conservation programmes and the rhetoric of 'the bad farmer' ensure that the most serious contributors to the water quality problems are unlikely to participate. One final accusation associated with this system is that government agencies, each with a different administrative agenda, often have competing visions for remediation and have different prescribed 'balances' for environmental stewardship. Consequently, potential participants are keenly aware of the often subtle differences in agency program assumptions, which farmers see as reflecting environmental preservation biases held by those in the agencies.[2] In considering a new approach to pollution reduction, it is important that the perceived inconsistencies in conservation programming be resolved. This research addresses these issues.

According to Morton and Padgitt (2004), there are no singular solutions to environmental problems that are adaptable to every situation. This article uses case studies to present the people and the multiple strategies of the Sugar Creek Method that are used to improve water quality in their part of the Sugar Creek Watershed (Parker et al., 2007; Morton and Padgitt, 2004; Moore et al., 2008). Four case studies were conducted to document the different approaches taken by the following watershed groups: the Sugar Creek Partners, North Fork Task Force (NFTF), the South Fork Amish, and Alpine Cheese Company. The approach described in this paper advocates early participation of residents in the identification of solutions and implementation of conservation programme activities, making it a unique contribution that spans farm scales and communities (e.g. large-scale specialised farms, small-scale diversified Amish). This marks a shift to conservation programming that emphasises community participation and valuation of local knowledge based on "ecosystem principles" with "people as active participants" in the system (Schellas, 2003).

From this point, the paper continues with a detailed discussion of the social background, farming strategies, and different water quality problems in each subwatershed as assessed by the OEPA. Then, the literature related to ecology and water quality remediation is presented. This is followed by a discussion of the case studies detailing the history and development of the four team approaches in the respective subwatersheds followed by a discussion and comparison of the successes achieved and the challenges encountered in each case. Finally, conclusions are offered regarding the strategies used and broader implications for moving forward in developing socially and economically compatible, productively efficient, and environmentally sustainable conservation programmes.

[2] The USDA tends toward an anthropocentric approach to water quality while the USEPA is viewed as too fish-friendly.

BACKGROUND

Farmers in the American Midwest have experienced rapid transition since WWII. Ohio, located on the eastern edge of the 'corn and soybean belt', exemplifies the national trends in agricultural economic development (Moore et al., 2008) that include: increased farm size associated with leasing, industrial farming models focusing on price and yield, higher capitalisation and debt of the farm operation, increases in commodity transportation distances, horizontally and vertically integrated commodity chains, decreased food varieties, migrant labour, and lower self-sufficiency of food production. The results of this agricultural transition are a number of social and environmental problems that are compounded by increased exurbanisation [3] and sprawl that have become central topics in environmental research.

While researchers, government agents and farmers have perceived soil erosion and water quality as a problem in the United States since colonial times, very little prevention had been practised until the drought and erosion crisis of the 1930s (Rasmussen, 1982). This lack of concern resulted from a perceived abundance of resources resulting from the large government subsidies available for settlement and development. As a result, there was little incentive for farmers to be concerned with soil or water conservation. Since the environmental crisis experienced in the first half of the 20th century, government agencies, Land Grant Institutions, and conservation and agricultural organisations have offered numerous solutions for the water quality crisis in the Midwestern United States.

Historically, state regulators have relied on various methods for achieving water quality improvements. While the USEPA often uses negative social sanctions in achieving regulatory compliance, other contemporary agencies such as the United States Department of Agriculture (USDA) and the National Resource Conservation Service (NRCS)[4] emphasise a voluntary approach (Flora, 2002). These programmes use the 'expert model' of regulation initiated in the 1930s by the Soil Conservation Service (now NRCS) whose agents promoted technical assistance that often increased on-farm productivity (Weber and Margheim, 2000). In addition, the USEPA has emphasised protection of the main streams shown on US Geological Survey maps but, until recently, has paid little attention to headwater streams[5] (Davic and Anderson, 2002). Today, most of the conservation programming in the US follows this model, described by Napier and Bridges (2002) as Information, Education, Technical assistance, and economic Subsidies (IETS).

Since 1998, TMDL limitations have been developed to address water quality problems in the Sugar Creek. Collectively, the impairments become mutually reinforcing (e.g. a decrease in riparian trees creates increased sedimentation because of the decreased soil-holding capacity). Community action emerged from a participatory research process emphasising local values, as described by Moore et al. (2008). This later transformed into a participatory governance process. These processes are central to this research as part of an emergent water quality remediation methodology developed by community members and researchers referred to as the 'Sugar Creek Method'. It has a combination of elements that allow for an adaptable, flexible partnership of local and expert knowledge built on grassroots input. The first step is to reorient the traditional 'downstream' approach of OEPA by emphasising headwaters. Next is an innovation in the community organisation that treats each sub-watershed as a unique physical, biological, and social unit, and that establishes headwater 'benchmarks' to document the physical, biological and social attributes of each subwatershed. Social benchmarking is used to

[3] Exurban development, or exurbanisation, refers to urban patterned, low-density development in rural areas within the commuter zone of an urban area.

[4] The NRCS (Natural Resource Conservation Service) is a division of the USDA (United States Department of Agriculture) and is responsible for oversight and administration, in partnership with local SWCDs (Soil and Water Conservation Districts), of government conservation programmes and BMPs (Best Management Practices).

[5] USGS 7.5' topographic maps show ~21,000 miles of 'blue-line stream', but recent Primary Headwaters Habitat evaluations estimate over 115,000 miles of headwater streams that drain to the 'blue-line' streams, and thus drain the majority of Ohio land (Davic and Anderson, 2002).

understand the people and their values, which require a study of their awareness, concerns, and visions, related to the stream, land uses, and trust of local agencies and organisations. Biophysical benchmarking provides a comprehensive assessment of water quality, habitat and biological features using scientific and local knowledge. These benchmarking processes are described in Parker et al. (2007) and Moore et al. (2008).

Environmental policy and natural resource management

Community watershed initiatives are difficult endeavours. Anthropologists have called for the inclusion of ethnographic methods, local indicators and perspectives in the development and implementation of such projects (Moran, 1990; Salamon, 1992; Bennett, 1993; Moore, 1996; Nazarea et al., 1997; Thu and Durrenberger, 1998; Kottak, 1999; Rhoades, 1999; Parker et al., 2007; Parker and Moore, 2008).

Upadhyay et al. (2003) describe three approaches to understanding conservation adoption. The first uses a classical economics approach that assumes a person will adopt only if there is a profit motive. The second employs a diffusion of innovation approach (see Rogers, 1962; Brown, 1981) in which the emphasis is placed on the conservation message and its dissemination. The third combines aspects of the two former approaches in suggesting that farmers will adopt a practice if they receive adequate information and perceive it to be beneficial and profitable for them (Upadhyay et al., 2003).

Participatory approaches in watershed governance and research

Both participatory governance and research methodologies are used in this project. While a large body of literature exists on participatory watershed development and management, Rhoades' (1999) assertion that there is little literature specific to participatory approaches emphasising headwaters still remains. Other participatory approaches in watershed and agricultural research have been described by Rhoades and Booth (1982) and Chambers (1983), and more recently in development in India by Kolavalli and Kerr (2002) and in East Africa by German et al. (2008). Rhoads et al. (1999) describe a project in Illinois where the local citizens and university researchers worked together in an open-ended way towards stream naturalisation. Other alternatives to traditional expert-driven models have been recently promoted by the USEPA, such as the Community-Based Environmental Protection (CBEP) and Watershed Protection Approach (WPA) (Crismon, 1999). Weber (2003) describes grassroots ecosystem management (GREM) in which rural residents work collaboratively to address natural resource issues. These groups often work in reaction to government agencies emphasising local knowledge over scientific and other specialised knowledge of agencies and scientists. Parkes and Panelli (2001) describe participatory action research in the Taieri River Catchment in New Zealand and stress the importance of horizontal and vertical connections between diverse coalitions of watershed stakeholders.

Culturally based indicators (Nazarea et al., 1997) are used to assess perceptions of watershed health. Morton and Padgitt (2004) analyse several theoretical and methodological approaches to understanding watershed management that include a diverse array of measurements, such as social sanctions, civic structure, economics, sense of place, and cultural or ethnicity factors. They further report that solutions to environmental problems will be rooted in a plurality of factors nested within a multi-scalar approach, in which there are no singular solutions adaptable to every situation. Their findings make clear that different groups will approach a watershed concern with different questions dependent on their interests and needs. As in the Sugar Creek, these questions will direct and influence the recommendations and actions taken.

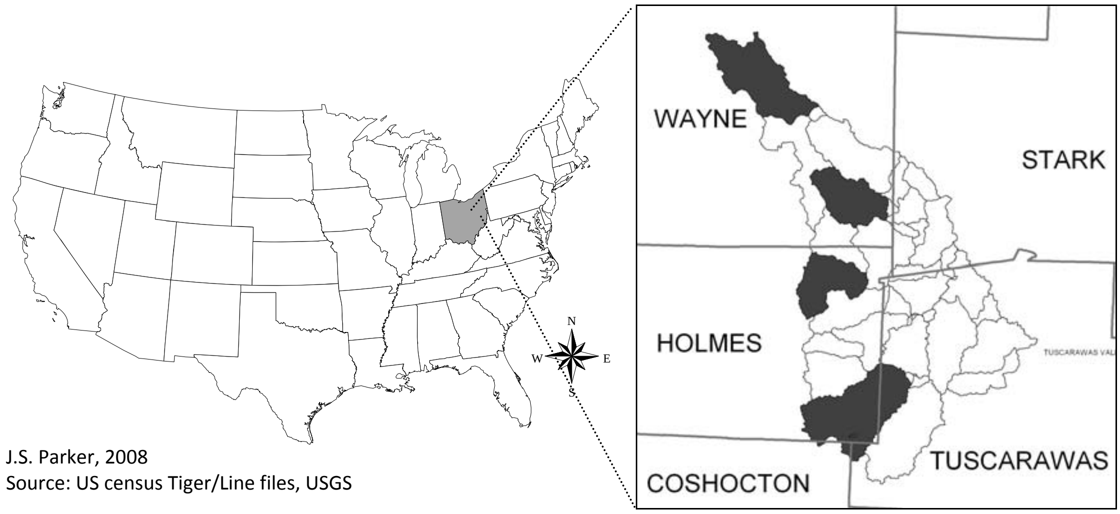
Stream ecology

The mainstream approach of USEPA to regulation overlooks many headwaters streams in most stream management assessment scenarios (Hansen, 2001; Moore and Richardson, 2003; Svec et al., 2005). Krecek (1981) notes the importance of benchmarking headwaters. Primary headwaters are subwatershed areas draining typically less than one square mile and made of streams that are classified into three types based on flow (ephemeral, intermittent, or perennial flow), substrate, width, and fauna. Most of the stream networks are made up of these primary headwaters, which provide numerous ecological services including nutrient cycling, water filtering, water retention, flood mitigation, and habitat creation (Nadeau and Rains, 2007; MacDonald and Coe, 2007). The importance of primary headwaters has been highlighted in recent OEPA habitat evaluations According to Peterson et al. (2001), primary headwater streams have the greatest potential and shortest response time for nitrogen and phosphorus filtering. The findings in these reports support the logic and approaches of the Sugar Creek Method.

CASE STUDIES

The subwatershed study sites include the Upper Sugar Creek, North Fork, Middle Fork, and South Fork subwatersheds, principally located in Wayne and Holmes counties, Ohio (see figure 1). They are part of the Muskingum sub-basin that is a headwater of the Mississippi basin. Wayne and Holmes counties produce diverse agricultural products and represent two of the largest dairy counties in Ohio (USDA, 2002). The historic settlement patterns of the counties overlap with the watershed to produce a gradient in social organisation and land use and offer a microcosm of Midwestern American agricultural communities. Additionally, the Sugar Creek falls on the divide between the glaciated and non-glaciated sections of the Allegheny Plateau, creating differences in topography, geology and soil, and ecosystems.

Figure 1. Location of the Sugar Creek Watershed within the State of Ohio, USA. From north to south: Upper Sugar Creek, North Fork, Middle Fork, and South Fork.



Ohio has the largest Amish settlement in the world with approximately 70% of the Ohio Amish living in the area of the Sugar Creek. Other less traditional Anabaptist communities that include Apostolic, Mennonite, and Swiss Brethren also live in the Sugar Creek. These cultural groups strive to avoid conflict and public acrimony, preferring to maintain harmony by using social pressure toward conformity to a common set of social values. Cultural and geographic patterns in the watershed vary from northwest to southeast. The patterns found in each of the four subwatersheds are listed in table 1.

Using the benchmarking results of each subwatershed, participatory grassroots groups are catalyzed in a way that fosters their visions and approaches to remediation. This is done by understanding the local community structure, such as social networks, values, farm types (e.g. row crop, dairy, hog, etc), and sizes. After these steps have been taken the process begins by building collaboration among subwatershed groups.

Table 1. Social and environmental features of Selected Sugar Creek subwatersheds.

Subwatershed	Participatory team type	Heritage characteristics	Farming characteristics	Major pollution problems §	Major pollution causes §
Upper Sugar Creek	Farmer-led; grassroots; Neighbours with land on stream; works with the Agroecosystems Management Program (AMP); multi-step.	German with some English and French (referred to as 'English', or non-Amish)	Dairy, hog, and grain farming (average farm size 287 acres)	Organic enrichment/DO (H); habitat alteration (H); sedimentation (H); nutrient loading (M); wetland loss (H); pathogens (H).	Pasture (H); agriculture (H); riparian vegetation removal (H); stream-bank modification (H); channelisation (M); flow regulation/modification (M).
North Fork	County Soil and water conservation District-led community leaders from diverse organisations; pluralist.	Mixed German, Swiss Mennonite, and Old Order Amish	Dairy, poultry, and Amish rotations (farm size about 228 acres)	Nutrients (H); sedimentation (H); habitat alteration (H), pathogens (H); ammonia (M); flow alteration (H).	Pasture (H); feedlots (H); animal-holding areas (H); septic tanks (H); channelisation (H/M); removal of riparian vegetation (H); flow regulation/ modification (M); septic point source (M); minor industrial point source (M).
South Fork	Amish churches, parochial schools, oat-threshing rings, and silo-filling rings.	Old Order Amish	Dairy and Amish rotations, cash vegetable crops (farm size of 80 acres)	Habitat alteration (H); sedimentation (H); nutrient loading (H); flow alteration (L); pathogens (H); loss of wetlands (H).	Agriculture (H); Pasture (H); Riparian vegetation removal (H); Streambank modification (H); channelisation (M); Flow regulation/modification (M); Mining activity (L).
Middle Fork	Local NPDES* permit-holding business, Amish churches, parochial schools, oat-threshing rings, and silo-filling rings.	Mennonite, Old Order Amish	Dairy and Amish rotations, cash vegetable crops (farm size of 80 acres)	Habitat alteration (H); sedimentation (H); nutrient loading (phosphorus) (H); flow alteration (L); pathogens (H).	Agriculture (H); Pasture (H); riparian vegetation removal (H); stream-bank modification (H); channelisation (M); flow regulation/modification (M).

§ Intensities of major pollution problems and causes are indicated by (H) high, (M) medium, (L) low.
* National Pollutant Discharge Elimination System (NPDES)

An assumption at the base of the Sugar Creek Method is that the participatory structures that emerge will be different for each subwatershed. Furthermore, a grassroots process is necessary to build watershed groups in which there is a genuine collaboration among local residents, government agents, and scientists that combines the requirements of government with the needs and values of local residents.

Case studies are used in presenting the results collected from several sources between 1999 and 2005. These sources include: participant-observation at farmer meetings (20), stream days (4), family days (4), and conservation workshops (5), and numerous informal meetings and conversations with community members and agency personnel. Additionally, semi-structured interviews (35) were conducted using a stratified snowball sample of head of households from each subwatershed that farm the land on or adjacent to the Sugar Creek or tributary. Unstructured oral histories (30) were performed with members of both farm and non-farm households in each subwatershed. Based on these data, we are able to create an accurate portrayal of the development, successes and challenges of each of the four subwatershed cases.

The first case (North Fork) describes an 'agency model' of team formation. The Upper Sugar Creek and South Fork provide examples of a 'grassroots model'. The fourth case (Middle Fork), the Alpine Cheese Company Nutrient Trading Project, explores the potential benefits of coupling social and technological solutions to address water quality problems and represents a blending of agency model and grassroots approaches as explained below. The cases are presented in the order in which each was started.

Case study #1: North Fork Task Force (NFTF)[6]

The North Fork is a mixture of Old Order and more traditional Swartzentruber Amish, and other predominantly larger conventional Mennonite farm households managing a mixture of grain and dairy farming. The average total farm size is around 228 acres with average leasing being less than in the Upper Sugar Creek (Parker et al., 2007).

The North Fork Task Force (NFTF) was formed at a public meeting in January, 2000, as the first subwatershed group in the Sugar Creek Watershed. The beginning of the NFTF stems from a series of meetings among Wayne Soil and Water Conservation District (Wayne SWCD) and other local, state and federal agencies, principally the National Resource Conservation Service (NRCS), Ohio State University Extension (OSUE), and Wayne County Environmental Services. What resulted from these meetings was the desire to create a model subwatershed that will spur further local interest and promote increased conservation-adoption in surrounding communities (Wayne SWCD, 1999). Shortly thereafter, a Technical Advisory Committee (TAC) was formed to design and implement a community initiative in the North Fork subwatershed. TAC membership came mainly from the above government agencies with representatives of three additional local groups: the Wayne County Health Department, the Northeast Ohio Four County Regional Planning and Development Organisation (NEFCO), and the OEPA Sugar Creek TMDL team (Schultz, 2002).

The North Fork was chosen for the following reasons: OEPA's assessment of severe water quality problems in the Sugar Creek; it would allow a grassroots approach that would focus on "backyard conservation practices"; local agency personnel wanted to establish a closer working relationship with members of the Amish community, which occupied "approximately 44% of the acreage in the North Fork Watershed" (Schultz, 2002); and agency personnel were integrated in existing social networks in the community.

From its inception, the local members of the "TAC wanted to see the community landowners in charge of the situation and be the driving force behind any action taken in the watershed" (Schultz, 2002). It was also decided that NFTF members should represent a broad spectrum of North Fork

[6] Background data on the North Fork Taskforce comes from original documents and interviews presented in greater detail in Weaver et al., 2004.

communities and should include "farmers (both Amish and English), businessmen, township trustees, community council members, schoolteachers and administrators, and any other concerned landowner who wishes to attend the meetings" (Schultz, 2002). Eight prominent community leaders representing various groups within the subwatershed were recruited to leadership positions and a push for community participation was underway. These eight persons represented the following groups: Amish and non-Amish residents, farmers, business owners, educators, and members of the local government.

By February, 2000, there were 23 NFTF members who had chosen a 'chairman', adopted a 'statement of purpose', and discussed a committee structure proposed by members of the TAC. In March, members reviewed and adopted a mission statement which reads as follows:

> Promote the restoration and rehabilitation of the North Fork of the Sugar Creek through coordinated volunteer efforts and by encouraging the use of Best Management Practices within the watershed (NFTF, 2000).

Members also began to write an Ohio Department of Natural Resources (ODNR) Watershed Action Plan in which Task Force members would identify water quality problems and develop a strategy to resolve them. This plan requires a great deal of information-gathering regarding soils, land use (e.g. agriculture, commercial, residential, etc) and hydrology of the subwatershed and a large commitment from team members to identify local solutions.[7] Four committees were formed by April to begin developing and writing the watershed plan. A draft covering the four Sugar Creek subwatersheds in Wayne County was ready by the summer of 2001; it was completed in January of 2002.

There were other issues addressed by the NFTF. It was important to secure funding for a 'watershed coordinator' position that would be responsible for coordinating remediation projects in the Sugar Creek and obtaining grants to support programmes. Because of extremely elevated *E. coli* levels in the streams due, in part, to direct household sewage discharge,[8] the NFTF took a leadership role in organising the planning of an OEPA-mandated wastewater treatment plant. Milk-house waste, a by-product of dairy production, was a large problem in the North Fork and other subwatersheds in the Sugar Creek because its effluent adds a significant amount of phosphorus to the creek.

There was a decline in Task Force activity by the summer of 2001. The NFTF leadership felt that members were confident "the planned wastewater treatment plant will solve most of the problems impacting the stream". Stakeholder enthusiasm waned because the team was formed around a specific purpose that the community felt they had successfully achieved. Another challenge to this type of approach was that the group relied too heavily on the organisational skills and directed goals of the watershed coordinator, who was charged with implementing the goals listed in the Watershed Action Plan.

The plan in the community was now to "sit back and wait to see if the wastewater treatment plant solved the water quality problem". In addition to this, there was a sense of 'burnout' felt among NFTF members who had dedicated an incredible amount of energy in a very short period of time to create and accomplish these goals. This included focusing on local needs while navigating among the myriad of rules and mandates that included producing several time-sensitive reports for the highly bureaucratic OEPA and ODNR. Currently, there is little activity within the NFTF organisation with the exception of several Amish members from the same church district who are still actively engaged in their own local water quality projects.

[7] The Watershed Action Plan is not a requirement for ODNR funding of the Watershed Coordinator position for the NFTF, but subsequent plans have required endorsement by ODNR prior to receiving funding.

[8] As noted below, agricultural animals, particularly dairy cows, were also cited as contributing to the pathogen-loading to the North Fork streams.

Case study #2: Sugar Creek Partners

The second case study is of the Upper Sugar Creek team who call themselves the Sugar Creek Partners. The Upper Sugar Creek area is predominantly farmed by Anabaptist (Apostolic, Mennonite, and Swiss Brethren) households; there are no Amish. Tractors and combines are used because labour is more difficult to recruit because of demographics (e.g. small families) and farm structure (e.g. large farm and high labour costs). Grain farming is the dominant agricultural type with a 2-year corn-soybean pattern, followed by dairy. The average total farm size, including leased land, is approximately 287 acres with nearly two-thirds of the farmers using leased land (Parker, 2006).

Beginning in 1999, members of the interdisciplinary Agroecosystems Management Program (AMP),[9] of the Ohio Agricultural Research and Development Center (OARDC), planned a watershed research project to foster a different remediation programme from the dominant expert-driven model. The goal was to initiate a project focused on the Sugar Creek headwaters that emphasised combining research and grassroots team formation. The AMP chose the Sugar Creek because of its cultural uniqueness, OEPA's classification, and the subwatersheds proximity to the main research station of the OARDC, which would allow for continuous interaction with community members.

The Upper Sugar Creek case is distinguished from the North Fork by the emergent qualities of the farm team as they relate to their values of moral responsibility. The team evolved out of the social dynamics of the local area rather then having a structure imposed from outside. The emergent team was initially composed exclusively of farmers, who were viewed as being the best suited to initially address solutions because they controlled much of the land around the affected streams. Except for one grain farmer, team members have mixed livestock and grain operations and are self-selected through an informal nomination process, or 'snowball' approach in which the first farmer, AMP's initial contact in the subwatershed, contacted three additional farmers with whom the farmer was comfortable working and who would be interested in water quality solutions. They chose to meet regarding local needs and OEPA's water quality findings. Shortly thereafter, using the same criteria, each of these three farmers decided to select three to four additional neighbouring farmers and to invite them to the group. Large-scale or prominent (i.e. elite or powerful) farm operators were not invited by the team as a conscience decision to avoid the dominance of one personality or agribusiness influence.

In September 2000, the Sugar Creek Partners met for the first time and have since met monthly during the non-growing season. The meetings are informal and the team lacks a committee structure and a formal voting procedure. Rather, they make consensus-based decisions after items are discussed. Members have the opportunity to talk, debate, and otherwise discuss items and are free to speak against a suggestion and members are not required to agree on everything before a decision is made. This may appear contradictory, but the informal nature of the group means that members have the option to object and still offer their consent to an action, and choose to not participate. AMP members, who regularly attend the meetings use USDA Sustainable Agriculture Research and Education (SARE) funding to provide the meeting location, help with the logistics and meeting content (e.g. scheduling guest speakers), and offer technical advice and research capabilities related to conservation and other farming issues.

Sugar Creek Partner meetings generally have an agenda based on current issues (e.g. on-farm energy costs and efficiencies, ideas for 'home-grown' conservation practices), current and alternative farming practices, water quality analyses, and educational programmes and operate much like a 'learning circle'. The first few meetings formed a discussion regarding OEPA's water quality tests during which time team members expressed much doubt about the validity of those data. These doubts were formed not only out of a distrust of OEPA, and government in general, but also because the farmers

[9] AMP team members represent several disciplines including agricultural economics, agronomy, animal science, anthropology, entomology, horticulture and crop sciences, political science, and rural sociology, among others, and they participate in programmes that seek to integrate community participation.

perceived the data points to be too few and covered too many acres of land to be relevant to them. From their perspective, it was not possible to infer the sources of impairment with respect to their farm. These perceptions prompted the farmers to devise a testing protocol in collaboration with OARDC scientists that would initially sample 21 sites in the Upper Sugar Creek on a biweekly schedule. Using funds from an OEPA grant, this was later expanded to 105 sites covering the entire watershed. While the farmers awaited the results of their first year of testing, they decided to take action to improve their watershed even if the results showed OEPA was either wrong or that their farms were shown to be 'clean' (Moore et al., 2008).

This team emphasises experience and activities in conjunction with education. Many conservation organisations offer educational resources to the community but this group has decided to make experiential learning central to its programme. This is accomplished in several ways. Farmers have yearly farm tours in which two to three team members prepare on-farm demonstrations and a tour of their operation to share their strategies and challenges as well as exchange ideas with other team members that can assist the entire team. Other activities include 'family stream days' in which team members and other invited families spend the day learning about an aspect of stream ecology by having activities in or around the stream. Another technique that members use is to create their own on-farm research to test the efficacy of a particular Best Management Practice (BMP), such as late-spring nitrate testing.

The informal strategy toward recruiting members, emphasis on education through experience, preference for pragmatic decision making and a solution-oriented approach have been crucial to the long-term development and success of the team. The results of the water quality tests showed OEPA’s data were correct. When this became apparent to the team members, most of them enrolled or updated their farm conservation plans at the county SWCD. Unlike the NFTF, the Sugar Creek Partners have been successful in maintaining their group integrity and interest. There has been fluctuation in membership from year to year based on interest in meeting topics and activities, but members continue to participate. Additionally, the group has frequently worked with other groups or institutions and has increasingly attempted to communicate with the wider community.

Case study #3: South Fork Sugar Creek Amish

The South Fork offers an exceptional example because of its topography and cultural uniqueness in being farmed exclusively by Old Order Amish households. Long (2003) sets the average farm size at 80 acres. In this section of the watershed, and a few others nearby, Amish households and farms tend toward organising church district boundaries along natural divisions of watershed areas. Amish social structure makes the church district an ideal existing network to tap into for the development of local watershed teams without replicating or attempting to design a unique form of social organisation (Rhoades, 1999). The abundance of local labour provides positive feedback for supporting labour-intensive small dairy operations using draft horses. Proximity and interaction among residents, and common goals create a sense of place that enhances social capital and strengthens ability to coalesce around natural capital, such as local streams.

The cumulative lessons learned in the Upper Sugar Creek and the North Fork were applied in catalyzing farmer teams in the South Fork Sugar Creek. In the winter of 2004, discussions began among North Fork Amish participants, AMP and both the Wayne and Holmes County SWCD to develop a similar participatory approach to working in the South Fork subwatershed. After initial discussions among these groups, members of AMP and the Holmes SWCD, following the advice of the North Fork Amish leaders, worked through existing connections in the South Fork Amish communities to establish contacts with prominent Amish leaders from two different church districts; both church districts were along a main tributary south of Farmerstown, a small village centre.

An informational meeting was organised and conducted in the evening by lantern light in the barn of one of the Amish Bishops. This familiar social setting allowed for traditional forms of social intercourse among the Amish. The issue of water quality was discussed using maps and aerial photos with sampling data points. These were important in demonstrating the relationships among farm management practices, streams, sample sites and data. When the Amish in attendance saw these, they immediately made the connection between the stream impairments and the potential health risks to their families and livestock and responded by stating that something must be done to improve the water quality. Soon thereafter, in May of 2004, the South Fork Amish visited the North Fork to see their fencing and stream exclusion and get ideas about water quality and organisation. This was in part due to the success that the North Fork Amish had in reducing the somatic cell count from their milk,[10] which, in addition to providing for healthier animals, enhanced their profitability by receiving a premium milk price.

This 'team' coalesced around an already existing social structure of two local church districts whose members had a vested interest in improving the quality of the stream water as a social and economic benefit (e.g. community image, family health and animal health, lower somatic cell count, respectively). By mid-July of 2004, seven Amish households had made arrangements for Comprehensive Nutrient Management Plans (CNMP) to be created for their farms. Additionally, with further technical and financial assistance[11] from the Holmes County SWCD and AMP, the Amish farmers in these church districts had installed more than 6000 linear feet of livestock exclusion fencing along their segments of South Fork streams. In collaboration with members of this team, AMP and Holmes SWCD have also created one final approach to water quality remediation involving the Alpine Cheese Company, which is the focus of the final case study.

Case study #4: Alpine Cheese Nutrient Trading

The fourth case is the nutrient trading programme in the Middle Fork involving the Alpine Cheese Company of Winseburg, Ohio, that AMP, and local Amish farmers from the Middle and South Fork subwatersheds. This case represents the blending of an 'agency model' with a grassroots approach and is unique in this analysis because of the circumstances surrounding programme development and the strategy used in its implementation. Furthermore, it highlights the continuous or interconnected approach of the Sugar Creek Method in building complementary networks of collaborative farmer teams. This trading programme is the first of its kind in that it represents a voluntary but targeted approach to water quality remediation by implementing innovative conservation practices that are scaled to Amish farms and in areas of the watershed with proven need. This is different from other programmes that are based on a voluntary, first-come first-serve approach.

The Alpine Cheese Company, a producer of specialty cheeses including the renowned Jarlsburg© previously made only in Norway, renewed its National Pollutant Discharge Elimination System (NPDES)[12] permit in 2005. This NPDES permit limits phosphorus (P), a cheese manufacturing byproduct, release to the stream and establishes a phosphorus-nutrient trading protocol specifically focused on the Middle Fork Subwatershed.

In late April 2004, members of the AMP team were contacted by associates from ATS Engineering, Inc.; an environmental management consulting firm hired by the Alpine Cheese Company, regarding the need for the company to reduce phosphorus effluent to be in compliance with NPDES permit mandates from OEPA. These mandates, included in the Sugar Creek TDML, established a phosphorus level of 1 mg/litre of water per day. Alpine Cheese was releasing 225 mg/litre of water per day prior to approval of the NPDES permit. With the establishment of the 2005 nutrient trading programme, Alpine Cheese

[10] Somatic cell testing is used as a quality marker for milk in which a lower count indicates healthier animals and allows for higher milk prices.
[11] The Amish farmers accepted technical assistance and fence building materials and equipment, but in keeping with their desire to avoid direct government ties, no direct payments were made.
[12] NPDES permits are issued by state Environmental Protection Agencies to regulate point source discharges by limiting the concentration of nutrients in waste-water effluent. The limited nutrients are specific to each permit.

has implemented a technological solution to reduce emissions to 4 mg/litre of water. It was recognised by the participants early in the NPDES planning process that the technology needed to remove 221 mg/litre of phosphorus from the water would cost as much money as it would to reduce them an additional 3 mg/litre, from 4 mg/litre to levels meeting OEPA TMDL standards (1 mg/litre). This would double Alpine Cheese's financial commitment to complying with the NPDES permitting process. The company's president, in collaboration with AMP and ATS Engineering, decided to use their resources toward phosphorus reduction across the community rather than toward purchasing more expensive technology. The decision was made to achieve full compliance with the OEPA 1 mg/litre mandate by installing water filters to reduce the phosphorus concentration to 4 mg/litre and paying more than US$800,000 over 5 years to the Holmes County SWCD, the OARDC, and most importantly local farmers in the Middle Fork, and other nearby watersheds, "to implement conservation measures (e.g. sand infiltration beds for milk house waste, grass waterways, and livestock exclusion fencing) that will further reduce phosphorus levels and counteract the emissions from Alpine Cheese" (Moore et al., 2005). In this trading programme, farmers receive payments from Alpine Cheese for implementing BMPs that will reduce phosphorus. In return, Alpine Cheese receives 'credits' to be used toward meeting their NPDES standard. Surplus credits can be traded to other participants as the programme expands to other Sugar Creek subwatersheds.

Drawing on survey findings that have been substantiated in each subwatershed approach taken, local farmer trust of government agencies was accounted for in choosing the Holmes County SWCD as the 'broker' of the nutrient trading plan and the Ohio State University's OARDC as the mediator and facilitator (i.e. liaison between Alpine Cheese and local farmers, OEPA and local farmers, OEPA and Alpine Cheese) of the programme (Moore, 2006). This trading plan is projected to promote the retention of local jobs and increase the demand for local milk, with the hope of creating more sustainable farms.

The final NPDES phosphorus reduction programme operates through nutrient trading in the following manner: Alpine Cheese will reduce the total daily phosphorus effluent from 225 mg/litre to 4 mg/litre, using a new water filtration system. Farmers participating in the trading programme will reduce the remaining 3 mg/litre, leaving a net effluent matching EPA's mandated 1 mg/litre.

Beginning 1 January 2006, the nutrient trading was implemented as an appendix to the company's NPDES permit. The AMP and the SWCD worked with local Amish leaders to use church district networks to identify and recruit potential farm households for participation, with the goal of enrolling 1000 acres of land in specific BMPs. As of this writing, all of the acres needed have been registered and are in the process of conservation planning, with more farmers wanting to participate, sometimes receiving only technical assistance.

Adding a nutrient-trading stipulation to the NPDES permit accomplishes several goals with respect to the objectives of the Sugar Creek Headwaters Project. First, this programme will enhance water quality for the watershed more than if the company relied solely on technology, with local farmer remediation equalling approximately six additional pounds of phosphorus for each pound conserved through the remediation measures taken by Alpine Cheese.

Second, this process does not overlook the potential of integrating new technologies to solve environmental problems; rather it allows for both a combined approach using technological and social solutions to the water quality problem. Participants quickly recognised the benefits of spending money on social and technological solutions to work toward phosphorus reduction across the community.

Third, there is a net gain of 13 jobs in the community, 12 at the cheese company, and one at the local SWCD, and more economic security for farmers from increased milk sales and premiums. Economic security can lead to social continuity of the farming communities with an enhanced quality of life.

Finally, the long-term effect of partnering community and business interests in solving the water quality problem creates broader awareness of surface water issues and provides an experiential learning in which participants make decisions that may potentially have long-lasting changes in farming practices by integrating new behaviours into their farm enterprises. Whereas milk house waste has been treated as a point source violation by the OEPA making farmers subject to financial penalties, rather than treating them as the problem in this programme, farmers in the surrounding watersheds who sell their milk to Alpine Cheese are included in the solution thereby allowing them to have ownership in the solution by way of participation. Additionally, excess on-farm phosphorus remediation becomes credits that can be sold, and the additional revenue may be used to further support the trading programme. Furthermore, the environmental benefits of phosphorus reduction have multiplier effects for other nutrients, such as nitrates and ammonium, which are reduced using the same types of BMP as used to reduce phosphorus. This approach represents the first nutrient-trading programme of its kind in the State of Ohio, and the United States, in which grassroots organisations and targeted remediation are used. It has been adopted by the OEPA as a model to use for other communities seeking innovative approaches to solving community and industrial pollution problems. It is not without conflicts, however. The perception of government regulatory agencies, such as the Ohio EPA, as being untrustworthy or overstepping their authority has made it difficult to reach this settlement between agency regulatory goals and company social, economic and environmental goals. Although both sides sought similar goals, their means to achieve them led to several occasions in which regulatory mandates threatened to derail the agreement. And, by extending their remediation expenses over 5 years, Alpine Cheese had a further financial incentive to participate.

DISCUSSION

The case studies presented here provide elements of strength and challenges for community-based water quality remediation programmes. Through awareness of the social and biophysical complexity of each subwatershed, specifically an awareness of local social networks and values, watershed programme planners are able to adapt programme structures and details to the individual community. In this manner, farmers become part of finding the solutions. As reported in this paper, the OEPA has taken a role somewhere between a 'follower' and an 'encourager' (Koontz et al., 2004) in providing solutions to water quality problems in the Sugar Creek Watershed. Table 2 shows a comparison of team similarities and differences.

The lessons from the North Fork were adopted in the Upper Sugar Creek where farmers were the focus of participatory team development efforts. This team is created and directed by farmers. This group lacks the conflicts of interest that often arise between farm and non-farm residents as well as between large- and small-scale farmers. The common background, existing social networks and the informal team structure allowed farmers to effectively address the current water quality problem and refocus on other aspects of water quality and sustainability. Farmers can use this common purpose to build consensus, and as Salamon et al. (1998) found, the farmers can move forward in acting to address problems even when there are still doubts and concerns because of the trust that is built from the consensus process. Since farmers own or work most of the land in the subwatershed, the benefits of their management changes and BMP implementation were readily seen in watershed-wide nitrate reductions. A weakness of this approach was the informal structure that precludes the team from, so far, taking large-scale community action, as in the North Fork, and the slow pace of the process. However, the capacity for addressing future challenges is built into this type of organisation because the opportunity for learning and leadership in community issues opened channels of dialogue and enhanced social networks showing farmers that their actions could be effective.

Similarly, in the South Fork, the strategy used in the Upper Sugar Creek was replicated using existing Amish social networks, which centre on kinship and church district networks of the Amish households. Since the South Fork is farmed nearly by all Amish, this type of an organisation was uniquely adapted to the area without needing to replicate organisations in the community. The common social basis among these households allowed them to adapt the group's structure toward these and other goals. The challenges to this group are different in magnitude, but still similar to those of the Sugar Creek Partners in that they will likely have a difficult time making large-scale changes due to the limits of local social organisation, and the SWCD and AMP must always be mindful of cultural differences and assumptions when collaborating with these Amish households.

Table 2. Comparison of subwatershed team benefits and challenges.

Characteristic	Sugar Creek Partners	North Fork Task Force	South Fork churches
Primary drive	Driven by local needs	Policy driven	Driven by local needs
Funding source	USDA SARE, OEPA 319	Ohio Department of Natural Resources (ODNR)	USDA SARE, OEPA 319
Agenda source	Local agenda set by participants and assisted by AMP	Ohio EPA and ODNR set broad agenda, SWCD and NFTF set specifics	Local agenda set by participants, and assisted by AMP and SWCD
Organisational documents	None	ODNR Watershed Coordinator Grant; OEPA Watershed Action Plan (WAP) required.	None
Group ethnicity	Predominantly Mennonite and Brethren, no Amish	Amish and non-Amish	Old Order Amish
Group composition	Environmentally conscious medium-sized farmers	Community leaders (agency calls for a 'representative' group: farmers, business, educators, politicians)	Environmentally conscious small, community-oriented farm households (no agency mandate)
Membership stratification	No 'Big Men'; conscious decision to exclude large-holders and 'influential families'	'Big Men' – community leaders are the 'movers and shakers' or the power-elites	No 'Big Men'
Group structure	Informally structured; loose coalition	Formal structure; WAP calls for group by-laws	Existing structure adapted to a new goal
Membership	Informal invitation	Open, public venue	Informal, open
Public perception	Less visible because membership is restricted to farm households	More visible because meetings are open to farm and rural non-farm residents	External, less visible, Internally visible because of the closed nature of the Amish society
Values	Commonality of values and ideas based on community cohesiveness	Values and ideas in conflict with state agency agenda that limit local decision-making; WAP guidelines are to be followed; amendment process is complicated and time-consuming	Commonality of values and ideas based on community cohesiveness
Membership participation	Participants are engaged and debate actions and ideas	Participants disillusioned and often not proactive because of 'Big Men' dominance	Participants are engaged, based on common values of community action and ecological stewardship
Goals and long-term capacity	Adaptable to multiple goals, and change focus through time. Less able to develop a strong plan and execute it	Single goal orientation with strong ability to address issues and develop and execute a plan	Adaptable to multiple goals, and change focus through time. Ability to address issues and develop and execute a plan

Public conflict and acrimony were rarely seen in these communities. Within the subwatersheds conflict among residents is rare and has not been directly observed. However, within the North Fork Task Force, some discontent can be interpreted by the precipitous drop in attendance that occurred when the group changed focus away from the waste water treatment facility and toward farm conservation issues that included livestock access to streams, manure storage facilities, and application of manure and other field inputs. Similarly, in the Upper Sugar Creek, two farm families expressed their disapproval of group activities by discontinuing their attendance and activity with the group after a few meetings that focused on planting trees in riparian zones. This was discovered to be the case after members of the Agroecosystems Management Program made inquiries to the heads of households. One other family discontinued attendance because its members felt the process was too time-consuming and not creating results fast enough; these members have since then reactivated their affiliation with the group. Conflict often arises between farm and non-farm households. This was recognised early in the process by farmers who recommended that the project focus on farmers since they owned most of the land drained by the Sugar Creek and were the residents being blamed by the Ohio Environmental Protection Agency (OEPA) for much of the problem.

Much of the conflict seen in this process has been that of silent resistance toward government agency regulation, specifically that of the US and Ohio Environmental Protection Agencies. This often manifests itself in minimal compliance and reluctance to interact with agency personnel as well as the general negative reactions expressed by residents when these agencies are mentioned. This is fuelled by perceptions of these agencies as working beyond their legal authority, which is confirmed by media presentations of farmers losing their land because of an alleged agency 'crackdown'. This, when combined with the perceptions of agency personnel as being out of touch with farmers, or not understanding farming, generates a mood of non-compliance in which households are likely to seek information, interaction, and resources from other sources.

Although trust has improved between community residents and state and federal government agencies, undertones of distrust and potential conflict still existed. The ability to replicate this process hinges on the presence of a trusted organisation like the Ohio Agricultural Research and Development Center (OARDC) whose representatives can act as liaisons with other government agencies. Although the OEPA is viewed negatively by most farmers in the watershed as acting on their own 'environmental agenda' (an image reinforced by farmer experiences during the TMDL public comment period and public hearings), it must be acknowledged that the openness to funding new programme ideas put forth by the farmers and AMP was indispensable to programme development.

Conclusion

Respect of the people involved in the conservation programme area demands that the best knowledge be gathered or created making it imperative that "careful, empirical, and reproducible research" be conducted (McCay, 2000). To this end, local farmers and researchers at the OARDC have collaboratively developed, through participant observation, interview and questionnaire surveys, and participation from other agencies and community members, a flexible and adaptable methodology that can be applied toward watershed improvement projects. While the authors acknowledge that watershed collaboratives have been in existence for several years, there has not existed an approach so unique in its attention to local factors and needs or that has implemented such a diversity of solutions, based on the same basic methodology.

Like GREM (Weber, 2003), the groups in the Sugar Creek have, to date, been successful because of the emphasis they place on the perspectives of local residents, their needs and values. This has made it possible to address stream impairments and pollution remediation in a way that government agency goals are met while simultaneously meeting and enhancing local community needs. This can be done without creating an antagonistic relationship between agency regulator and citizens, whereby citizens are part of the planning, design and implementation of the water quality programme. In short, they are a part of the solution. Simultaneously, the Sugar Creek approach is different from the GREM concept because these are Midwestern coalitions that have evolved around ideas of stewardship and not products of the resource scarcity (e.g. water, arable land) of the American West. Concomitantly, pollution of the Sugar Creek was not perceived by watershed residents as a problem prior to the beginning of this project (Weaver et al., 2005), while decades-old resource conflicts were contributing factors in western programme development. The Upper Sugar Creek farmers made the choice to act primarily because they felt it was the right thing to do and had a stake in creating the solutions. Only secondarily did the farmers respond because they feared regulatory pressure.

The North Fork Task Force exemplifies a 'carrot and stick' approach to management in which the compulsory mandates of OEPA pressured the community to address their water quality problem. What resulted was a formalised 'democratic' group structure akin to those described in the Collaborative Watershed Management approach (Sabatier et al., 2005) that was accountable to solving the problem. But, once the problem was solved, the structure of the group did not adapt to a new purpose or reason and the group unofficially disbanded without addressing other water quality problems, such as high levels of nitrogen in well water, or access of livestock to streams.

The team formation of the Upper Sugar Creek is a voluntary farmer group focused on concepts of stewardship. This group has limited accountability outside of social pressure and contractual obligations individually entered into by farmers in agency conservation programmes. Water quality was not perceived to be a problem prior to the team's formation but the farmers decided to do something, regardless of their perception of the OEPA's data. This deviates from Sabatier et al. (2005) Collaborative Watershed Management approach of Sabatier et al. (2005) because it emphasises in-group selection over broad representation of community members.

Similarly, the South Fork group is unique in its Amish-only composition and high degree of socially derived accountability. Amish farmers wanted to do something to fix the problem and while some feared government 'interference', most stated they acted out of social responsibility. This group also emerged after learning of the water quality problem. Previous distrust of OEPA led them to discount earlier reports.

The Alpine Cheese nutrient-trading programme provides additional jobs, increased demand for local agricultural products such as milk, and the added benefit of improving other impairments such as nitrogen and soil loss. This resulted from a compulsory government mandate to satisfy NPDES permit requirements. The company chose to include socially responsible approaches to remediation over the purchase of an increased phosphorus removal system. The owners saw the benefit of a social and technological solution hoping it would build capacity in the community to deal with future water quality problems that would not be available through technology alone.

Consistent with the conclusions of Morton and Padgitt (2004), regarding group information needs, the teams and other people in the Sugar Creek bring different needs and values in their solutions to the water quality problem. This approach is made possible by the headwaters benchmarking methods such as water quality monitoring that systematically converts the non-point source pollution problem into a localised source that can be identified and addressed at the farm and field level, using information and data relevant to local people. This approach does not assign blame or issue violations and assess fines, which may be necessary in some forms of regulation, but presents convincing evidence that allows farmers to then act in accordance with their values of stewardship.

Through their actions, teams in the Sugar Creek Watershed differ from many other watershed initiatives in Ohio where, according to Koontz and Moore (2000), most watersheds programmes do not incorporate long-range planning as seen in the 81% of a state-wide survey respondents who did not choose the "development or implementation of watershed plan" as a group objective. The study further reveals that a majority of these citizen-groups reported having an emphasis on water quality with a private property education focus. This is likely due to the expert-model approach taken by most government agencies, which continue to follow the IETS model using a diffusion of an innovation approach. With regard to the Sugar Creek, the lack of past and current conflict regarding water resources in this watershed has enhanced the effectiveness of this programme because such conflicts are often found in other watersheds causing difficulty in programme development (Weber, 2003; Koontz et al., 2004; Sabatier et al., 2005) and requiring the GREM or Collaborative Watershed Management approaches.

Any explanation of the success of this approach in achieving measureable water quality results (OEPA, 2006) needs to include the treatment of perceptions farmers have of government agencies. Overcoming concepts such as the perceived 'environmental' or 'socialist' agendas of these agencies is needed and this approach offers one way to accomplish this goal. To date, the successes of these groups have been largely due to the creative combinations of government funding and local support. As such, a difficulty in future approaches may be found in finding a suitable liaison that bridges the divide between state and federal government agencies and watershed residents. As seen in the four applications of this method, by emphasising local variables and participation rather than transposing one community's successful subwatershed model on to another, this process allows for adaptability of these principles to other watersheds. This offers the potential of a replicable model for dealing with non-point source pollution in other regions.

Today, most natural resource problems are social in origin resulting from social and economic structures of society, and consequently solutions for them require incorporating cultural and community-focused solutions that engage people. As Flora (2002) states, social science must extend its understanding to include how to understand current social and environmental circumstances and develop programmes to address challenges rather than continuing to simply document how social forces interact and are affected by the environment. Collaboration and participation toward sustainable solutions, through which local people are able to express their values and meet their needs and by which government agencies can accomplish the public's agenda and meet their goals, constitute the growing challenge of the 21st century.

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