



Research

Analysis of social-ecological dynamics driving conflict in linked surface-groundwater systems

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ABSTRACT. Conflict over water resources emerges from complex interactions among biophysical, social, and economic processes operating at multiple scales. Competing use of linked surface-groundwater (LSGW) resources is an excellent yet relatively unexplored example of such conflict. Dynamic circumstances surrounding the contested installation of a high capacity municipal well in southeastern Wisconsin were examined through the theoretical lens of adaptive governance using document analysis and open-ended key stakeholder interviews. A framework analysis method extracted 16 controlling variables from the qualitative data. These controlling variables were placed on a threshold matrix at their appropriate geospatial scale (Property, Watershed, State) and process domain (Biophysical, Economic, Social), which revealed several social-ecological feedbacks not currently addressed by management authorities. Three dynamic feedback loops were identified that explain the emergence and resolution of LSGW conflict in the case study area. Conflict emerged when processes driving new development in southeastern Wisconsin threatened to impact a highly valued groundwater dependent lake. Lake groups engaged in collective learning, utilized information networks, and displayed leadership to address the issue. However, lack of participatory avenues for dispute resolution at the scale of occurrence drove lake groups to challenge the regulatory authority of the Wisconsin Department of Natural Resources (WDNR). Through order-based legitimacy, legal resolution affected governance of LSGW resources across the state, but did little to address the underlying stakeholder values driving conflict. We conclude this system will continue to be subjected to “legal back and forth,” recurrent conflict, and uncertainty for both environmental and developmental interests until a more participatory process is developed with regulatory authorities to resolve conflicts over LSGW.

Key Words: *adaptive governance; conflict; linked surface-groundwater resources; resilience; social-ecological systems; thresholds*

INTRODUCTION

With competing demands on water resources in the face of growing populations and climate change, the need for developing governance frameworks that can identify feedbacks and engage communities to continue the delivery of ecosystem goods and services is increasing (Rockström et al. 2014). In stark contrast to the geophysical interdependence of surface and groundwater resources, the governance of these resources typically operate independently of each other, often creating conflict over water resource use (e.g., Bergquist 2016). Although our understanding of the relationships between surface and groundwater has advanced considerably, laws and regulations continue to address each of them as separate, independent systems (Sophocleous 2002, Shaw et al. 2013). This is particularly evident in the state of Wisconsin where the mismatch between surface and groundwater laws have driven state water policy over the past decade (Scanlan 2012). The resulting inability to address the biophysical, social, and economic interconnections and feedbacks that underlie resource use in turn contributes to fueling conflict in linked surface-groundwater (LSGW) systems (Llamas and Martínez-Santos 2005, Theesfeld 2010).

Adaptive governance theory argues that the social context surrounding ecosystem management must be considered to ensure the equitable and sustainable distribution of ecosystem goods and services (Dietz et al 2003, Folke et al. 2005). A key aspect of this theory is that it views natural resource problems as multiscale in nature, and that cross-scale interactions provide opportunities for adaptive governance to emerge (Chaffin and Gunderson 2016). In their 2014 review of the literature, Chaffin

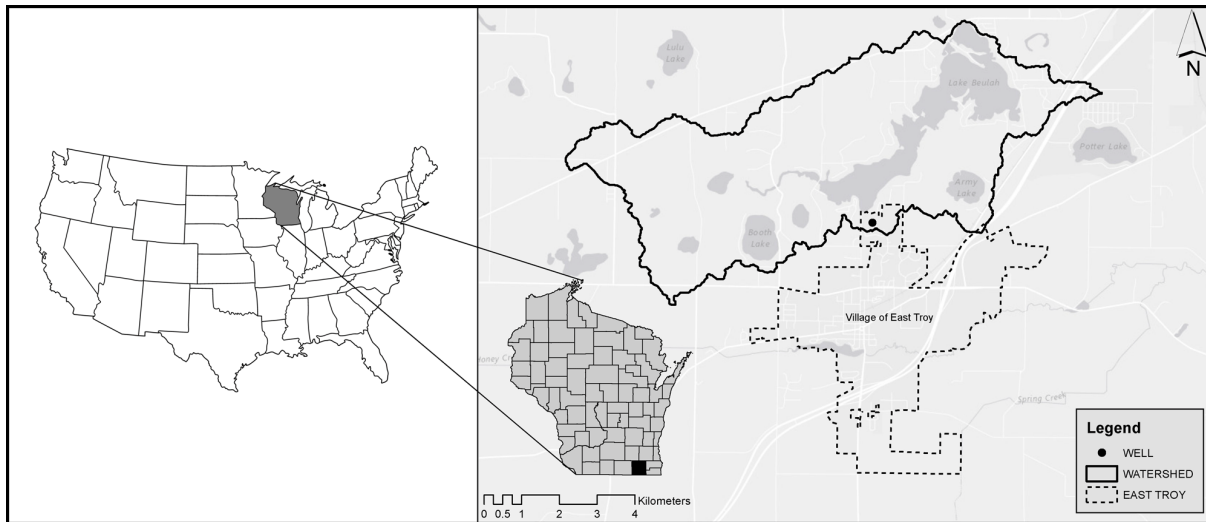
et al. define adaptive governance as “a range of interactions between actors, networks, organizations, and institutions emerging in pursuit of a desired state for social-ecological systems.” Communities of practice are cited as operationalizing adaptive governance when they utilize networks for collaboration and learning, build social capital across diverse groups of stakeholders, and share decision making power across scales of resource management (Huitema et al. 2009).

To operationalize adaptive governance in social-ecological systems, crisis, whether real or perceived, has been identified as a possible prerequisite (Folke et al. 2005, Schultz et al. 2015). The sense of urgency drives key actors to acquire knowledge, build trust, and leverage network connections to pursue a desired state for a given social-ecological system (Olsson et al. 2006). However, with crisis can also come conflict. Where decisions call for a dramatic change in the status quo to implement adaptive governance, those with the power to prevent such a change must be engaged (Chaffin et al. 2014). Viewing LSGW systems through the multiscale, social-ecological lens of adaptive governance allows us to ask: How do conflicts over LSGW resources emerge?

To address this question we examined the conflict between the Lake Beulah Management District (LBMD) and Village of East Troy in southeastern Wisconsin, USA (*Lake Beulah Management District v. DNR* 2011). Framework analysis (Spencer and Ritchie 2002) was applied to key stakeholder interviews, legal proceedings, news articles, and development plans to extract the controlling variables involved in the emergence of conflict. Placing these controlling variables within the context of a

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Fig. 1. Geographical perspective of the Lake Beulah / East Troy conflict.



threshold matrix (Kinzig et al. 2006) revealed feedbacks between them, spanning the scales (individual, watershed, state) and domains (biophysical, social, and economic) over which conflict occurred. Analysis of the threshold matrix reveals three dynamics that explain the emergence and resolution of LSGW conflict in the case study area. These findings are followed by a discussion of the underlying cause of conflict over LSGW resources, compared to the implications of conflict resolution through legal processes. The following sections acquaint the reader with the legal context and conflict between the LBMD and Village of East Troy.

Legal context: water law in Wisconsin

As a state within the United States, Wisconsin has primary governing authority over water quantity issues occurring inside of its political boundaries (Adams 1993). Laws governing surface waters in Wisconsin are drawn from two legal sources: riparian rights and the public trust doctrine (Kent and Dudiak 2001). Riparian rights temporally precede the public trust doctrine and provide the right of reasonable use of surface water to riparian landowners (Kent and Dudiak 2001). Rights include the direct or consumptive use of surface waters (*Muffington v. Wisconsin Conservation Comm'n* 1949), access to water and exclusive use of shore land (*Doemel v. Jantz* 1923), and right to additions of shore land from natural processes (Wisconsin State Legislature §87.30). These rights extend to the center of navigable streambeds, although the water above the streambed is held in public trust, and all natural lakebeds are considered state property. Riparian rights are subject to two major restrictions: the common-law restriction of reasonable use and the public trust doctrine (Kent and Dudiak 2001).

The public trust doctrine has its origins in Roman and English common-law and was written into Wisconsin's constitution verbatim from the Northwest Ordinance of 1787 (Quick 1994, Kent and Dudiak 2001). It states that navigable waters in Wisconsin "shall be common highways and forever free ... to the inhabitants of the state" (Wisconsin State Legislature Article IX,

§1). There are three crucial aspects of the public trust doctrine that have dictated its evolution over time. First, it is a Constitutional grant of authority to the state to regulate navigable waters. This grant of authority was not just to preserve, but to promote the public trust doctrine (*City of Milwaukee v. State* 1927). This stresses that the public trust doctrine is an active trust, and that the government must uphold it wherever they see necessary. Second, it establishes public right of use that the state cannot unreasonably compromise. Third, it defines state property rights in navigable waters. The public trust doctrine was originally used to protect commercial navigation, but has since been expanded to protect public rights such as fishing (*Willow River Club v. Wade* 1898), recreation (*Nekoosa-Edwards Paper Co. v. Railroad Commission* 1930), and enjoyment of scenic beauty (*Muench v. Public Service Commission* 1952). The state also has authority to regulate non-navigable waters if they have the potential to adversely affect navigable waters (*Just v. Marinette County* 1972).

Groundwater law in Wisconsin has been less stringent in terms of regulation on water users and currently is a contentious regulatory issue (Kent and Dudiak 2001). It was not until the 1974 court ruling in *State v. Michels Pipeline Construction Inc.*, which imposed reasonable use standards on groundwater withdrawal that there was regulation on pumping limits. In 2003, the state senate passed a bill that implemented a 1200-foot (366 meter) buffer around neighboring high capacity wells, exceptional resource waters^[1] of the state, trout streams and springs (State of Wisconsin 2004). Any new high capacity well placed within the buffer zone requires the WDNR to complete an environmental impact statement and conditions are made to the permit to ensure the avoidance of significant adverse environmental impacts before approval. In 2011 and 2014, a pair of rulings placed considerable authority in the WDNR under the public trust doctrine to consider the adverse environmental impacts of high capacity wells (*Lake Beulah Management District v. DNR* 2011) and the cumulative impacts of high capacity wells (Wisconsin Division of Hearings Appeals 2014) on all surface waters (not just those within the buffer zone).

However, the authority to consider cumulative impacts has been reversed through an Attorney General Opinion (Wisconsin Attorney General 2016) and recent legislative activity (State of Wisconsin 2017) has limited the instances when a high capacity well permit is necessary and thus also limiting when an environmental assessment is mandated.

Study context: the Lake Beulah social-ecological system

Lake Beulah is a flow through lake in northeastern Walworth County, Wisconsin (Fig. 1). The lake is located in the Mukwonago River Basin, which contains multiple reaches of exceptional resource waters of the state despite being in close proximity to two of the state's most populated areas, Milwaukee and Madison (SEWRPC 2010, Thornton et al. 2013). One of the reasons for the high aquatic ecological integrity of the lake is the ample amount of groundwater input from springs into the lake, leading to the production of calcareous marl sediments. The subsurface soils in the region are predominantly well-sorted glacial outwash, which allow water to recharge the shallow aquifer and reduce surface runoff (SEWRPC 2010). The Mukwonago River is also home to multiple Wisconsin threatened and endangered species including the long ear sunfish (*Lepomis megalotis*) and the rainbow mussel (*Villosa iris*; SEWRPC 2010). To protect these resources, stakeholders in the greater Mukwonago River Watershed (municipalities, lake associations, environmental nonprofits, etc.) have vowed to work together to control future development in the region (Slawski 2013, Thornton et al. 2013). All of these factors result in one of the most biologically diverse and highest quality riverine ecosystems in Wisconsin.

The outlet from Lake Beulah was impounded in the late 19th century in order to raise water levels to increase the amount of developable shoreline property. At that time Walworth County was mostly undeveloped, and houses on Lake Beulah were primarily vacation homes for families traveling from Milwaukee, Madison, or Chicago. This dynamic still persists today, with property owners having their primary residences as far away as California and Arizona (Author interviews). Typical properties on the lake are valued around \$1 million, and based upon interviews conducted by the authors (see below) property owners characterize themselves as “lake stewards.” This situation is different from what exists for residents in much of the surrounding region. Since the 1950s there has been steady population migration in southeastern Wisconsin out from the urban center of Milwaukee into the outlying rural communities, resulting in low-density residential development in areas surrounding Lake Beulah including Waukesha, Mukwonago, and East Troy (SEWRPC 2002). The population trend has resulted in increased pressure on public resources, including transportation, sanitation, and drinking water quantity and quality.

In late 2002, the Lake Beulah Management District^[2] (LBMD) learned that the Village of East Troy planned to install a high capacity well within Lake Beulah's watershed (Fig. 1). The well site was chosen by the village because a developer was creating a residential subdivision in the area and agreed to provide the necessary infrastructure to connect a new high capacity well to the village's water system, allowing the village to increase their municipal water capacity without having to pay for the installation and connection of a new well. In return, the village would annex the subdivision in accordance with their extraterritorial rights

(Author interviews). This came at an opportune time for the village because the Wisconsin Department of Natural Resources (WDNR) had informed them that to be in compliance with state drinking water regulations the village needed to increase their water capacity (Author interviews). The Village was also experiencing a period of population growth and had plans for new commercial development.

The Lake Beulah Protective & Improvement Association (LBPIA), along with unaffiliated lake homeowners, worked with the village to find an alternate site for the well. Although adequate sites were found outside of Lake Beulah's watershed, the village moved forward with plans to drill at the primary well site by submitting a high capacity well permit application, which was approved by the WDNR. This sparked a lawsuit by the LBMD that resulted in a Wisconsin State Supreme Court decision in 2011 (*Lake Beulah Management District v. DNR* 2011). The LBMD argued that the WDNR had the authority under the public trust doctrine to deny the high capacity well permit because the well had the potential to cause adverse environmental impacts on the lake. The Village argued that because groundwater and surface water are regulated under different statutes, the WDNR did not have authority under the public trust doctrine because groundwater resources are not “navigable waters.” The State Supreme Court ruled that the WDNR did have the “right and general duty” under the public trust doctrine to take into account the potential adverse environmental impacts a high capacity well poses on adjacent surface waters (*Lake Beulah Management District v. DNR* 2011). The State Supreme Court also stated that in order for the WDNR's public trust duties to be triggered, concrete scientific evidence of the potential adverse environmental impacts must be presented to them (Scanlan 2012). The Court affirmed the WDNR's approval of the well because sufficient concrete scientific evidence was not present in the record before the agency at the time the permit was issued (*Lake Beulah Management District v. DNR* 2011).

The Lake Beulah Decision, as it is now known, set precedent in the State of Wisconsin in that it held that the public trust doctrine applies to groundwater permits for high capacity wells to protect connected navigable waters (Scanlan 2012). This decision has triggered significant ongoing debate about water governance in the state (Wisconsin Attorney General 2016) by exposing a gap between legal doctrine and scientific understanding (Scanlan 2012).

METHODS

The dynamics of conflict between the LBMD and Village of East Troy are complex and occur across multiple scales and domains. Using the Lake Beulah watershed as the focal scale, we examined the dynamics present that crossed scales and domains resulting in conflict over LSGW resources. Analysis of documents and interviews provided the controlling variables contributing to conflict. Placing these controlling variables in a threshold matrix cut through the complexity to understand the emergence of conflict.

Data sources

Documents (state statutes, smart growth plans, environmental assessments, etc.) pertaining to the development of southeastern Wisconsin (SEWRPC 2002, 2006, 2010), East Troy (Village of

East Troy 2008), and Lake Beulah specifically (M. M. Bach 1993, *unpublished report*, https://cdn4.sportngin.com/attachments/document/0140/0772/LBYC_Centennial_Yearbook_1893-1993.pdf), were analyzed to understand the conflict's context. The written decision given by the Wisconsin State Supreme Court provided detailed background about the conflict and the policy arena in which it played out.

Key stakeholder groups involved in the conflict were identified from a list of parties that submitted amicus briefs to the court. From this group, a representative sample of 15 individuals was selected for open-ended interviews. This included consultants (n = 3), state regulators (n = 1) regional regulators (n = 3), LBMD members (n = 2), village officials (n = 2), conservation groups (n = 2), and residents on Lake Beulah (n = 2; total n = 15). The University of Wisconsin-Milwaukee Institutional Review Board (IRB) approved the study in June of 2015 and interviews were conducted between July and September of that year. Interviews lasted from 30–90 minutes; interviewers took field notes as well as audio recordings for further analysis. Open-ended questions were used to cover the following topics:

- Personal account of the conflict and concerns over water resources
- Water governance in Lake Beulah, East Troy, and the State of Wisconsin
- Sources of scientific and political information pertaining to water resources in Wisconsin
- Individuals and organizations involved in water governance in Wisconsin
- State of information sharing between conflicting parties

Framework analysis

Documents, field notes, and interview recordings were analyzed using an adapted version of framework analysis (Spencer and Ritchie 2002), a method that abstracts, filters, and sorts qualitative data through five steps. First, familiarization involves the researcher immersing themselves in the data. In this study, documents, interview audio recordings, and field notes were iteratively reviewed to identify themes, categories, and key passages for data extraction. Second, framework identification occurs when themes, and categories within those themes, emerge through the familiarization process. The documents analyzed in this study provided a preliminary set of themes and categories that were used to identify a thematic framework when reviewing interview material. Themes and categories also emerged from the interviews themselves allowing them to verify and bolster the researchers' understanding of the Lake Beulah social-ecological system. Third, indexing requires the researcher to identify portions of the data that correspond to specific themes and categories. Fourth, the process of charting extracts the data identified in the indexing step and organizes them to generate a table for analysis. The results of the charting process provide a detailed analysis of how the themes and categories emerged from the data (Smith and Firth 2011). Finally, mapping involves analyzing the data extracted from the previous steps to create a "schematic diagram of the phenomenon" (Srivastava and Thomson 2009).

Threshold matrix

Thresholds are levels of underlying controlling variables of a system at which feedbacks to the rest of the system change (Walker and Salt 2012). Controlling variables of a system often change slowly and are not taken into consideration by resource managers (Folke et al. 2009). However, crossing a threshold in one controlling variable can have cascading effects across the scales and domains of a social-ecological system. For example, Bodin et al. (2006) showed that cultural shifts away from sustaining sacred forest patches at a regional scale (social threshold) resulted in loss of pollination services at the patch scale (biophysical threshold) and the inability to maintain a viable farm at the farm scale (economic threshold). To understand the cascading nature of thresholds, threshold matrices were developed.

Threshold matrices, first developed by Kinzig et al. 2006, consist of a 3X3 grid where each cell represents a specific domain at a specific scale. Placed within these cells are controlling variables with potential alternative states separated by a threshold (Walker and Salt 2012). Arrows depict relationships between controlling variables across the scales and domains of a social-ecological system. These relationships are used to generate hypotheses about the possible cascading effects that crossing a threshold at one scale and domain may have on the surrounding controlling variables and/or the system as a whole (Kinzig et al. 2006).

Data extracted from framework analysis were used to generate a threshold matrix to understand the multiscale, social-ecological aspects of the case study conflict. Domains and scales were determined a priori using biophysical, economic, and social domains (Kinzig et al. 2006) and property, watershed, and regional/state scales. Themes and categories identified in the framework identification step of the framework analysis were interpreted as controlling variables and alternative states, respectively. Controlling variables, with their alternative states, were then placed at the scale and domain at which they occurred on the threshold matrix. Arrows were placed between controlling variables based on the narratives present in the key stakeholder interviews.

The resulting threshold matrix was subjected to a participatory group review process to examine internal consistency (with published literature on surface water and ground water), contextual connectivity (local knowledge of the Lake Beulah situation), and dynamic cohesiveness (behavioral changes and feedbacks). This review was conducted utilizing graduate students in the Sustainable Peacebuilding program at University of Wisconsin-Milwaukee as group exercises in their coursework. The first review verified the controlling variables and their positioning on the matrix, and then vetted the directionality of relationships among variables. The second review substantiated the dynamics and feedback loops in the matrix through considering a series of alternative scenarios as a role-playing exercise in a conflict transformation course. In both cases, the process of substantiating the threshold matrix used methods adapted from Wilson-Grau and Britt (2012) developed for outcome harvesting and from Quinn-Patton (2014) for developmental evaluation.

RESULTS

Framework analysis identified a total of 16 controlling variables for the Lake Beulah social-ecological system, each having two alternative states (Table 1). Controlling variables were then

Table 1. Controlling variables and their potential alternative stable states. Controlling variables are organized by the domain in which they occur.

Domain	Controlling Variable	Alternative States	System Scale	Threshold Matrix ID
Biophysical	Water System	Personal / Municipal	Property	A
	Aquifer	Productive / Depleted	Watershed	B
	Hydrology	Infiltration / Runoff	State	C
	Surface Water	Clear / Turbid	Property - Watershed	D
	Water Quality	Attaining / Nonattaining	Watershed - State	E
	Landscape	Natural / Human-dominated	State	F
Economic	Housing Market	Resort / Residential	Property	G
	Economic Base	Recreational / Agro-industrial	Watershed	H
	Economy	Local / Global	State	I
	Development Mindset	Smart Growth / Suburban Sprawl	Watershed -State	L
Social	Water Policy	Environmental / Developmental	State	M
	Values	Environmental / Development	Property	N
	Land Ethic	Conservationist / Utilitarian	Property	J
	Identity	Lake People / Townspeople	Property -Watershed	K
	Watershed Identity	Locally Invested / Bedroom Community	Watershed	O
	Governance	Proactive / Reactive	State	P

positioned at appropriate domains and scales of occurrence on the threshold matrix (Table 1), with relationships between controlling variables drawn based on the narratives present in the key stakeholder interviews (Fig. 2). Examination of the relationships between controlling variables revealed three distinct dynamics: policy development (Fig. 3), identity-based resilience (Fig. 4), and cross-spectrum conflict (Fig. 5). Each dynamic is explained in detail below using the identifiers in Table 1 as a reference.

The policy-development dynamic

The policy development dynamic connects the watershed/community and regional/state scales across the biophysical and economic domains (Fig. 3). The dynamic illustrates how state water policies are driven by a development mindset that in turn is enabled by lax environmental regulations. For example, until recently, regulations regarding high capacity wells were mainly focused on well construction:

The main concern and the main statutory authority was to ensure that [a] well was constructed according to the state well code, which was based primarily on water quality, proper construction given the geology (Interviewee 42).

These lax environmental regulations contributed to a more human-dominated landscape as the state’s economy transformed from a local to global state over the final decades of the 20th century. The same interviewee outlines this as well:

So if I had up on that board a map of the state with high capacity well coverage by decade you would see that, back when we were reviewing for municipal wells there really weren't that many high capacity wells. Then we go to the 70s and 80s and all of a sudden the central sands starts to blow up. Northwest Wisconsin increases, southeast Wisconsin increases, south central Wisconsin increases and they increase by decade.

For southeastern Wisconsin, this coincided with a sprawling development mindset, which required development water policy

facilitating a shift in the economy^[3] that changed the landscape and hydrology of the region (Fig. 3: L→M→I→F→C).

Upon first hearing of the well proposal, members of Lake Beulah expressed concern over the state of the aquifer and how that would affect the adjacent surface water body (Fig. 3:C→B→D). As put by one Lake Beulah resident:

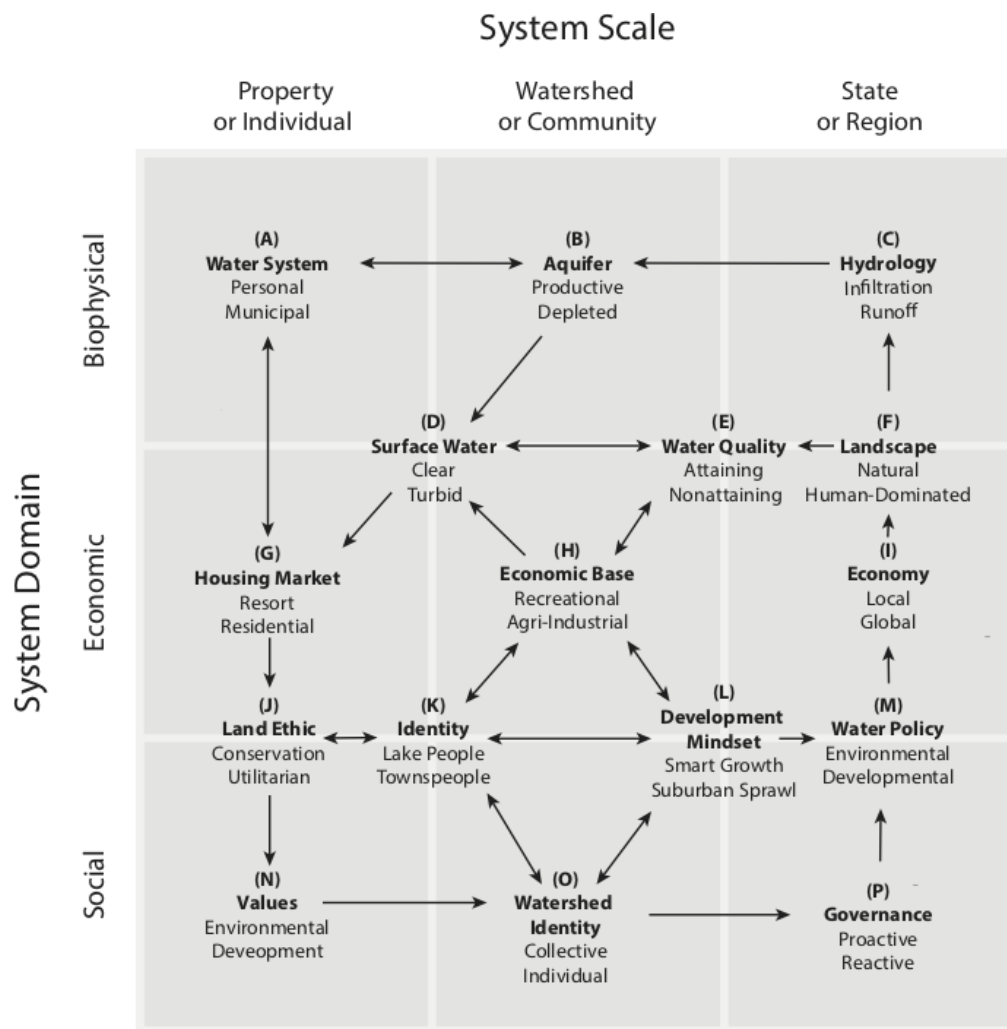
[The village] wanted a well, [the village] wanted to put a well right at the point of our main aquifer for the lake. [The lake homeowners] did not want them to do it (Interviewee 11).

A drastic change in water quality, as feared by people on Lake Beulah, would “Kill the golden goose” (Interviewee 18). Homeowners on the lake view themselves as contributors to the recreational economic base and if they were to leave, the village and town would have to expand to make up the loss in the tax base, reinforcing the sprawling development mindset requiring continued developmental water policies for high capacity wells (Fig. 3: D→E→H→L→M).

Identity-based resilience dynamic

The identity-based resilience dynamic (Fig. 4) connects the individual/property and watershed/community scales across the social, economic, and biophysical domains. The dynamic illustrates how residents of Lake Beulah distinguish themselves from the surrounding population, and how this distinction influences their decision making and the ecological status of the lake. The main concern of property owners is the state of the lake, which translates into a lake people identity. At the watershed scale, this identity contributes to a recreational economic base with second homes, restaurants, summer camps, and retreat centers all having shoreline property on Lake Beulah (Author interviews). An economy based on use and aesthetics reinforces a desirable clear surface water state, keeping property values high and a resort housing market (Fig. 4: K→H→D→G). Individuals’ conservation land ethic are influenced by property values (Fig. 4: G→J),

Fig. 2. Threshold matrix with controlling variables placed at their respective scales and domains of occurrence.



There is \$375 million dollars' worth of property value I think on the shore of Lake Beulah so if that many million dollars is going to decrease in value because of lake quality they're going to file a lawsuit right away (Interviewee 80).

The economic incentive to conserve water resources influences individuals' value system, at least for Lake Beulah (Fig. 4: G→J→N). While discussing the role of homeowners in protecting Lake Beulah, it was expressed that

It really counts on the people living on the lake. If they like the lake, respect it, take ownership, that's what you really need (Interviewee 72).

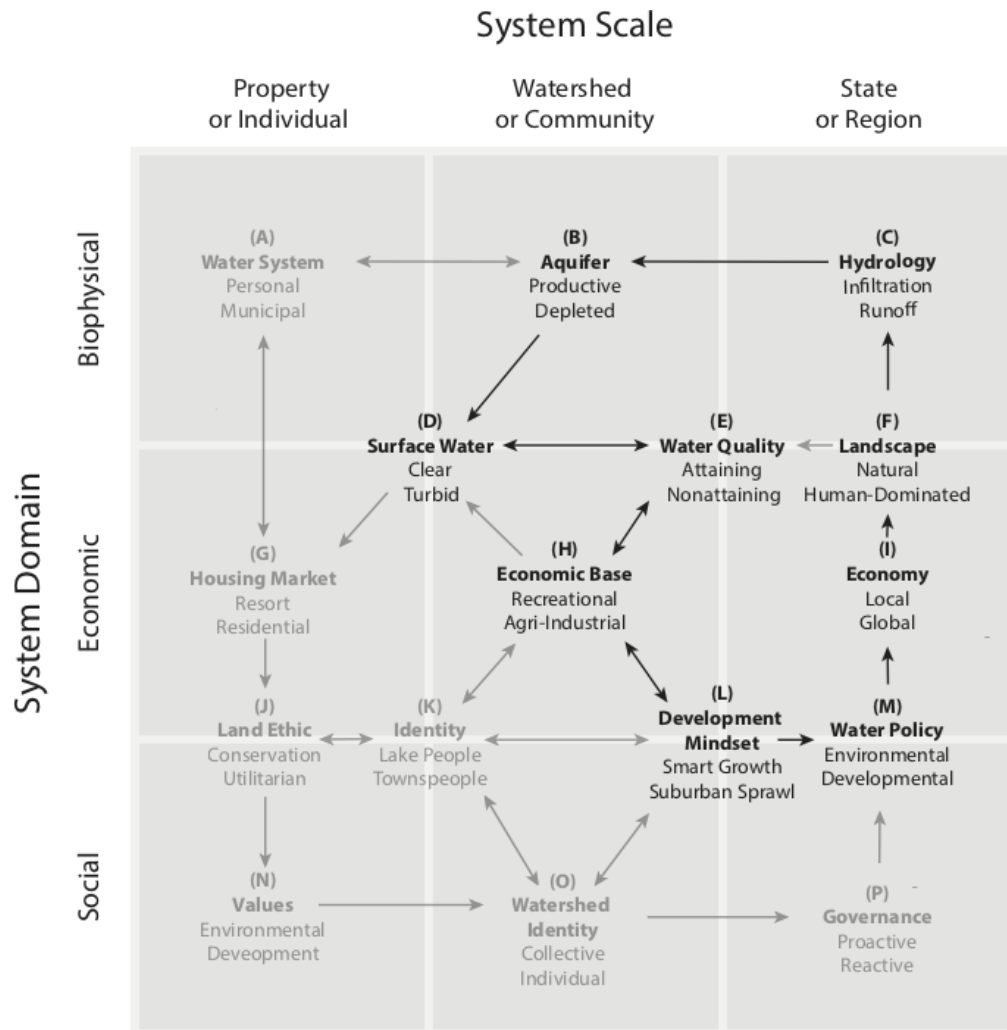
When asked if the feeling of ownership pertained to the people of Lake Beulah, the same interviewee responded "I think so, it's pretty strong." The collective watershed identity is evident in Lake Beulah, with the Lake Beulah Protective & Improvement Agency (LBPIA) being one of the oldest civil society lake stewardship organizations in the State of Wisconsin (Author interviews).

Collective participation to protect Lake Beulah reinforces both the lake people identity and the identity-based resilience dynamic of the Lake Beulah social-ecological system (Fig. 4: N→O→K).

Cross-spectrum conflict dynamic

The cross-spectrum conflict dynamic (Fig. 5) emerges through interactions across all scales and domains in the threshold matrix. The effects of development water policy at the state scale cascades through the economic and biophysical domains as illustrated in the policy development dynamic (Fig. 5: M→I→F→C). When the Village of East Troy applied for the high capacity well near Lake Beulah, residents began educating themselves on the effects these wells have on adjacent surface waters, generating their trajectory of expected change. Key individuals on Lake Beulah, well connected individuals on the lake who were not members of the LBMD, consulted with natural resource managers and conservation groups throughout the Mukwonago watershed and the State of Wisconsin to gain understanding of how the well might affect water quality and quantity:

Fig. 3. The policy-development dynamic where a sprawling development mindset creates the need for lax policies regarding the environmental regulations for high capacity wells.

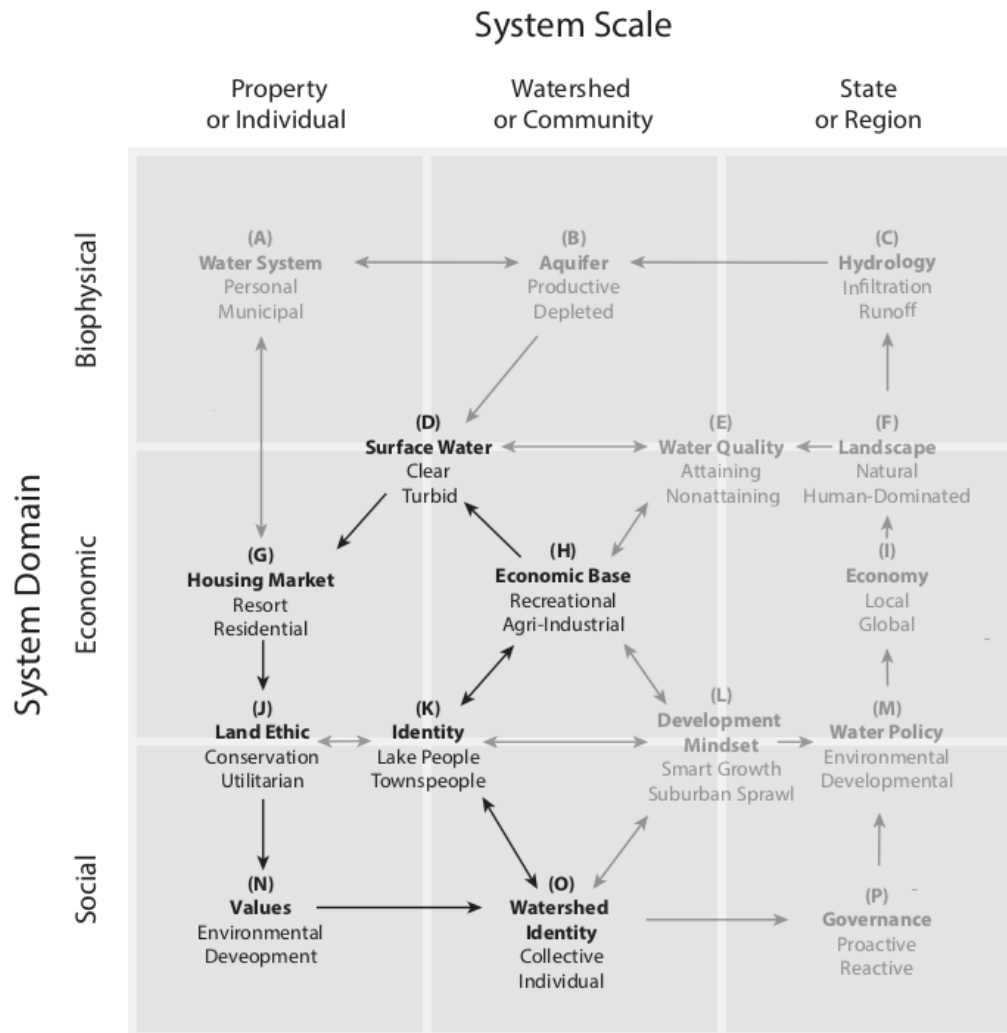


[The interviewee] talked to a number of people on the lake and an ad hoc committee was formed of nonmanagement district people put up their own money to hire a consultant and they found two or three other sites for the well ... We did contact some lake districts [as well] in the Wausau area^[4] because we heard high cap wells did some damage up there (Interviewee 11).

A licensed hydrogeologist conducted test studies and concluded that the well caused groundwater flow feeding Lake Beulah to reverse. Key individuals on Lake Beulah perceived that a depletion of the aquifer would trigger a shift to a turbid surface water state that would have detrimental effects on property values around the lake (Fig. 5: C→B→D→G). Leaders in the Lake Beulah community informed by their conservation land ethic and environmental values began calling for a collective watershed identity to address the issue (Fig. 5: J→N→O).

The collective watershed identity of Lake Beulah pursued multiple pathways to resolve the issue of East Troy's high capacity well. First, members outside of the LBMD formed an ad hoc committee to explore alternate well locations outside of the lake's watershed (Author interviews). This was an attempt to address the sprawling development mindset at the watershed scale, where the stakeholders would have control over the outcome. The Village of East Troy was initially involved in the exploration, but the working relationship between the two parties quickly dissolved (Author interviews). The LBMD then took charge of the issue and hired a lawyer to challenge the DNR's granting of the permit for the well. Once within the court system, the issue of the well was decided by the State Supreme Court and pushed the high capacity well permitting process toward a proactive governance state (Fig. 5: O→P). Although this resolved the issue legally, it did not address the root cause of the conflict between the development mindset of the Village and the identity of the people on Lake Beulah.

Fig. 4. The identity-based resilience dynamic. Residents on Lake Beulah consider themselves separate from the surrounding population, influencing their decision making and the ecological status of the lake.



DISCUSSION

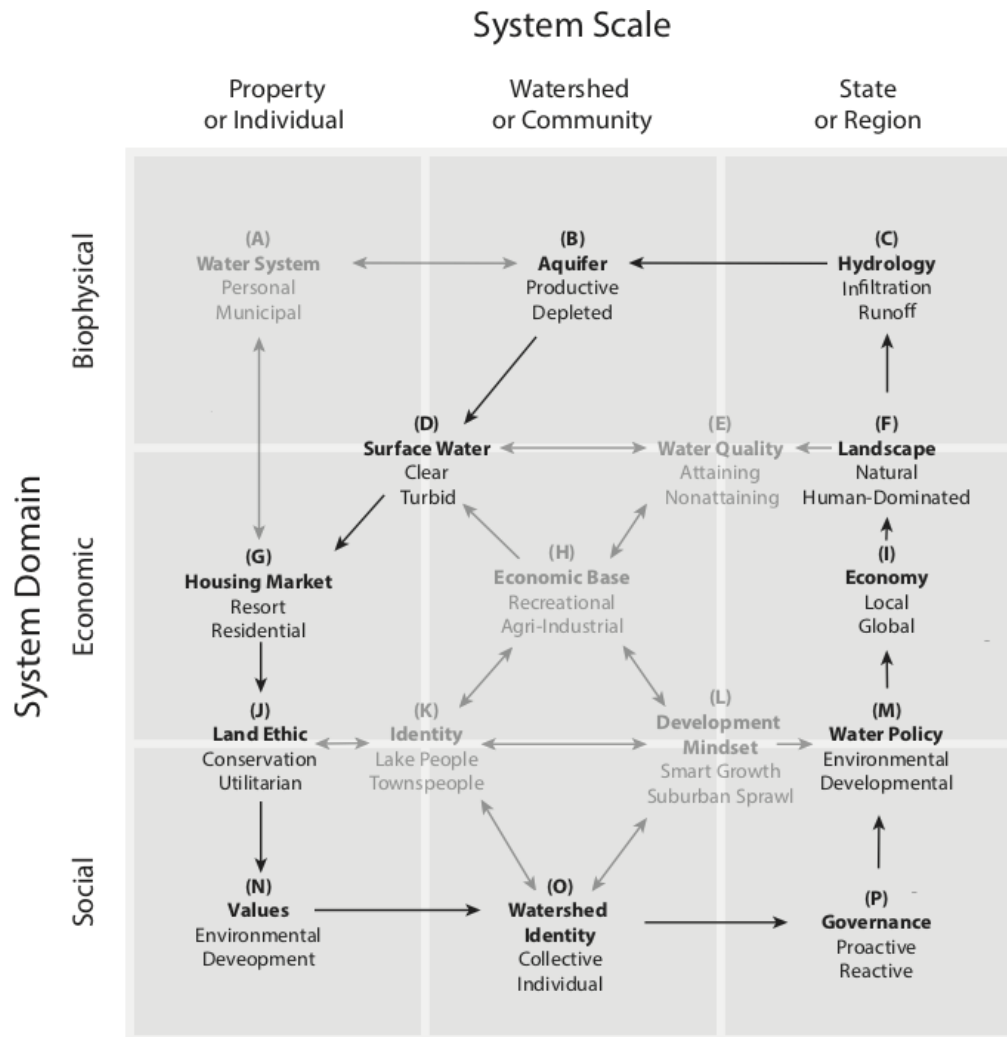
Adaptive governance and the emergence of LSGW resource conflict in Lake Beulah

Attributes of adaptive governance including the use of networks, learning, leadership, and flexibility provided the LBMD the capacity to motivate collective action and address a perceived crisis (Folke et al. 2005). Through a series of events, the Lake Beulah community defined the issue of the well as one of water quality. The LBMD cast a wide net to identify potential issues posed by the high capacity well. Initially, the threat of water quantity issues motivated the LBMD to utilize weak network relationships with other lake districts in Wisconsin to gather information about the effects of high capacity wells on lake level (Author interviews). A consultant hydrogeologist conducted monitoring studies to build knowledge about the system and concluded the issue to be one of lake water quality. These experiences made the people on Lake Beulah realize “there is more

to watch other than lake levels and monitoring wells” and with respect to this, “they have done a great job educating themselves” (Interviewee 34). The use of networks and learning to gather information enabled the LBMD to identify potential issues and motivate the community to act collectively to resolve them.

The first attempt to resolve the issue of the well was through the formation of an ad hoc committee made up of individuals outside of the LBMD (Author interviews). Through the generation of the initial conflict and supporting collective action, the ad hoc committee displayed elements of leadership necessary to operationalize adaptive governance (Lichtenstein and Plowman 2009, Rijke et al. 2012). Upon first hearing of the well, these individuals self-organized and used their own resources to hire a consultant and found an alternative site outside of Lake Beulah’s watershed. After the alternative well site was denied by the Village of East Troy, the ad hoc committee consulted with the LBMD to begin legal procedures to challenge the DNR’s authority to permit

Fig. 5. The cross-spectrum conflict dynamic. Interaction of the policy-development and identity-based resilience dynamics generated conflict that significantly impacted the governance of water resources in the state of Wisconsin.



the well. The LBMD then sought the approval of lake residents to raise taxes for the lawsuit. The votes were unanimously in favor of the lawsuit (Author interviews), reinforcing a collective watershed identity.

The LBMD expressed flexibility through identifying the problem at hand and exploring diverse avenues to resolve the issue with the Village of East Troy. They initially tried to solve the problem at the scale of occurrence through communicating with the Village of East Troy and hiring a hydrogeologist as a consultant. When these attempts at resolution failed, the LBMD “tried to head them off at the pass and get the DNR to not issue a permit” (Interviewee 80). The capacity of lake management districts to utilize multiple conflict resolution venues provides them with what some interviewees think is the proper tool kit to resolve these issues at the scale of occurrence:

I would like to set some case law that would substantiate the actual power of the district in contrast to the power

of the DNR. I think there is room for both but I think that the DNR shouldn't be the controlling entity. They should be equal or the Lake District should have primacy and the DNR should be the fall back so if the district wasn't doing its job the DNR could find out and come in and do something (Interviewee 80).

A process where lake districts and state agencies shared power promotes polycentric governance of LSGW resources, an attribute that builds social-ecological resilience (Biggs et al. 2015). However, as will be discussed later, the current state of water governance in Wisconsin makes this an unlikely outcome.

Role of identity and development mindset in LSGW conflict

Two controlling variables are central to the conflict in the Lake Beulah social-ecological system, identity and development mindset. The identity subsystem indicates a distinction between the lake people who live on Lake Beulah and the townspeople who live in the surrounding Village and Town of East Troy. This

stark difference in identity drives conflict in that the priorities of the people living on the lake can result in an “us vs. them” mentality:

The people that live on the lake, it's the lake and that's the big thing. If you live outside the lake it's your local environment maybe, maybe you're interested in garbage pick-up or something like that. But on the lake, it's the lake and it's very intense ... We have to keep vigilant on everything and I don't know what the next thing that pops up is going to be. And when you have something this valuable people try to take advantage of it. That's what we have to be alert to (Interviewee 72).

The Village of East Troy interviewees also acknowledged the difference in identity:

[The LBMD] put blockades up everywhere they could legally. It forced the Village unfortunately to spend a great deal of money defending itself ... They seemed to have unlimited deep pockets, the Village doesn't look at it that way. So we were annoyed that we had to defend ourselves all the way to the [State] Supreme Court (Interviewee 29).

Although the identity-based resilience dynamic outlines how the lake people identity has resulted in the stewardship of Lake Beulah, it also reinforces the divide between the two populations. As such, the Village of East Troy is viewed as an outside influence attempting a water grab. The sprawling development mindset controlling variable is a reflection of the way the final decades of the 20th century saw growth of suburban communities surrounding Milwaukee in southeastern Wisconsin:

A lot of people move to East Troy because the housing is cheaper, and they commute to [the surrounding areas] to work (Interviewee 87).

As new areas in southeastern Wisconsin were being developed, regulations on high capacity wells were not taking environmental impacts into account, as outlined in the policy-development dynamic (Fig. 4). This caused conflict to emerge between the LBMD and the Village of East Troy. The lake people identity created a barrier to placing a well within Lake Beulah's watershed. The Village of East Troy's development mindset led them to believe they had the right to drill a well to remain in compliance and continue to develop. The conflict that emerged between the identity and development mindset controlling variables created a cognitive impasse:

The engineering firm had blinders on: You need the water, here's how we are going to construct your water usage and supply system. They ignored all the environmental issues that had to deal with water outside the pipe. They only looked at water inside the pipe (Interviewee 80).

When common ground could not be found, the LBMD took to the court system and the State Supreme Court legally resolved the conflict.

The results of this study indicate that the identity and development mindset controlling variables can be viewed as underlying values (Chaffin et al. 2014). These values placed on water informed the decisions made by the LBMD and Village of

East Troy throughout the conflict and are integral to understanding its emergence. In this instance, adaptive governance theory would call for a local process, facilitated by and within the authority of administrative agencies, that utilizes underlying values to inform decision making (Schulz et al. 2017).

Legal resolution in LSGW conflict

Legal resolution of the conflict resulted in considerable changes in water governance at the state scale (Author interviews). However, the resolution did not provide a process to address the driving cause of conflict, the underlying values of identity and development mindset across stakeholder groups. Current participatory processes communities can use to engage in the permitting of high capacity wells (periods for public comment and informational meetings) are inadequate to resolve complex problems causing conflicts to emerge over LSGW resources. When a high capacity well permit is applied for in the State of Wisconsin, the public has 30 days to comment (Author interviews). This is when community groups or other parties opposed to the high capacity well can submit concrete scientific evidence to trigger the WDNR's public trust duties. During this time, the public can also ask for an informational meeting regarding the well permit. These meetings involve information dissemination but lack contextual understanding of the conflict itself (Interviewee 87). If these measures do not resolve the issue and if the well permit is approved, then opposing parties must navigate the court system.

The “ladder of citizen participation” concept (Arnstein 1969) places periods of public comment and informational meetings on the level of tokenism. At this level, citizens are heard but lack the power for their views to be heeded and have little power to change the status quo. Periods for public input and informational meetings may expose the differences in identity and development mindset across stakeholder groups, but it does not address these differences to resolve the problem at the scale of occurrence. The adaptive governance literature looks at these modes of participation as providing administrative agencies with deliberative legitimacy (Cosens and Williams 2012). However, once in the court system, the issue shifts from stakeholder groups in conflict with one another to defining the administrative authority of the WDNR (Interviewee 87). Defining administrative authority is a process of order-based legitimacy, played out in the political arena by politicians (Cosens and Williams 2012). The results of this study indicate that the type of legitimacy sought by administrative agencies may depend on the nature of the conflict when pursuing adaptive governance.

To develop deliberative legitimacy in conflicts driven by underlying stakeholder values calls for procedural processes that resolve the issues instead of complex sets of rules to govern resources (Garmestani and Benson 2013). This requires key actors at the appropriate scales to resolve LSGW conflicts by adapting state law to fit the problem. An example of this would be Michigan's Public Act 602, Aquifer Protection and Dispute Resolution, which outlines a formal process to resolve disputes between high capacity well users and users of residential and other low capacity wells (Jarvis 2014). Applying this approach to LSGW use in Wisconsin would move the focus away from WDNR authority and toward the stakeholder and environmental context of the conflict itself (a move from order-based to deliberative

legitimacy). This is the opposite of how the LSGW arena has evolved since the Lake Beulah Decision.

Current situation and generalizability

In the time since the Lake Beulah Decision, the residents on Lake Beulah have addressed a number of issues across the property, watershed, and regional scales, driven in great part by the identity-based resilience dynamic. For instance, the LBMD worked to prohibit the placement of a pier in an ecologically sensitive area of the lake as well as negotiated with WDNR to have the authority to set lake levels (Author interviews). The LBMD, in conjunction with the LBPIA, has also started working with other lake management districts and environmental organizations in the Mukwonago River to initiate a program to limit the spread of invasive species. These actions enhance the ability of the Lake Beulah social-ecological system to respond to and shape change occurring both within and outside of the basin, a key hallmark of adaptive governance (Folke et al. 2005).

Conditions at the state scale have continued to change following the Lake Beulah Decision. Since 2011, the regulatory authority of the WDNR has both expanded and contracted considerably with regard to permitting high capacity wells. In 2014 the Richfield Dairy Decision (Wisconsin Division of Hearings Appeals 2014) stated the WDNR has the right and general duty to consider the cumulative impacts of all wells in the landscape on surface water when permitting a new high capacity well. The ruling significantly expanded the regulatory authority of the WDNR and created tension between regulators and the regulated community. The regulatory authority of the WDNR was subsequently limited by an Attorney General Opinion (Wisconsin Attorney General 2016) stating that the agency can only act on authorities explicitly stated in the State Statutes, and a bill passed by the State Senate allowing landowners to repair, replace, reconstruct, and transfer ownership of high capacity wells without additional approval (State of Wisconsin 2017). The legal back and forth regarding the authority of the WDNR is well established in the realm of the public trust doctrine (Scanlan 2000, 2012), and reinforces the need for a process to socially resolve conflicts over LSGW resources at the scale of occurrence.

We hypothesize that the dynamics identified using the threshold matrix method, and the issues of underlying values and legitimacy implicit in them, occur across LSGW resources conflicts. Examples are abundant in the Great Lakes Region where antiquated groundwater policies are driving conflict between business (industrial agriculture, water bottling, etc.), development, and environmental interests (Morris et al. 2008, Kraft et al. 2012). The Columbia River Basin in the northwestern United States is an example of conflict spurring over western economic and tribal spiritual values placed on the same water (Cosens and Williams 2012). Internationally, communication and collaboration among the countries within the Nile River Basin is essential if basin-wide trust and legitimacy is to be maintained (Kameri-Mbote 2007). The identity and development mindset dynamics can be observed in all of these instances, contribute to understand conflict emergence, and provide insight into resolution options.

Findings from this study can also inform the broader theory of adaptive governance, especially the aspects of underlying values and legitimacy. Underlying values are often key motivators in the

emergence of conflict over natural resource use (Chaffin et al. 2018). Making these values explicit can help uncover which values are most important to conflicting stakeholder groups and assess whether power asymmetries exist between the values favored in policy and those held by stakeholders (Chaffin et al. 2014, Schulz et al. 2017). Taking underlying values into account when attempting to implement adaptive governance may prove useful when dealing with two resource systems (in this case surface water and groundwater in Wisconsin) that have different institutionalized rules and norms of use.

The emergence of conflict can also indicate the type of legitimacy required to resolve the problem at hand (Cosens and Williams 2012). In the present study, the pursuit of legal resolution focused on agency authority (or order-based legitimacy) and resulted in a dramatic change in the responsibility of administrative agencies at the state scale. However, the initial reaction of conflicting groups was to collaborate, indicating that the capacity to resolve LSGW issues at the scale of occurrence existed. In this case, adaptive governance theory would instead call for the development of deliberative legitimacy, where public dialogue plays a key role in the process of decision making, to bolster local adaptive capacity while remaining within the boundaries of agency authority at the state scale (Cosens 2013). Understanding how conflicts emerge and unfold could provide insight into how legitimacy affects the emergence and institutionalization of adaptive governance.

CONCLUSION

An adaptive governance lens, applied to the Lake Beulah social-ecological system, identified core dynamics that played a significant role in the emergence of conflict over LSGW resources. By examining the 16 controlling variables identified through framework analysis within a threshold matrix, three dominant dynamics were revealed, operating across scales and domains. The policy-development dynamic outlined how a sprawling development mindset reinforced the status quo of lax high capacity well regulations to ensure continued development of new areas. The identity-based resilience dynamic illustrated how a lake people identity instilled a sense of stewardship in Lake Beulah residents as well as an us vs. them mentality. The cross-spectrum conflict dynamic occurred after attempts to resolve the issue at the scale of occurrence broke down and the LBMD resorted to the court system to challenge WDNR's authority to permit the well.

The LBMD expressed multiple attributes of adaptive governance including collective learning, use of networks, leadership, and flexibility to navigate the conflict with the Village of East Troy. Ultimately, the LBMD had to resort to the court system to air their grievances. Although the State Supreme Court case set precedent regarding WDNR authority over high capacity well permitting, legal resolution did not address the root cause of conflict in the Lake Beulah social-ecological system. The difference between development mindset and identity controlling variables across stakeholder groups is still present today, and members of both parties believe that the issue will come up again (Author interviews).

The use of threshold matrices has proven to be beneficial in identifying the underlying values driving conflict over LSGW resources in the Lake Beulah social-ecological system and

assessing the impact of legal resolution on these drivers. The dynamics present, although restricted to LSGW resources, have the potential to be generalizable to other cases. The policy-development, identity-based resilience, and cross-spectrum conflict dynamics are hypothesized to be present across conflicts and resources systems.

This case study highlights the important role that underlying stakeholder values and legitimacy play in the emergence of conflict and adaptive governance. Processes that formally address underlying values of conflicting stakeholder groups may provide capacity for resolution at the scale of occurrence. Understanding how conflicts unfold, and what drives them, can also provide insight into the type of legitimacy necessary to bolster adaptive governance.

^[1] As per State of Wisconsin definition, an “exceptional resource water” is a lake, stream, or flowage having excellent water quality, high recreational and aesthetic value, and high quality fishing, but may be affected by point source pollution or have the potential for future discharge from a small sewer community (Wisconsin State Legislature §102.10).

^[2] Lake districts are special purpose units of government whose main objectives are lake management and provision of services to property located within its established boundaries (Wisconsin State Legislature §33, Lyden et al. 2006).

^[3] In this instance, the increase in high capacity wells is indicative of the State of Wisconsin’s contribution to the global economy. For example, this has been seen in the central part of the state with a move from smaller farms meeting local or state scale need to larger “factory farms” and confined animal feeding operations (CAFOs) that supply agricultural goods nationally and internationally (Bergquist 2016).

^[4] Wausau, Wisconsin is located 330 km from the study area and has also been dealing with LSGW issues.

Responses to this article can be read online at:
<http://www.ecologyandsociety.org/issues/responses.php/10510>

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