A WICKED METHODOLOGY FOR THE ANALYSIS OF WICKED PROBLEMS: INTEGRATING THE ANALYSIS OF MEETINGS AND NETWORKS

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ABSTRACT

One feature of the Anthropocene is the rise of large-scale environmental problems produced by human actions. A pressing problem is how to manage these environmental problems effectively. Their governance is often challenging because different stakeholder groups disagree on what the appropriate course of action should be. Furthermore, the problems are often complex, and scientific knowledge about them may contain significant gaps and uncertainties. We are interested in understanding the most challenging of these situations, which are often termed "wicked problems," and what effective environmental governance might look like under those conditions. In this paper, we report on a new, integrative methodology we have developed for analyzing governance processes by examining communications both within an environmental decision-making group and across the stakeholder networks within which the group is embedded. Shaped by a systems perspective, our methodology weaves together multiple theoretical frameworks, methodological approaches, forms of data, and levels of analysis. Very few previous studies have closely examined the actual decision-making process in participatory meetings, or situated these meetings in the broader stakeholder network interactions within which they are embedded. Our approach redresses this significant gap in the literature. For our field site, we selected a commission that was formed to develop recommendations for a new municipal ordinance on hydraulic fracturing (fracking). In order to preserve the anonymity of the commission, we do not identify the geographic region in which the commission was located, other than to say it was in the United States. Fracking exhibits all of the features associated with wicked problems, including multiple stakeholders with conflicting values, scientific uncertainty, and political complexity.

Keywords: Integrative analysis; social-environmental systems; wicked problems; anthropology; participatory decision-making

THE RISE OF ENVIRONMENTAL CRISES IN THE ANTHROPOCENE

Recent years have seen the rise of large-scale environmental problems produced by human actions, from effects of climate change to the 2010 BP oil spill in the Gulf. "This

is the first human generation… whose rate of resource use exceeds 2.5 times the production capacity of the planet… Future supplies of the air we need to breathe, the water to drink and the food to eat are in doubt" (Brown et al., 2010, 3). Earth scientists have argued that a new epoch has begun, the Anthropocene, in which humans affect the environment more than any other factor. This epoch "signifies a new role for humankind: from a species that had to adapt to changes in their natural environment to one that has become a driving force in the planetary system" (Biermann, 2014, 57; Galaz, 2014; Malm and Hornborg, 2014).

A pressing problem facing human societies is how to manage these environmental problems effectively. As Biermann notes, humans are "a 'political animal' that distinguishes itself from other species by its capacity to collectively organize its affairs through joint institutions… The Anthropocene is political" (2014, 57). The governance of these recent environmental crises is often challenging because different stakeholder groups disagree on what the appropriate course of action should be. Furthermore, the problems are often complex, and scientific knowledge about them may contain significant gaps and uncertainties.

We are interested in understanding the most challenging of these situations, which are often termed "wicked problems," and what effective environmental governance might look like under those conditions. In this paper, we report on a new, integrative methodology we developed for analyzing governance processes by examining communications both within an environmental decision-making group and across the stakeholder networks within which the group is embedded. Shaped by a systems perspective, our methodology weaves together multiple theoretical frameworks, methodological approaches, forms of data, and levels of analysis.

WICKED PROBLEMS

The concept of "wicked problems" was first articulated by Rittel and Weber to describe complex social policy challenges where different stakeholder groups define and conceptualize the problem and its solution in different ways (1973). Such problems are particularly difficult to address when scientific knowledge is limited. Rittel and Weber identified nine conditions associated with wicked problem
1. Lack of a unique problem statement
2. Conflicting objectives
3. Conflicting values
4. Dynamic context
5. Scientific complexity and uncertainty
6. Political complexity and uncertainty
7. Administrative complexity and uncertainty
8. Multiple tactics to address problems
9. Multiple stakeholder groups with the power to assert their values (Balint et al., 2011, 31, based on Rittel and Webber, 1973).

A Wicked Methodology for the Analysis of Wicked Problems

Wicked problems are not uncommon in environmental resource management. Studies have shown how the "clashing interests of environmentalists, developers, and others have elevated many environmental problems… from simple, to complex, to wicked problems" (Balint et al., 2011, 2). Environmental crises are often characterized by scientific, political, and administrative complexity and uncertainty, continuously shifting conditions, and profound stakeholder disagreements concerning values, risks, and the definition of the problem (Brown et al., 2010; Galaz, 2014).

Since disagreements among stakeholder groups constitute a fundamental aspect of wicked problems, collaborative decision-making by representatives of diverse groups is essential in successfully managing complex environmental issues. However, while it is "now part of the received wisdom that public participation is essential… typical participatory processes generally fall victim to shortcomings that limit their utility in dealing with wicked problems" (Balint et al., 2011, 103).

Some scholars have argued that in practice, the term "participation" has been used for decision-making practices that are not actually egalitarian. Participatory techniques may not take into account the ways knowledge is produced, and fail to recognize ways they may reflect or even exacerbate the inequality of existing power structures (Beierle and Cayford, 2002; Cooke and Kothari, 2001; Hickey and Mohan, 2005; Mansuri and Rao, 2013; Reed, 2008). Environmental anthropologists have extensively examined participatory decision-making in resource management, and have found that participation may either give more voice to stakeholders, or reinforce inequalities (Agrawal, 2005; Dove, 1986; Spaeder and Feit, 2005; Glenzer et al., 2011; Greenough and Tsing, 2003; Nadasdy, 2003, 2005; Peterson, 2010; Spaeder, 2005; Taddei, 2011). "Uses of co-management have thus ranged from… co-opting [social groups] into compliance with nation state regimes, to being a means of empowerment of disenfranchised rights claimants" (Spaeder and Feit, 2005, 149). Studies have most often found that participatory processes end up reproducing at least some of the prior political inequalities.

Very few previous studies have closely examined the actual decision-making process in participatory meetings, or situated these meetings in the broader stakeholder network interactions within which they are embedded (Roncoli et al., 2011). Our approach redresses this significant gap in the literature.

A Wicked Methodology For the Analysis of Wicked Problems

Although the title of our paper is intended to be playful, developing a methodology that adequately analyzes and assesses the management of wicked environmental problems is, indeed, almost a wicked problem in itself. The complexity of these situations means that an adequate analytical framework needs to capture a broad range of factors. We conducted a pilot study to innovate and test out a fairly complex systems approach that integrated multiple theoretical and methodological perspectives. It was sufficiently challenging that we were awarded an EAGER grant by the U.S. National Science

Foundation; EAGERs are designed to fund "high risk high reward" projects (BCS-1408169).

A short overview indicates the complexity of our approach. We combined the analysis of face-to-face meetings where decisions were made by a commission with the analysis of online communications, both within the commission and across the stakeholder networks within which members were embedded. For the analysis of meetings, we drew on conversation analysis and issue framing. For the analysis of online communications, we drew on semantic and social network analysis. These core methods were further situated in the analysis of six interviews, twenty versions of the evolving municipal ordinance, and various other documents. The computer technologies we used included Atlas.ti, Amazon WorkSpaces, Word, LIWC, WORDij, Condor, and Excel.

THE FIELD SITE: A COMMISSION ON MUNICIPAL FRACKING ORDINANCE

For our field site, we selected a commission that was formed to develop recommendations for a new municipal ordinance on hydraulic fracturing (fracking). In order to preserve the anonymity of the commission, we do not identify the geographic region in which the commission was located, other than to say it was in the United States. We have given the city the pseudonym "Burnett." Gas drilling was a highly contested issue of considerable environmental concern in Burnett and the surrounding region. At the time of the commission, there were nearly 500 active gas wells in the city, some just a few hundred feet from residences. In 2011, the city council of Burnett realized that existing ordinance was not adequate for the new drilling activities. It placed a moratorium on drilling and constituted a commission to develop recommendations for new ordinance. The commission included five voting members and two non-voting city staff members. It was intended to carry out participatory decision-making among representatives of diverse stakeholder groups: according to the City of Burnett website, the purpose of the commission was to "represent the interests of all stakeholders by soliciting the broadest possible input" to "assist with the composition of an Ordinance." The commission developed its recommendations over the course of eleven weekly meetings, from January to March 2012.

Fracking as a Wicked Environmental Problem

The nine conditions that Rittel and Weber (1973) associate with wicked problems are all present for fracking (Jackson et al., 2014; Lave and Lutz, 2014; North et al., 2014; Stern et al., 2014). There are multiple stakeholder groups with conflicting values. These groups form two major clusters, pro-industry and pro-environment. As noted in a recent report organized by U.S. National Research Council:

> Proponents argue that the shale gas revolution has enabled a new era of clean domestic energy, bringing significant economic benefits and jobs to those who need them and reducing U.S. greenhouse gas (GHG) emissions, while posing

modest environmental risks… In contrast, opponents of "fracking" argue that it poses significant upstream, operational and downstream risks, and is currently implemented with inadequate safeguards and monitoring to protect against multiple environmental, human health, and socioeconomic impacts (Stern et al., 2014, 8287).

North et al. argue that shale gas development poses particularly strong challenges for risk governance because of the multidimensional and inequitable impacts, strong value conflicts, need to make decisions urgently, and mistrust across the decision making environment (2014, 8388; Small et al., 2014).

Scientific complexity and uncertainty about fracking impacts are a recurrent theme in recent scholarship (Eaton, 2013; Jackson et al., 2014; Kinnaman, 2011; Lave and Lutz, 2014; Lustgarten and Kusnetz, 2011; Small et al., 2014). For instance, Small et al. argue that domains exhibiting especially acute deficits of knowledge and attention include "integrated studies of public health, ecosystems, air quality, socioeconomic impacts on communities, and climate change" (2014, 8289). Jackson et al. argue that data gaps are particularly evident "for human health studies, for the question of whether natural gas will displace coal compared with renewables, and for decadal-scale legacy issues of well leakage and plugging and abandonment practices" (2014, 327).

Political complexity and uncertainty are also characteristic of the current fracking landscape (Ash, 2011; Davis, 2014; Eaton, 2013; Rabe, 2014; Rabe and Borick, 2013). Since fracking has spread so recently, new policies are in the process of being developed across the United States. In the U.S., there are a number of statutory and political constraints on federal engagement with fracking (Rabe, 2014). As a result, states are taking the lead role in crafting policies. In some cases, municipal governments are also playing an active role, although their authority varies, depending on different state constitutions. Pro-industry and pro-environment stakeholder groups are actively lobbying state governments, and conflicts have arisen between state and local governments. In general, it appears that states are supporting the pro-industry position, but the situation is still in flux (Rabe, 2014; Rabe and Borick, 2013). There is future potential for cross-state conflicts, and of course international conflicts may arise as well.

Activities of Commission

The work of the commission we studied consisted a series of distinct activities. Furthermore, the work of the commission was embedded in related activities of city staff and the city council. Figure 1 summarizes the sequence of events. The first step was the creation of the commission. In interviews, we were told that the selection of commission members was ultimately under the control of the City Council, but that city staff played a significant role. By July 2011, the commission had been created and staffed with three community members. In November, two further members were added, both from the oil and gas industry, and neither resident in Burnett.

There were two preliminary public meetings whose sole purpose was to collect input from residents. Anyone who wanted could get up and voice their opinion for up to three

minutes. There was a further preliminary meeting to plan the commission's decision-making process. All topics that the commission would examine regarding ordinance changes were identified at this meeting, and a 10-week timeline was generated (which eventually slipped to 11 weeks).

From January to March 2012, the commission performed its work over the course of eleven weekly meetings. In Figure 1, this box is shaded a darker gray to communicate that these activities are the heart of our study. During these decision-making meetings, commission members put forth 82 proposals, each of which was discussed, reformulated until all commission members were satisfied with the wording, and then voted on. When these eleven meetings were concluded, the work of the commission was done.

However, the social life of the commission's recommendations continued. From April to December 2012, the recommendations were transformed into municipal code by city staff and consultants. In October, the commission was shown a version of the draft code, but it was not given power to formally recommend changes. From the point of view of commission members, this time period was a "black box," as no one knew what process the city staff were using to translate the commission's work into the text of the ordinance, which was significantly different.

On January 15, 2013, the City Council reviewed the proposed ordinance prepared by city staff and approved it, with a few minor changes.

Timeline	Activities of City Staff and City Council	Activities of Commission
Jul 2011	Commission created with 3 community members	
Aug		Aug 25 – Citizen input meeting
Sep		
Oct		
Nov	Between Nov 4 and 10, 2 industry members are added to commission (as seen in emails)	
Dec		Dec 8 – Citizen input meeting Dec 20 – Planning meeting
Jan 2012		Jan 9-Mar 26 – 11 decision-making meetings, resulting in set of recommendations
Feb		
Mar		
Apr	Commission's recommendations transformed into municipal code by city staff and consultants	
Jun		
Jul		
Aug		
Sep		
Oct		Oct 1 and Oct 22 – Meetings for commission to view draft of code
Nov		
Dec		
Jan 2013	Jan 15 – City Council approves new ordinance	

Figure 1. Timeline of Commission's Activities

FORMS OF DATA

Our analysis of the commission's work brought together multiple forms of heterogeneous data. Figure 2 lists the main forms of data we collected. The data fall into five broad categories. First were the meetings of the commission. The heart of our study was the eleven decision-making meetings that took place January-March 2012. These were the meetings we analyzed in depth, using issue framing and conversation analysis. We obtained videorecordings of these meetings and prepared quasi-transcripts. The transcripts are accurate at the level of turn-by-turn sequencing, but they do not always include all the words in each turn. We would have preferred to develop fully detailed transcripts, but budgetary constraints did not permit it. In addition, we obtained minutes for the pre- and post-decision meetings.

Second, we collected emails that commission members sent to one another. These messages were mainly used for meeting administration, e.g. sharing minutes and meeting agendas. Commission members also distributed information relevant to the next meeting. They did not engage in decision-making over email.

Third, we collected various kinds of online communications that took place across the broader stakeholder networks in which the commission was embedded. These communications included emails between four of the commission members and community members, a blog by a local activist who was against fracking, and relevant news articles.

Fourth, since the goal of the commission was to develop a set of recommendations for a new ordinance, we traced the evolution of the fracking ordinance, from its wording prior to the commission to its new formulation as approved by the City Council in January 2013. The commission's recommendations took the form of 71 approved motions; meeting discussions more or less followed Robert's Rules of Order. (There were 82 motions in total; 9 failed and 2 received a decision of "no action.") As described in the previous section, the city staff then took the commission's recommendations and translated them into municipal code. We obtained 18 versions of draft code from the city.

Fifth, we conducted in-depth interviews with five members of the commission and the community activist blogger. These interviews were videorecorded and transcribed. We also asked study participants to sketch the social networks within which the commission was embedded, using pen and paper, and then describe what they had drawn.

Category	#	Forms of Data	Time Period
Commission Meetings			
Decision-making meetings	11	Videorecordings Quasi-transcripts	Jan-Mar 2012
Pre-decision meetings	3	Meeting minutes	Aug and Dec 2011
Post-decision meetings	2	Meeting minutes	Oct 2012
Online Communications of Commission			
Emails among commission members	329	Email messages	Jul 2011-Dec 2012

Online Communications of Broader Stakeholder Networks			
Emails between four commission members and their contacts outside of commission	8329	Email messages	Jul 2011-Dec 2012
Blog by community activist	157	Blog posts	Jul 2011-Dec 2012
News	116	News articles	Jul 2011-Dec 2012
Ordinance Versions			
Official ordinance before commission's work	1	Municipal code	Jul 2011
Commission's recommendations (produced through meeting discussion)	71	Motions	Mar 2012
Draft code based on commission's recommendations	18	Draft municipal code	Apr-Dec 2012
Revised official ordinance	1	Municipal code	Jan 2013
Interviews			
Commission members and community activist blogger	6	Videorecordings Transcripts Social network sketches	2014

Figure 2. Forms of Data

SYSTEMS-ORIENTED, INTEGRATIVE METHODOLOGY

The initial purpose of the research design was to integrate four different analytic methods, embedded in several different, interdisciplinary research streams, with the goal that this systems-oriented approach would reveal a more comprehensive picture of participatory decision-making.

When we planned the study, we had a simple and elegantly structured 2x2 analysis design, shown in Figure 3. However, in the face of the more complex reality of the many forms of data we ended up with, the actual analysis become more multifaceted. The core of our vision did not change; it just became surrounded by additional layers. Even to this day, we continue to extend our analyses in various directions because the data are so rich.

	Data	Analysis Methods
Meetings Approach	• Transcripts of commission's meetings	• Conversation analysis • Issue framing
Networks Approach	• Emails among commission members and stakeholder networks • Public online conversations (blog and news articles)	• Social network analysis • Semantic network analysis

Figure 3. Initial Analysis Design

The core of our vision was to combine the analysis of face-to-face meetings where decisions were made with the analysis of online communications across the stakeholder networks within which the commission was embedded. For the analysis of meetings, we planned to draw on conversation analysis and issue framing. For the analysis of online communications, we planned to utilize semantic and social network analysis. This central

methodology was indeed carried through and it remains the heart of our analytic approach.

However, we eventually realized that we could productively cross-fertilize our methods. Conversation analysis and issues framing proved illuminating for the online communications, and network analysis proved illuminating for understanding meeting interactions.

Furthermore, we situated these methods within ethnographic fieldwork to immerse ourselves in the local context. For the pilot study, we did this by conducting in-depth interviews, and by watching the videorecordings of the meetings over and over. In the city of Burnett, we engaged in casual conversations about fracking with whatever people we happened to encounter, and attended a meeting by an anti-fracking citizen's group. (In a larger study, we would engage in more extensive participant observation.)

In the following sections, the core methodology is described in more detail, focusing on 1) initial analysis of meeting transcripts, 2) initial analysis of online communications, and 3) initial integration of these approaches.

INITIAL ANALYSIS OF MEETING TRANSCRIPTS

Our initial approach to the analysis of meetings where participatory decision-making takes place combined two analytic methods: conversation analysis (CA) and issue framing (IF). These two methods were first combined in a recent publication by one of the authors, Wasson (under review). While CA and IF had both been applied to collaborative decision-making in meetings, each approach, on its own, suffered from significant limitations.

The extensive CA literature on negotiation in meetings illuminates the *process* of the interactions (e.g. Boden, 1994; Deppermann et al., 2010; Ehlich and Wagner, 1995; Firth, 1995a, 1995b; Francis, 1995; Kangasharju, 1996; Maynard, 1984; Svennevig, 2012; Wasson, 2000). CA unpacks the sequential organization of how a negotiation unfolds over time, as each speaker's turn responds to the previous turn, and as meeting participants draw on a repertoire of interactional sequences they regularly use (Sacks et al., 1974). However, CA does not concern itself with the *content* of those decisions. Yet the content of decisions obviously has great importance for the people affected by those decisions.

IF is a valuable complement to CA because it illuminates the *content* of discussions. IF examines the substantive issues at stake in a negotiation, and how these issues are understood in different ways by the parties to the decision (Dewulf et al., 2009; Putnam and Holmer, 1992). We should note that "framing" is a concept that has been used extensively in multiple research traditions. Here we draw on its conceptualization in the body of communication theory that examines negotiation and conflict resolution (Dewulf and Bouwen, 2012; Dewulf et al., 2004; Dewulf et al., 2009; Dewulf et al., 2011; Drake

and Donohue, 1996; Lewicki et al., 2003; Putnam and Holmer, 1992). In this literature, frames are defined as **perspectives on *issues***, where issues are defined as "agenda items or topics of concern in a dispute" (Putnam and Holmer, 1992, 138). However, IF has limited ways of understanding how negotiation actually takes place through discussions among meeting participants, how frames evolve and change through emergent interactions. The conversational process has been somewhat of a black box in IF.

CA complements IF so effectively because the combination allows negotiation talk in meetings to be examined holistically, integrating a consideration of both process and content. New relationships among interactional sequences and framing processes are revealed, leading to the discovery of patterns across the trajectory of the decision-making activity as a whole. These patterns, in turn, can be situated in the context of the institutions within which the negotiations being examined take place.

INITIAL ANALYSIS OF ONLINE COMMUNICATIONS

Our initial approach to the analysis of online communications across stakeholder networks combined two analytic methods: social network analysis (SocNA) and semantic network analysis (SemNA). These two methods had previously been combined by one of the authors in a study of decision-making and the spread of innovation in the private sector (Gluesing et al., 2014). The approach involves the coordinated use of Condor, WORDij, and LIWC. For our pilot study, we examined three kinds of online communications: emails, a blog, and news articles.

SocNA has become popular in studies of social-ecological systems and environmental governance because it facilitates the examination of relationships among stakeholders and the identification of factors that contribute to effective collaboration (Bodin and Prell, 2011; Carlsson and Berkes, 2005; Crona and Hubacek, 2010). For instance, denser networks of heterogeneous stakeholders can help bridge differences and promote the development of a common view of the ecosystem (Sandstrom and Rova, 2010). Trust facilitates communication among people who have different sources of information and perspectives, promoting a more complete, shared view of governance issues and possible approaches (Prell et al., 2009). Social network studies on environmental issues have found that it may not be enough to bring together diverse stakeholders representing different constituencies in a formal governance structure, because the informal social ties in which stakeholders are embedded also influence their perceptions (Crane, 2010; Prell et al., 2010). Understanding the network position of individual actors in informal networks can help identify those who can serve as brokers in change efforts that cross institutional boundaries, as well as people who are accorded informal power because they possess local knowledge (Crona and Bodin, 2010; Ernston et al., 2010; Hirschi, 2010).

SemNA is just starting to be used in environmental studies. Lefsrud (2013) uncovered the discursive network and integrated cultural, environmental and economic perceptions surrounding oil sands and their development in Canada, and how they changed over time. Hasell and Hodges (2015) examined the ways in which fracking is framed in social

media, comparing the United States and Great Britain and tracking changes over time. Semantic network studies reveal the content of conversations and how they dynamically change over time by examining the topics being discussed and the emotions around these topics, identifying what is new, what remains the same or re-occurs, and what drops out of the conversation.

INITIAL INTEGRATION OF TWO APPROACHES

Integrating the CA/IF analysis of meeting transcripts with the SocNA/SemNA analysis of emails and other online communications initially seemed like a wicked problem. We were not sure at first how exactly to combine such different forms of data and levels of analysis. The CA/IF analysis of meetings is based on the relationships between words or turns and their surrounding interactional context. For instance, what role does a turn play in a particular interactional sequence or activity? How is it related to the preceding turn and the subsequent turn? How do topics and frames evolve over the course of a discussion? By contrast, the SocNA/SemNA analysis of online communications examines words or turns in the aggregate; its power lies in the ability to find patterns in a very large corpus of text. This approach illuminates broader patterns of word use and who talks to whom over time.

The literature on qualitative data analysis characterizes analysis as a trajectory that starts close to the raw data and moves ever further away toward abstractions, patterns, and conclusions (Bernard and Ryan, 2010; LeCompte and Schensul, 1999; Miles and Huberman, 1994; Yin, 2009). For instance, Miles and Huberman summarize qualitative data analysis as consisting of three concurrent flows of activity: data reduction, data display (i.e. visual summaries of data), and conclusion drawing/verification (1994, 10-12).

However, this basic insight still left us with a number of questions for our project. Where along the trajectory should the integration take place? Toward the beginning, toward the end, or in the middle? After some experimentation, we concluded that it was easiest to bring the two approaches into dialogue toward the end of the trajectory. There was just too much information to manage at the beginning, and the data were in such different forms. Later in the analysis process, we were able to draw on various summarizing documents that highlighted emerging patterns. We were then able to fruitfully bring these patterns into conversation with each other. We conclude that the integration of disparate analytic approaches may occupy a similar position along the analysis trajectory as cross-case analysis, which is also usually placed near the end (Bernard and Ryan, 2010; Miles and Huberman, 1994). Integrating disparate analysis approaches has some similarities with cross-case analysis since the latter may also represent an effort to bring potentially incommensurate findings into dialogue with each other.

We identified five major steps in our analysis trajectory, each building on the previous one in a ladder-like fashion. Figure 4 summarizes these steps, and shows that integrative analysis took place near the end of the process, in step 4. The first step was preparing the

data into a form that would be amenable to the various forms of analysis. For meetings, this meant preparing transcripts. For online communications, the process was more complex. Although the software used for social and semantic network analysis can find patterns in huge corpora with amazing speed, the "data wrangling" required to transform data into a format that the software recognizes can be incredibly time-consuming. A description of our data wrangling process can be found on our website (Wasson 2014).

The second step was pattern discovery. For meetings, this meant annotating the transcripts with interactional moves and sequences as well as topics and frames. We also imported the transcripts into Atlas.ti to obtain counts of all of these items. The SemNA of the blog and news articles used LIWC to obtain the positivity index, and WORDij to identify the most common words and word pairs, and reveal the semantic networks of most commonly used words. We also examined how all of these patterns shifted over time. Condor was used to map the activity, sentiment, emotionality and complexity of emails as they evolved over time. With regard to SocNA, we used Condor to map the social networks revealed by the emails, including betweenness centrality, degree centrality, group degree centrality, density measures, and influence.

The third step was pattern examination. In this step, we examined the annotated transcripts and the output from the SemNA and SocNA software, and wrote documents summarizing the patterns we identified. These documents then formed the basis for integrative analysis in step 4. Here we looked for ways in which our research questions were illuminated by the findings identified in step 3, bringing into dialogue emergent insights about both the meetings and online communications. Finally, in step 5, we took another step back and prepared summaries highlighting the key findings for each research question.

Steps	Analysis of Meeting Transcripts		Analysis of Online Communications	
	CA	*IF*	*SemNA*	*SocNA*
1 Data Preparation	• Created transcripts based on videorecordings and meeting minutes		• Prepared email data for use in Condor • Prepared blog entries for use in LIWC and WORDij • Identified relevant news articles using LexisNexis and Newsbank, and prepared them for use in LIWC and WORDij	
2 Pattern Discovery	• Annotated transcripts with interactional moves and sequences • Used Atlas.ti to obtain counts of interactional moves and sequences	• Annotated transcripts with topics and frames • Used Atlas.ti to obtain counts of topics and frames	• Used LIWC to obtain positivity index for blog and news articles • Used WORDij to identify most common words and word pairs and their semantic networks for blog and news articles • Used Condor to map activity, sentiment, emotionality and	• Used Condor to map social networks of emails

			complexity of emails	
3	**_Pattern Examination_**	Examined annotated transcripts and Atlas.ti counts and prepared Word documents describing patterns, both for CA and IF separately and together	Examined output from programs and prepared Word documents describing patterns, both for SemNA and SocNA separately and together	
4	**_Integrative Analysis_**	For each of four research questions: • Created table with columns for research sub-question, analysis document, method, and findings • Listed initial research sub-questions from proposal • For each sub-question, examined all analysis documents produced in step 3 and started to fill in table • In the process of filling in the table, edited the research sub-questions: deleted some, combined some, added some; engaged in iterative process between identifying research sub-questions and identifying answers to those questions in the analysis documents		
5	**_Significance_**	Prepared summaries highlighting key findings for each research question		

Figure 4. Steps in Our Analysis Trajectory

SAMPLE FINDING

While this paper is primarily about methods, the reader may be wondering where all this analysis led. What were the findings? In this section, we provide one example of a finding that resulted from the integration of our methods. While this finding was fairly simple, it was also unexpected. In short, our finding was this: personal relationships among commission members did *not* play a significant role in the decision-making process. There were clearly two clusters on the commission, three pro-industry members and two pro-environment members. But within each cluster, members did not know one another well before the commission, and they did not develop close relationships during or after the commission.

We first noticed this phenomenon as we analyzed meeting transcripts using the tools of CA and IF (while watching videos of the meetings). In our previous studies of collaborative decision-making in business organizations, meeting participants typically engaged in a considerable amount of affiliative joking, apparently to communicate friendliness and build relationships (Wasson, 2000; under review). There is an extensive CA literature on affiliative joking (Ellis, 1997; Ford, 2008; Glenn, 2003; Holt, 2012; Jefferson et al., 1987; Lindstrom and Sorjonen, 2013). Yet in the commission meetings, there was hardly any affiliative joking or other relationship-building type of interaction. Furthermore, in examining the evolution of topics and frames across each meeting discussion, it appeared that commission members were primarily driven by their individual ideological commitments, rather than seeking accommodate each other's perspectives, even within the pro-industry or pro-environment clusters. It appeared as though the relationships that mattered to them were not those with other commission members, but those with the external stakeholder communities they belonged to. Our analysis here drew on IF studies of environmental conflicts (Dewulf et al., 2004, 2011, 2013; Dewulf and Bouwen 2012; Pahl-Wostl et al., 2007; Triezenberg et al., 2011).

However, we considered the possibility that even though commission members didn't seem to be influenced much by their relationships during meetings, they might be interacting with each other outside of meetings, beyond the public eye. This is where the analysis of their emails proved valuable. SocNA confirmed that the pro-environment members were not sending messages to each other without copying the rest of the group, nor were the pro-industry members. So it appears that clusters within the commission were not plotting behind the scenes, at least to the extent we can see in the email record. However, SocNA showed that each commission member was closely tied to an active stakeholder network outside of the commission.

Our emerging insights were further illuminated by the interviews, during which we asked each commission member to draw a map of the stakeholder network around the commission, and how they fit in it. As they described these maps, we learned that each commission member was indeed connected to a somewhat different stakeholder group. The pro-industry members moved in separate circles within the broader gas industry. Likewise, the pro-environment members belonged to somewhat different, though overlapping, groups: one was a professor at a local university, and the other was active in progressive political circles.

If we had only examined meeting data, we would not have known whether backstage strategizing was taking place behind the scenes. And if we only examined email data, we would not have been able to examine the discussions that produced decisions, since those occurred during meetings. The interviews added depth to our findings and provided a context for them. In combination, we obtained a holistic picture of environmental decision-making in the context of interactions across broader networks and outside of official meetings.

Why were relationships relatively unimportant on this commission? We believe that an important part of the answer is the short life of the commission. All of its decision-making meetings took place within a three-month period. After that, nothing tied members together. By contrast, employees in the business organizations we studied expected to spend years working for the same employer. There was always a possibility that a friendly relationship with another employee could prove useful at some point in the future, or even in the present.

CONCLUSIONS

This paper presented an overview of the initial solution we developed for the wicked problem of integrating two disparate approaches to the analysis of environmental decision-making. However, the solution described here was only one part of our overall analysis process. For clarity and brevity, this paper focused only on the key components of our original research design: IF/CA of meeting transcripts and SocNA/SemNA of online communications. Additional aspects of our analysis process that we did *not* describe here include: IF/CA of online communications, SocNA/SemNA of meeting transcripts, analysis of interviews and other ethnographic fieldwork, and analysis of 20

versions of the ordinance that was being rewritten. These further analytic threads are still ongoing; we keep finding new ways to look at our data. And we also keep thinking about potential ways we might begin integrative analysis earlier in the analytic trajectory. Together, all of these interwoven methods and forms of data constitute our effort to construct a systemic and holistic approach to collaborative decision-making on environmental issues.

As noted at the start of the paper, the Anthropocene has seen a sharp rise in wicked problems concerning environmental governance. Balint et al. identify a number of reasons for this rise:
- Societies in later stages of industrialization may start to feel they can afford the economic costs of more stringent environmental policies, bringing citizens into conflict with existing policies that accept environmental degradation as the price of economic growth
- New environmental laws require public participation and permit citizen lawsuits; more stakeholders are now involved in almost every decision
- Interest groups from across the spectrum are competing with increasing sophistication and intensity to push policies in the direction their members favor
- The rise of social media facilitates the formation of communities of interest
- The rise of large-scale planning, at the level of ecosystems, increases the number and diversity of stakeholders (2011, 2013-2016).

When environmental governance activities become ineffective – paralyzed or embroiled in intractable conflicts – there can be serious consequences. Environmental crises may worsen. Human communities may suffer (Brown et al., 2010; Galaz, 2014).

For this reason, we believe it is important to conduct research that can help participatory decision-making groups move beyond paralysis and intractable conflicts. The long-term goal of our research is to contribute to the improvement of environmental governance in the Anthropocene. Once we have followed up the pilot study with a longer-term study, we expect to identify leading practices for participatory decision-making, and work with groups to implement them. As applied anthropologists with a history of working in the areas of design and organizational change, our approach will naturally take a systems view. We look forward to reporting on the specific form our applied work will take at a future meeting of ISSS.

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REFERENCES

Agrawal, A. (2005). *Environmentality: Technologies of government and the making of subjects*. Durham: Duke University Press.

Ash, H. (2011). EPA launches hydraulic fracturing study to investigate health and environmental concerns while North Dakota resists regulation: Should citizens be concerned? *North Dakota Law Review, 87*(4), 717-741.

Balint, P. J., Stewart, R. E., Desay, A., & Walters, L. C. (2011). *Wicked environmental problems: Managing uncertainty and conflict*. Washington, DC: Island Press.

Beierle, T. C., & Cayford, J. (2002). *Democracy in practice: Public participation in environmental decisions*. Washington, DC: Resources for the Future.

Bernard, R. H., & Ryan, G. W. (2010). *Analyzing qualitative data: Systematic approaches*. Los Angeles: Sage.

Biermann, F. (2014). The Anthropocene: A governance perspective. *The Anthropocene Review, 1*(1), 57-61.

Boden, D. (1994). *The business of talk: Organizations in action*. Cambridge: Polity Press.

Bodin, O., & Prell, C. (Eds.). (2011). *Social networks and natural resource management: Uncovering the social fabric of environmental governance*. Cambridge: Cambridge University Press.

Brown, V. A., Harris, J. A., & Russell, J. (Eds.). (2010). *Tackling wicked problems: Through the transdisciplinary imagination*. Abingdon: Earthscan.

Carlsson, L., & Berkes, F. (2005). Co-management: Concepts and methodological implications. *Journal of Environmental Management, 75*(65-76).

Cooke, B., & Kothari, U. (2001). *Participation: The new tyranny?* New York: Zed Books.

Crane, T. A. (2010). Of models and meanings: Cultural resilience in social-ecological systems. *Ecology and Society, 15*(4).

Crona, B., & Bodin, O. (2010). Power asymmetries in small-scale fisheries: A barrier to governance transformability? *Ecology and Society, 15*(4).

Crona, B., & Hubacek, K. (2010). The right connections: How do social networks lubricate the machinery of natural resource governance? *Ecology & Society, 15*(4), 18.

Davis, C. (2014). Substate federalism and fracking policies: Does state regulatory authority trump local land use autonomy? *Environmental Science & Technology, 48*, 8397-8403.

Deppermann, A., Schmitt, R., & Mondada, L. (2010). Agenda and emergence: Contingent and planned activities in a meeting. *Journal of Pragmatics, 42*, 1700-1718.

Dewulf, A., & Bouwen, R. (2012). Issue framing in conversations for change: Discursive interaction strategies for "doing differences". *Journal of Applied Behavioral Science, 48*(2), 168-193.

Dewulf, A., Brugnach, M., Termeer, C., & Ingram, H. (2013). Bridging knowledge frames and networks in climate and water governance. In J. Edelenbos, N. Bressers, & P. Scholten (Eds.), *Water governance as connective capacity* (pp. 229-247). Farnham, UK: Ashgate.

Dewulf, A., Craps, M., & Dercon, G. (2004). How issues get framed and reframed when

different communities meet: A multi-level analysis of a collaborative soil conservation initiative in the Ecuadorian Andes. *Journal of Community & Applied Social Psychology, 14*, 177-192.

Dewulf, A., Gray, B., Putnam, L., & Bouwen, R. (2011). An interactional approach to framing in conflict and negotiation. In W. A. Donohue, R. G. Rogan, & S. Kaufman (Eds.), *Framing matters: Perspectives on negotiation research and practice in communication* (pp. 7-33). New York: Peter Lang.

Dewulf, A., Gray, B., Putnam, L., Lewicki, R., Aarts, N., Bouwen, R., & van Woerkum, C. (2009). Disentangling approaches to framing in conflict and negotiation research: A meta-paradigmatic perspective. *Human Relations, 62*(2), 155-193.

Dove, M. (1986). Peasant versus government perception and use of the environment. *Journal of Southeast Asian Studies, 17*(113-136).

Drake, L. E., & Donohue, W. A. (1996). Communicative framing theory in conflict resolution. *Communication Research, 23*(3), 297-322.

Eaton, T. T. (2013). Science-based decision-making on complex issues: Marcellus shale gas hydrofracking and New York City water supply. *Science of the Total Environment, 461-462*, 158-169.

Ehlich, K., & Wagner, J. (Eds.). (1995). *The discourse of business negotiation*. Berlin: Mouton de Gruyter.

Ernstson, H., Barthel, S., Andersson, E., & Borgstrom, S. T. (2010). Scale-crossing brokers and network governance of urban ecosystem services: The case of Stockholm. *Ecology and Society, 15*(4).

Firth, A. (1995a). 'Accounts' in negotiation discourse: A single-case analysis. *Journal of Pragmatics, 23*, 199-226.

Firth, A. (Ed.). (1995b). *The discourse of negotiation: Studies of language in the workplace*. Oxford: Pergamon.

Ford, C. E. (2008). *Women speaking up: Getting and using turns in workplace meetings*. New York: Palgrave Mcmillan.

Francis, D. (1995). Negotiation, decision-making and formalism: The problem of form and substance in negotiation analysis. In K. Ehlich & J. Wagner (Eds.), *The discourse of business negotiation* (pp. 37-63). Berlin: Mouton de Gruyter.

Galaz, V. (2014). *Global environmental governance, technology and politics: The Anthropocene gap*. Cheltenham, UK: Edward Elgar.

Glenn, P. (2003). *Laughter in interaction*. Cambridge: Cambridge University Press.

Glenzer, K., Peterson, N., & Roncoli, C. (2011). Introduction to symposium on rethinking farmer participation in agricultural development: Development, participation, and the ethnography of ambiguity. *Agriculture and Human Values, 28*(1), 97-98.

Gluesing, J., Riopelle, K. R., & Danowski, J. A. (2014). Mixing ethnography and information technology data mining to visualize innovation networks in global networked organizations. In S. Dominguez & B. Hollstein (Eds.), *Mixed methods social networks research: Design and applications* (pp. 203-235). Cambridge: Cambridge University Press.

Greenough, P., & Tsing, A. L. (Eds.). (2003). *Nature in the global south: Environmental projects in South and Southeast Asia*. Durham: Duke University Press.

Hasell, A., & Hodges, H. (2015). *Framing fracking: An examination of the public*

discussion of fracking in social media. Paper presented at the Society for Applied Anthropology Annual Meeting, Pittsburgh.

Hickey, S., & Mohan, G. (Eds.). (2005). *Participation - from tyranny to transformation: Exploring new approaches to participation in development*. London: Zed Books Ltd.

Hirschi, C. (2010). Strengthening Regional Cohesion: Collaborative Networks and Sustainable Development in Swiss Rural Areas. *Ecology and Society, 15*(4).

Holt, E. (2012). Conversation analysis and laughter. In C. A. Chapelle (Ed.), *The encyclopedia of applied linguistics* (pp. 1033-1038). Hoboken, NJ: John Wiley and Sons.

Jackson, R. B., Vengosh, A., Carey, J. W., Davies, R. J., Darrah, T. H., O'Sullivan, F., & Petron, G. (2014). The environmental costs and benefits of fracking. *Annual Review of Environment and Resources, 39*, 327-362.

Jefferson, G., Sacks, H., & Schegloff, E. A. (1987). Notes on laughter in the pursuit of intimacy. In G. Button & J. R. E. Lee (Eds.), *Talk and social organisation* (pp. 152-205). Clevedon: Multilingual Matters.

Kangasharju, H. (1996). Aligning as a team in multiparty conversation. *Journal of Pragmatics, 26*, 291-319.

Kinnaman, T. C. (2011). The economic impact of shale gas extraction: A review of existing studies. *Ecological Economics, 70*, 1243-1249.

Lave, R., & Lutz, B. (2014). Hydraulic fracturing: A critical physical geography review. *Geography Compass, 8*(10), 739-754.

LeCompte, M. D., & Schensul, J. J. (1999). *Analyzing and interpreting ethnographic data*. Walnut Creek: AltaMira Press.

Lefsrud, L. (2013). *When worlds collide: The intersection of meaning-making between hearings and media for Alberta's oil sands*. (Ph.D.), University of Alberta, Edmonton.

Lewicki, R. J., Gray, B., & Elliott, M. (Eds.). (2003). *Making sense of intractable environmental conflicts: Concepts and cases*. Washington: Island Press.

Lindstrom, A., & Sorjonen, M.-L. (2013). Affiliation in conversation. In J. Sidnell & T. Stivers (Eds.), *The handbook of conversation analysis* (pp. 350-369). Chichester: Wiley-Blackwell.

Lustgarten, A., & Kusnetz, N. (2011). Science lags as health problems emerge near gas fields. Retrieved from http://www.propublica.org/article/science-lags-as-health-problems-emerge-near-gas-fields

Malm, A., & Hornborg, A. (2014). The geology of mankind? A critique of the Anthropocene narrative. *The Anthropocene Review, 1*(1), 62-69.

Mansuri, G., & Rao, V. (2013). *Localizing development: Does participation work?* Washington, DC: The World Bank.

Maynard, D. W. (1984). *Inside plea bargaining: The language of negotiation*. New York: Plenum Press.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd edition ed.). Thousand Oaks: Sage.

Nadasdy, P. (2003). *Hunters and bureaucrats: Power, knowledge, and aboriginal-state relations in the Southwest Yukon*. Vancouver: University of British Columbia Press.

Nadasdy, P. (2005). The anti-politics of TDK: The institutionalization of co-management discourse and practice. *Anthropologica, 47*(2), 215-232.

North, D. W., Stern, P. C., Webler, T., & Field, P. (2014). Public and stakeholder participation for managing and reducing the risks of shale gas development. *Environmental Science & Technology, 48*, 8388-8396.

Pahl-Wostl, C., Sendzimir, J., Jeffrey, P., Aerts, J., Berkamp, G., & Cross, K. (2007). Managing change toward adaptive water management through social learning. *Ecology & Society, 12*(2), 30-47.

Peterson, N. D. (2010). Choices, options and constraints: Decision making and decision spaces in natural resource management. *Human Organization, 69*(1), 54-64.

Prell, C., Hubacek, K., & Reed, M. (2009). Stakeholder analysis and social network analysis in natural resource management. *Society and Natural Resources, 22*, 501-518.

Prell, C., Reed, M., Racin, L., & Hubacek, K. (2010). Competing structure, competing views: The role of formal and informal social structures in shaping stakeholder perceptions. *Ecology & Society, 15*(4).

Putnam, L. L., & Holmer, M. (1992). Framing, reframing, and issue development. In L. L. Putnam & M. E. Roloff (Eds.), *Communication and negotiation* (pp. 128-155). Newbury Park: Sage Publications.

Rabe, B. G. (2014). Shale play politics: The intergovernmental odyssey of American shale governance. *Environmental Science & Technology, 48*, 8369-8375.

Rabe, B. G., & Borick, C. (2013). Conventional politics for unconventional drilling? Lessons from Pennsylvania's early move into fracking policy development. *Review of Policy Research, 30*(3), 321-340.

Reed, M. S. (2008). Stakeholder participation for environmental management: A literature review. *Biological Conservation, 141*(10), 2417-2431.

Rittel, H. W. J., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences, 4*, 155-169.

Roncoli, C., Orlove, B. S., Kabugo, M. R., & Waiswa, M. M. (2011). Cultural styles of participation in farmers' discussions of seasonal climate forecasts in Uganda. *Agriculture and Human Values, 28*(1), 123-138.

Sacks, H., Schegloff, E. A., & Jefferson, G. (1974). A simplest systematics for the organization of turn-taking for conversation. *Language, 50*, 696-735.

Small, M. J., Stern, P. C., Bomberg, E., Christopherson, S. M., Goldstein, B. D., Israel, A. L., . . . Zielinska, B. (2014). Risks and risk governance in unconventional shale gas development. *Environmental Science & Technology, 48*, 8289-8297.

Spaeder, J. J. (2005). Co-management in a landscape of resistance: The political ecology of wildlife management in western Alaska. *Anthropologica, 47*(2), 165-178.

Spaeder, J. J., & Feit, H. A. (2005). Co-management and indigenous communities: Barriers and bridges to decentralized resource management - Introduction. *Anthropologica, 47*(2), 147-154.

Stern, P. C., Webler, T., & Small, M. J. (2014). Special issue: Understanding the risks of unconventional shale gas development. *Environmental Science & Technology, 48*, 8287-8288.

Svennvig, J. (2012). Interaction in workplace meetings. *Discourse Studies, 14*(1), 3-10.

Taddei, R. (2011). Watered-down democratization: Modernization versus social

participation in water management in Northeast Brazil. *Agriculture and Human Values, 28*(1), 109-121.

Triezenberg, H. A., Knuth, B. A., & Yuan, Y. C. (2011). Evolution of public issues in wildlife management: How social networks and issue framing change through time. *Human Dimensions of Wildlife, 16*, 381-396.

Wasson, C. (2000). Caution and consensus in American business meetings. *Pragmatics, 10*(4), 457-481.

Wasson, C. (2014). Meeting and networks: A new approach to the analysis of participatory decision-making. Retrieved from https://meetingsandnetworks.wordpress.com/

Wasson, C. (under review). Integrating conversation analysis and issue framing to illuminate collaborative decision-making activities.

Yin, R. K. (2009). *Case study research: Design and methods* (4th ed.). Los Angeles: Sage.