4 VIRTUALLY VISUAL: THE VISUAL RHETORIC OF GEOGRAPHIC INFORMATION SYSTEMS IN POLICY MAKING

REBECCA MOODY, MATTHIJS KOUW, AND VICTOR BEKKERS

A number of authors, among them John Berger (1972), Jean-François Lyotard (1993), William Mitchell (1992), Stuart Hall (1997), and Laura Mulvey (1973), have argued that we live in a visual culture: that societies rely more and more on the use of visual material, and the importance of visual material appears to be increasing accordingly. One reason for this importance of the visual is the increasing ubiquity of media and technologies that have enabled the creation and diffusion of images in unforeseen ways. Another reason behind the importance of visual material relates to its rhetorical aspects: the perceived ability of visual material to illustrate, to mobilize authority, and to communicate knowledge. The ubiquity of the visual and of visual rhetoric can affect policy making.

In this chapter, we ask how the relationship between policy making and visual cultures can be understood. We focus on the use of geographic information systems (GIS), which feature a strong visual component that is often used in policy making. The ability of GIS to visualize information is often seen as a way to make complex information easier to understand. We assess this claim by looking at the influence of the visual component of GIS on how organizations, ideas, and actors are integrated. We do not simply assume that policy making has been changed by GIS and their visual component. Our analysis is more contextual. In addition to examining GIS and their visual components, we examine the influence of institutions and socio-political factors on GIS. We ask how and to what extent GIS affect the topic studied, thereby potentially also shaping the institutions and the socio-political contexts in which GIS operate.

Our main questions are these: How do GIS influence the integration of organizations along different dimensions? How does the visual component of GIS contribute to this, in the case of public policy making? In addressing these questions, we bridge two often separate lines of inquiry: policy studies and studies of visual culture. We propose a zigzagging between these: studies of visual culture bring into focus qualities attributed to the visual component of GIS, while insights from policy studies can show how the actual implementation of GIS affects both organizational structures and GIS themselves. We argue that studying the relationship between GIS and policy making in this manner provides an understanding of how technology plays a mediating role in visual culture. Along the lines of the discussion of "virtual knowledge" that recurs throughout this book, we discuss GIS as potential agents of change and ask whether they are capable of producing new forms of knowledge and unsettling existing power relations. More specifically, our study of the organizational aspects of GIS-related practices allows us to show whether and how practices surrounding GIS are affected by vested and emerging interests. Thus, our chapter bears a resemblance to that of Beaulieu, de Rijcke, and van Heur (chapter 1) in that we attempt to show the influence of pre-existent institutional elements in terms of their ability to shape epistemic authority. The epistemological promises attributed to the visual also feature in the chapter by Kouw, van den Heuvel, and Scharnhorst (chapter 3), whose discussion of uncertainty and knowledge production often alludes to the value attributed to visual representations of knowledge. Ultimately, we wish to contribute to the critical and contextualized approach to new media, new techniques, and new concepts proposed by the editors in the introduction to this volume.

We first discuss the notions of visual culture and visuality. Subsequently, we focus on GIS and examine their potential to integrate organizations, ideas, and actors. We then proceed to construct a conceptual framework based on work about policy design, which we use to analyze three policy issues: contagious livestock diseases, flood risk, and particulate matter. Based on these cases, we then assess the influence of GIS. We conclude by suggesting directions for future research regarding the relationship between studies of visual culture and public policy making.

VISUAL CULTURE AND VISUALITY

The study of visual cultures does not look exclusively at the content of images, but also examines the different origins and roles that visual images and visual experiences have within cultures. This includes researching cultural, political, economic, and technical dimensions of visual material that are particular to different times and contexts. Studies of visual cultures provide important insights relevant to our discussion of the relationship between public policy making and visual material. In this section, we discuss how studies of visual culture show how seeing and perceiving contain historically variable relations and therefore are not free of political motives. Studies of visual culture also examine the role played by the technologies involved in the production of visual material. The next section focuses more on the role of technologies in visual cultures, which, in our case, involves a discussion of geographic information systems.

Examining what constitutes and shapes the activities of "seeing" and "perceiving" requires us to look not only at the kinds of signifying systems, languages, skills, and techniques employed within a certain culture but also at the ability of that culture's members to make sense of visual information. Although seeing and perceiving can be explained as neutral and purely cognitive, studies of visual cultures show how perception involves historical and political specificities that influence what it means to "see" or to "perceive." According to Jonathan Crary, "vision and its effects are always inseparable from the possibilities of an observing subject who is both the historical product and the site of certain practices, techniques, institutions, and procedures of subjectification" (1992, 5). This implies that social environments and perception cannot be understood independently, a concept that studies of visual cultures identify as "visuality":

> Within visual culture studies, the term 'visuality' stands for the way that vision and the various modes of attention that we commonly identify—seeing, looking, gazing, spectating, and observing—are historically variable. It reminds us that vision is an active, interpretative process strongly governed by communities and institutions, rather than an innocent openness to natural stimuli. (Alpers et al. 1996, 68)

Apart from studying the spectator, studies of visual culture also provide critical readings of authorship of visual representations. Studies of visualizations often emphasize their potential to disclose important properties that usually are not read, or that cannot be read simply from complex datasets (Ware 2000, 2). Various sciences now feature strong visual components that arose in the late 1980s when computation and data storage became more accessible and scientists had to confront the vast amounts of information that were becoming available as a result (Wright 2008, 78). Edward Tufte discusses the role of the information visualization designer, heralded as an individual who has the ability to create an optimal fit between dataset and visualization (2001). However, designers increasingly embrace the idea that data can be represented in a multitude of ways. In an edited volume on cartographic visualizations, Abrams and Hall (2006) take up the possibilities of new visualization tools to address questions of meaning, objectivity, and interpretation in visualizations: "To design is to invent strategies for visualizing information that make new interpretations possible." (2006, 1) A notable example of a new means for visualizing data is the open-source platform Processing, developed by Casey Reas and Ben Fry (2007). Echoing a critical perspective often encountered in open-source communities, Reas and Fry express a desire to "facilitate designers' taking control of their own tools" (ibid., xxv). But since no visualization is free from the idiosyncrasies and choices of its creator, questions related to authorship remain important: Why is a particular visualization seen as thorough, optimal, or eloquent? For whom is this important?

In this chapter, we take a critical perspective by studying whether visualizations indeed enhance communication, participation, accessibility, and transparency. We use contextual approach in which we not only look at technologies but also at their social context. According to Martin Lister et al., "the capacity to see is educated and disciplined, habituated and interested, and primed to be alert or dominant in one way or another; ways that are specific to culture and history. Thus, there are different ways of seeing at different times and in different cultures that are shaped by the ideas, interests, social institutions, and technologies of an era or culture." (2003, 101)

GEOGRAPHIC INFORMATION SYSTEMS

In the previous section we argued that visual information is shaped by social, political, economic, and cultural factors that not only contribute to its acceptance but also create a demand for it. In addition to deconstructing practices of seeing and perceiving, studies of visual culture look at how technologies shape seeing and perceiving. In order to understand the relationship between geographic information systems and public policy making, we examine how GIS are used in creating, manipulating, and distributing visual images. Before assessing how GIS affect the process of public policy making within visual culture, we first explain what functionalities and qualities are commonly attributed to GIS.

Geographic information systems involve computerized systems that, like other ICTs, can order, manage, and integrate large quantities of data. Policy makers often argue that GIS present this data in a manner in which complex information becomes comprehensible for non-experts. GIS make it possible to visualize spatial distributions of social entities and their characteristics. Through GIS, dynamics of these entities can be visualized, and correlations between different social entities can be displayed. Furthermore, GIS can follow the accumulation in spatial terms of societal issues (Snellen 2000; Meijer 2002; Greene 2000). GIS support public policy making and decision making by presenting information visually—for example in the form of a map, a movie, or a virtual world. As a result, the expectation is that this opens up the variety of possible decisions in policy making: complex data now can be understood by a large group of people who would not have understood the data had they been presented in the form of a spreadsheet (Lips et al. 2000; Moukomla and Poomchatra 2004; Carver et al. 2000; Overchuk et al. 2005).

Although the ability of GIS to produce visualizations is often emphasized, other functionalities of GIS should not be pushed to the background, since they influence the content of GIS applications and how these are used.

First, GIS can be used for calculation. By using different calculation techniques, input values, and models, GIS enable the development of a scenario-based form of "if-then" reasoning. GIS thereby gain the reputation of being less fixed and more thorough than other forms of analysis. For example, in the case of an outbreak of avian flu in Thailand, GIS made it possible to base predictions related to the spread of the flu virus on the mobility of infected animals (Moukomla and Poomchatra 2004).

Second, GIS enable control through correlation in organizations by linking different datasets to one another. This can make visible issues that had been unknown or inaccessible, and thus can create new knowledge. Work procedures can thus be standardized, and standardization makes greater control over such procedures possible. For example, in California in the mid 1990s, GIS helped to make sure that federal funds were distributed in such a way that schools with large numbers of children from low-income families received more funding. Data about low-income families, school districts, and school attendance were stored in different databases. GIS helped to integrate these databases and calculate which schools should receive extra funding (Greene 2000).

A third and related quality attributed to GIS is their ability to enhance transparency. In the example of schools cited above, decisions about the allocation of funding were made in a way that was transparent for different public administrators. Such processes of decision making can be standardized, and the course of the policy processes can be studied. As a result, the process of decision making can become more transparent. As was detailed above, the ability of GIS to visualize different possible approaches to an issue may increase the accessibility and transparency of policy issues. What is more, combining datasets may yield new insights (Lips et al. 2000; Moukomla and Poomchatra 2004; Carver et al. 2000; Overchuk et al. 2005).

GIS can offer a means of communication through which different organizations can share data and see how other organizations look at policy issues. This can aid in the integration of such organizations: GIS provide a way for organizations to communicate with one another on how a particular policy issue is best approached. Another form of integration concerns the ability of GIS to integrate different datasets and thereby to make new information visible. We hasten to add that such advantages and disadvantages ascribed to the integration of actors and data should not be taken at face value. Rather, we ask exactly what aspects of policies and processes of deliberation make GIS so attractive to those involved with policy making, for example by endowing policy making with a degree of transparency, and whether this shapes policy making in some way (Bekkers and Zuurmond 2004).

POLICY DESIGN

Our conceptual framework of policy design is based on the institutional analysis and development framework of Ostrom et al. (1994). Our framework enables an analysis of integration in our case studies. In this theoretical approach, institutions structure action through rules. This framework distinguishes the "action arena" as the social space in which individuals interact about the policy issue at stake. All actors in the action arena have agendas of their own and aim for policies that fits their respective values and norms. As a result, groups of actors might come into conflict in trying to promote their values and norms within the policy design, thereby pushing values and norms of other actors to the background (Dror 1968; Etzioni 1967;

Lindblom 1959). Those who manage to push their values and norms forward most successfully see these norms reflected in the final policy design, which may exclude other actors. This is where the integration of organizations becomes relevant, since the ties of communication between these groups can influence the outcomes of conflicts they might have.

We approach power in terms of interaction, in the course of which the perception of power is most important. Actors and coalitions act on the basis of how much power they believe other actors and coalitions to have. Therefore, the power relations within the action arena can only be explained by reference to the perceptions of the actors themselves. When other actors see one actor as very powerful, that actor behaves in a dominant manner, and others react accordingly. Within the action arena there are also groups that try to hinder certain proposals and alternatives from being taken into the policy design. Their degree of success varies, depending on the relative amount of power wielded by such groups (Etzioni 1967). Therefore, the group with the largest amount of perceived power will see most of its values and beliefs reflected in the proposal. We not only discuss the influence of GIS in this process, but also outline the specific influence of the visual component of GIS on the process of integration.

We would like to emphasize that the actions and interactions within the action arena do not only depend on the power relations of actors within the arena and their values; actions and interactions are also influenced by formal institutions, regulations, and laws. The actions taken in the action arena have to fit within the legal system. Formal institutions thus determine the scope of the actions and interactions possible within the action arena (Ostrom et al. 1994). Formal institutions are not shut off from the action arena, however, and they can be influenced by actions in the action arena. For example, new legislation may be passed and new institutions formed in the action arena.

In addition to formal regulations, we also examine informal rules or "rules in use" (Ostrom et al. 1994). For example, some organizations always choose to work together because of past relationships, even though they are not legally obliged to do so. Through actions in the action arena, rules in use may change, new alliances may be made, and new actors may be included. Leading values and norms may also restrict the possibilities for actors (Bachrach and Baratz 1970; Cobb and Elder 1972; Birkland 1998).

Below we describe the case studies along the lines of the power relations within the action arena, according to the contextual variables such as the formal and informal rules, and according to the leading values and norms in society. On the basis of these descriptions, we look at the influence of the visual component of GIS. Do these visual components influence the power configurations among individual actors and among organizations? In addition, we analyze how organizations might be integrated, thereby changing the formal institutions, the rules in use, and the leading norms.

CASE STUDIES

LIVESTOCK DISEASES

Germany has a long history of dealing with contagious livestock diseases, having suffered many outbreaks in past centuries. Because of this history, financial resources are available to prevent and contain contagious livestock diseases. The outbreak of contagious livestock diseases, such as swine fever or foot and mouth disease, can have major economic and societal impacts. The GIS application used in Germany for managing livestock diseases is called TSN, which stands for Tierseuchen-Nachrichten (meaning, in English, Animal Disease News). TSN has been in development since 1993. It establishes a computerized nationwide alarm and evaluation system for outbreaks of infectious livestock diseases. Additionally, it demonstrates what course of action should be taken to evaluate whether the correct action has been taken and to learn from outbreaks. Moreover, it functions as a database for research in the areas of contagious livestock diseases. All people and organizations that are granted access to TSN are able to access this database through a Web browser. In addition, TSN includes an intranet application that enables veterinarians to find addresses of particular farms and statistics about them. A map server integrates all the data stored in TSN and enables those data to be represented in the form of maps.

In the case of each outbreak thus analyzed and represented, it becomes clear where exactly the outbreak has occurred, when it was found, what the history of the diagnosis is, and what measures were taken to cure the animals or to prevent the outbreak from spreading. This allows for follow-ups on the measures to be taken. In the case of an epidemic, others can see what actions have been taken. The GIS application calculates how fast the disease will spread, taking into account such variables as the presence of other farms in the vicinity of the infected farm, the presence and density of related (and possibly infected) animals living in the wild, the mobility of people in the area, and wind speeds (relevant in cases where the disease is airborne). The application can then predict the speed and the scope of the spread of the epidemic. This can be viewed on a map and in the form of animations. The application is able to calculate where a restricted area and a buffer zone should be created, and how large these should be.

The German government has appointed the Friedrich-Loeffler-Institut (FLI) to operate TSN. The FLI is funded by the national government and runs and operates TSN and functions as a center of expertise for infectious animal diseases. It is the primary organization responsible for informing policy makers in the German government about these issues. In the case of an outbreak, it establishes a diagnosis of the disease and tells the government what measures are needed to prevent further outbreaks. The government grants the FLI the power to operate TSN and to decide on all matters regarding TSN. In practice, this means that TSN is the sole repository of the data concerning farms, outbreaks, wildlife, and diseases. The FLI also has a monopoly position in providing information to government policy makers regarding the status of prevention. Therefore, the FLI is the only organization that advises the government on matters of infectious animal diseases and their consequences.

The information provided by the Friedrich-Loeffler-Institut to the government is communicated mostly in the form of maps or animations showing a simulation of the effects of measures taken. This is seen as an appropriate way of presenting data, since understanding the original data requires expert knowledge on the subject.. In interviews, representatives of both the FLI and the government have said that they are very pleased with this form of communication.[1] Respondents from both the FLI and the government argue that issues are far more "clear" when so represented. Respondents from the government in particular emphasize that they are happy to have one organization that they can trust provide them with accurate and up-to-date information.

However, there are two problems with this assertion of clarity. First, the original data have a margin of error, since wind and mobility cannot be predicted without error. The margin of error is visible in the original programming, and is also acknowledged by scientists at the Friedrich-Loeffler-Institut. However, visual representations of livestock diseases do not inform the viewer of this margin of error. Experts on livestock diseases believe this error cannot be communicated, since that would make it difficult for policy makers to understand the model. According to these experts, images containing margins of error would no longer be unambiguous. As a result, policy makers in the government are often not aware of these margins of error, and assume the image is the unambiguous truth.

Other organizations involved in the management of contagious livestock diseases are less pleased with the role of the FLI. These organizations include research institutes such as universities and organizations dealing with the meat industry, with environmental organizations, and with activist organizations advocating animal rights. (See note 1.) These organizations argue that containment and prevention should be dealt with in a manner different from the approaches suggested by the FLI. However, they are unable to communicate their ideas to the government for two reasons. The first is that they do not have any data. The second is that they do not have the power or the authority to communicate their ideas to the government.

The previously mentioned organizations have accused the Friedrich-Loeffler-Institut of embedding its own values in its programming, which is based on algorithms that reflect the norms on prevention and containment held by the FLI. (See note 1.) As a result, universities, animal-rights activists, and research institutes without access to TSN claim that other views are excluded from the application. In this way, especially in the eyes of organizations for animal rights, not all alternatives for policy creation, such as the alternative of diminishing the number of livestock farms as a measure for prevention, are being communicated to the government. They consider the alternatives that are communicated to be biased, since these reflect the values of only one actor. This is revealed in visual representations as well: when certain possibilities are excluded from the underlying calculations, they will not show up in the image. An example often given by universities and by animal-rights activists is that it seems to be impossible to ever obtain an outcome in which killing the animals would be the best alternative: any set of parameters entered in the application yields an image showing that vaccination of animals would yield the best results.

In the past, all involved organizations negotiated a solution. Since the emergence of TSN, that is no longer the case. Only some actors are invited to negotiate. The excluded actors claim that only actors that share the views of the Friedrich-Loeffler-Institut are invited to negotiate. According to them, they no longer have access to the databases, simply because they hold other norms and values. They find no chance to negotiate their issue(s), for they have no data with which to substantiate their point. The FLI admits that some actors are excluded for the sake of privacy of farmers, whose personal data cannot be given to any organization. (See note 1.)

There has been some integration among organizations. The application allows for organizations to work together, to share data, and to make sure that all information stays up to date. However, some organizations that hold opinions different from those of the Friedrich-Loeffler-Institut feel left out of the process of negotiation and argue they have no means of bringing their ideas and policy proposals to policy makers. The fact that the FLI has been able to position itself as the only organization responsible for communicating with the government on matters related to livestock diseases has further reinforced this situation.

People in the German government appear to believe that visual representations are very helpful. They are convinced they now have the means to understand issues in ways previously unavailable, and they argue they can actually see the consequences of different policy alternatives. Previously they were not able to understand consequences of measures, since this information was provided to them in lengthy documents written in technical language they were not able to understand. Policy makers consider the visual representations sufficient to make the situation clear, since they believe the representations in question are unproblematic and complete. In their opinion, this makes choosing the best alternative much easier. However, since these images do not allow for the display of margins of error, the "truth" attributed to them is not as straightforward as policy makers think. Furthermore, universities, animal-rights activists, farmers, and other actors not involved in TSN claim that the application and its calculations are manipulated to serve the interests of the FLI, and that this manipulation affects the content of the visualizations made available to the government. They believe that the government, on the basis of the "manipulated images," will not make decisions that don't serve the interests of the Friedrich-Loeffler-Institut.

HIS AND FLIWAS

The Netherlands, with a long coastline, many rivers, and a large part of the country lying below sea level, has a long history of dealing with water management. The floods of 1993 and 1995 led to a desire to speed up the development of applications for the purpose of monitoring water levels and as a means to communicate risk in case of flooding and to create operational warning systems. As a result, a number of applications to deal with these matters were developed.

First, an application named HIS (standing for Hoogwater Informatie Systeem, which means High-Water Information System) was developed. In 2001 the first version of HIS was launched. A geographic information system, HIS can be accessed through a website. The aim of HIS is to prepare for disasters. It monitors water levels, places them in a logbook, and is able to communicate this data to other organizations, to governmental bodies, and to stakeholders. Users of HIS may use the application to create scenarios related to flooding, which may then be displayed on an interactive map in the form of an animation. On the basis of predictions of flooding, HIS can be used to calculate flood-related damage in economic terms and also in terms of the environment, loss of landscape, numbers of victims, and plans for evacuation.

HIS has now been integrated into FLIWAS (Flood Information and Warning System), a larger application that also includes Infraweb, an application that was developed mainly for purposes of communication. The aim of FLIWAS is to develop and implement an application of flood management on a transnational level with Germany, thereby increasing knowledge about the risks of flooding and playing an important role in alerting the public to the risks. FLIWAS incorporates all the features of the applications described above, but also includes the additional feature of acquiring geographical data by satellites.

The Dutch have a long history of dealing with water management on the administrative level. In the field of Dutch public administration, several organizations are responsible for water management. Collectively known as the public water sector, they include the Water Boards (which deal with water management in their appointed territory) and the national Ministerie van Verkeer en Waterstaat (currently called the Ministry of Infrastructure and the Environment, after a recent merger).

The water sector had hoped to use the visual representations created by means of HIS to inform the public of water management and flood risks. However, the Ministry of Infrastructure and the Environment had to decide whether the public should be aware of the risks of flooding or not. The experts in the water-management sector were very much in favor of putting the animations and maps of the risks of flooding online so that citizens could see whether their surroundings were at risk and how fast and how high the water would be coming. The experts argued that citizens had the right to know, but also argued that more citizen awareness would bring attention, and thus resources, to the water-management sector. The Ministry of Infrastructure and the Environment eventually decided that the public should not be allowed to see this information, and established this by law. The position of the Ministry was that citizens would become over-sensitized to the issue as a result of watching the animations (interview with informant, Ministry of Infrastructure and the Environment, July 2008). Additionally, the Ministry argued that the property market would collapse if this information were to be made visible and accessible to citizens.

The initiative to implement FLIWAS was aimed at integrating different institutions operating within the water sector. In this way, the various agencies dealing with the weather, with water levels, with climate, and with landscape data could work together by means of a single application. These organizations have indeed worked together, thereby increasing knowledge of water management. In addition, FLIWAS enables these organizations to influence policy making as a block, and to confront the municipalities in negotiations.

In some cases, the municipalities and the water sector have conflicting interests. Where municipalities would like to build on their territory, the water sector claims space for water management. Because of the use of visual representations generated by HIS and FLIWAS, the water sector can graphically illustrate to municipalities the consequences of their building plans. The municipalities cannot bypass these perceived consequences. However, policy makers in municipalities are not always willing to change their development plans, and are not always happy with what they see as interference from organizations in the water sector.

Before HIS and FLIWAS, according to our respondents from the Ministry and the Water Boards, it was very difficult for policy makers to understand what was actually going on, or to what extent citizens were at risk. Policy makers regarded the information provided by water-management organizations as vague and too technical. Now the water sector can communicate this information to municipal policy makers far more easily. Visual representations are perceived as making visible what will happen if a certain property is built, what the resulting pressures on a dike would be, and how high the water would be in case of a breach of the dikes (and how quickly such an incursion might happen). As a result, visual representations of prognoses are perceived as representations of what will *actually* happen once certain conditions are met. Both policy makers and experts in the water-management sector claim that this way of communication ensures that policy makers understand what they are dealing with. Because the scenarios are represented on maps, they appropriate a higher degree of "reality": policy makers can relate to the physical environment on which the scenario is projected, which thereby becomes more closely related to reality itself for them.

A first example is the case of the village of Lent, where the municipality wanted to build a new neighborhood and the water-management sector wished to broaden a river at the same location. A conflict occurred, and each party pushed its idea forward. Animations were used to visualize what would happen if the river were not be broadened, which could, for example, result in an increased chance of flooding. In these visual representations, flooding occurred with such a speed that it would become impossible to evacuate citizens in time. In the face of such graphic depictions of flooding in this particular manner, the municipality reconsidered its policy and decided not to build a neighborhood there.

In another example, the town of Gouda wanted to build a neighborhood on the flood plains of a river. The water-management sector resisted this fiercely for the sake of the safety of citizens. In the end the municipality prevailed. The animations of the water sector had not impressed the municipality sufficiently.

These examples show that the battle between the municipalities and the water sector is ongoing. Before the implementation of HIS and FLIWAS, municipalities were usually able to carry out their plans unabated. Since the water sector has wielded the ability to mobilize visuals through the GIS applications, however, they have become a force to be reckoned with. Often the Water Boards challenge the municipalities' plans and force them to reassess their options. The municipalities no longer have to negotiate with just one actor dealing with water management, or only a few; now they are confronted with a coalition backed by an impressive package of information.

In conclusion, a lot of organizational integration has occurred. Because of HIS and FLIWAS, the organizations dealing with water management and the organizations holding information relevant to water management now cooperate and therefore form a power bloc with extensive up-to-date information. This has ensured that the policy interests of the water sector can be aggressively promoted. The water-management sector has thus become an actor to be reckoned with, and has secured its place at the negotiating table. The power that sector has achieved from promoting its information has clearly increased. Because of visual applications, the water-management sector has become able to communicate consequences, costs, and benefits to policy makers in a way they are able to understand. In several instances this has caused spatial development plans to be altered in favor of the ideas of the water-management sector.

PARTICULATE MATTER[2]

The case of particulate matter deals with air quality and public health. In contrast to the previous cases, the Netherlands does not have a long history of dealing with this issue. Particulate matter is material that remains suspended in air or liquids and which has a detrimental effect on health. It originates from several sources, some human (traffic, industry, agriculture) and some natural (dust, sea salt). Particulate matter can cause heart and lung diseases, cancer, acute or chronic bronchitis, and asthma. The Netherlands and the European Union have implemented a number of rules and regulations regarding particulate matter, such as norms that determine boundary values—the maximum concentration of particulate matter allowed in the air. Health risks posed by particulate matter were the main reason why regulations were negotiated in the European Union during the 1990s. In Dutch national law, these directives have been implemented. In areas where the norm is exceeded, the Dutch government, a province, or a municipalities can implement a program to improve air quality. Concentrations of particulate matter are measured by means of remote sensing. The Rijksinstituut voor Volksgezondheid en Milieu or RIVM (National Institute for Public Health and Environment), the organization dealing with public health and environmental issues, uses a geographic information system to process the data acquired by these means. After calculations are made, the data are presented in the form of a map

After 1996, municipalities in the Netherlands became responsible for measuring the air quality in their territory, and improving it when necessary. This proved problematic for two reasons. First, local government policy makers were not very happy to discover that the norm was apparently exceeded across a wide area, which precluded them from building anything there. Second, local governments acknowledged that they were not sure how to measure concentrations of particulate matter. There was the question of where to measure, and it wasn't clear how large the measuring areas should be. In addition, it wasn't always evident which substances should be measured. Some specialists on particulate matter argued that sea salt didn't count, since it was a "natural" substance; others claimed that excluding sea salt required lowering the norm. In any case, the results of the measurements are published on the Internet by the RIVM. However, most maps of concentrations and visualizations of scenarios (i.e., representations of concentrations in the case of a new road or a new building project) are not made public.

The national government wishes to reduce concentrations of particulate matter, but without damaging building projects. Municipalities wish to build, and are very unhappy with the strict regulations on concentrations of particulate matter. In contrast, environmental organizations wish to reduce particulate matter even further. Because it is so unclear what (and how) to measure, as respondents from environmental organizations argued, local governments were able to manipulate the data. As a result, some projects were allowed to be built, but should not have been built. This was achieved by manipulating maps, for example by enlarging the scale of the area or by placing the measuring poles in a different location. In both cases, the resulting image seems to show that a project is allowed. In reaction to this, environmental organizations have created their own applications for measurement. However, governmental organizations accused environmental organizations of manipulating data in order to make sure that projects that were really legal would be stopped. On a number of occasions, the judge responsible was unable to decide whether a project could or could not continue, since the methods of measurement and the calculations were so ambiguous and opaque that a decision could not be made.

This confusion regarding calculations and measurements stems from two sources. First, uncertainties in the calculations mean that the visualizations on which decisions are based have a large margin of error, though the images do not show and explain this. Second, there is no agreed-upon standard of measurement. As a result, local governments are still able to change the positions of the measurement points, and to enlarge or downscale areas for measurement.

In short, all actors agree that the data and the results of calculations are worthy subjects for discussion. In the case of a conflict, a judge will have to decide whether a building plan may continue (in case the norm is not exceeded by the realization of the plan) or not. Because municipalities often want to build, the data, simulations, and visualization they provide to the judge will support their claims. Environmental organizations generally want to stop construction plans, and provide the judge with their own data, simulations, and visualizations. Therefore, a judge has multiple scenarios from which to choose. According to respondents from the RIVM as well as municipalities and environmental organizations, decisions concerning whether a plan can continue seem to rely on the toss of a coin.

In contrast to the previous cases, there is not just a single application; rather, different groups (with different interests) have developed the skills to use their own applications. The outcome of the calculations in an application can be manipulated in favor of the group producing it. The environmental organizations are now actors to be reckoned with. In the past they only had the power to protest, but now they have a tool that can actually assist them in judicial hearings, and maybe even sway the balance.

Since the start of legislation on particulate matter, the relationships among the actors can be characterized as distrustful. Each actor accuses the other actors of manipulating the data for their own interests; however, since no actor has the formal power to promote its information as being more accurate or legitimate than the information of any other actor, distrust has continued to fester. Here we can see that the use of GIS has not integrated organizations. The fact that different organizations use different applications has only led to more animosity and conflict between organizations.

In the cases of infectious diseases and water management, the potential of visualizations made with GIS to enhance communication has shown that communication between experts and policy makers has indeed been made easier. In the case of particulate matter, however, such is not the case. Different organizations have used different calculations, which result in several conflicting visualizations. A judge has to confront these conflicting visualizations, and is thereby unable to decide which one is right, since there is no golden standard or unambiguous and perceivable truth against which the visualizations in question can be judged. The visualizations have given environmental organizations more power to negotiate their causes. Previously, municipalities made decisions and the environmental organizations could not protest on scientific grounds. Now, however, the environmental organizations are actually able to demonstrate (by means of visualizations) the consequences of building plans, which might cause a judge to rule in their favor.

ANALYSIS

The case studies have a number of similarities and differences. First, we find that the power relations between the involved actors have changed in all cases. In the case of TSN, the position of the experts on contagious livestock diseases with access to TSN has improved at the expense of other experts and farmers. The experts without access have been excluded from the organizational structure and are unable to use the data of the Friedrich-Loeffler-Institut or even to voice their opinion. The experts with access to TSN have the power to promote policy proposals on contagious livestock diseases, which they do in a very successful manner. TSN gives the experts who have access to it the power to negotiate with national and European policy makers. These experts have all the information, and they are able to communicate this information in a way that policy makers understand: in the form of a map and/or animations.

In the case of HIS and FLIWAS, all actors now perceive the water sector to have acquired a powerful position. Because of the visual component of HIS and FLIWAS, they can communicate their knowledge more easily. They can communicate with other organizations, but they can also communicate more easily with policy makers, since they are able to create visualizations. As a result, they can illustrate why, for example, a dike should be reinforced. This new-found power of the water sector has caused some friction with the municipalities, since the local authorities feel they are losing power over their territory. This fear relates to the fact that the water sector now has all available information at its disposal, which suggests a degree of completeness according to all respondents. Furthermore, this information can be communicated by means of images in a way the policy makers consider more convenient.

In the case of particulate matter, interactions are complicated by a great deal of conflict between municipalities and building corporations on one side and environmental organizations on the other. Where municipalities and building corporations would still like to build, environmental organizations want to prohibit them from doing so for reasons related to air quality. Both opponents ground their arguments in the inaccuracies of the applications, and both publish images and maps that are supposed to show that they are right. A large number of actors have access to applications that measure particulate matter, and are thereby able to present their information in the form of a map. However, this information is easily manipulated. In this case, the authority attributed to these images by the various stakeholders only reinforces the conflict. All parties expect to gain power by means of the visualizations they can present to a judge. In practice, however, the visualizations of one actor fundamentally conflict with the visualizations of another actor, and therefore do not lead to a straightforward conclusion.

A second point relates to the role attributed to GIS, including their visual component. The use of visual material in the three cases described reveals a certain flexibility of visualizations as epistemic authorities, which suggests a rhetorical dimension, also discussed in studies of visual culture. In the case of TSN, not all parties agree on what TSN actually entails. Those with access, namely policy makers and politicians, agree that TSN is a tool for providing up-to-date information, and that it is very valuable in making calculations and simulations so that policies can be designed. Others, however, believe TSN to be a tool for exclusion. Here we see that the potential of GIS to integrate organizations is used in the opposite way: organizations are denied access to the data. Furthermore, some believe that TSN is used to push certain ideas forward using seductive and persuasive visualizations, since the application can be manipulated. The water sector sees HIS and FLIWAS primarily as tools for calculation and visualization, while policy makers perceive them primarily as tools for visualization and communication. In the case of particulate matter, the applications used to measure, calculate, and present data on concentrations of particulate matter are mostly seen as calculation devices. Furthermore, all involved actors and coalitions agree that the application is an important source of power. Each coalition accuses other coalitions of using the application in such a way that data can be manipulated and outcomes are skewed in favor of a particular purpose.

Third, with respect to organizational integration, GIS provide a means for different organizations to communicate with one another (and share their data in the case of water management). In this way, these organizations and the actors working for them have become more integrated. This does not seem to apply in the case of particulate matter, where integration of organizations has not taken place, and in the case of infectious diseases, where some organizations have been excluded.

CONCLUSION

Whether the way organizations are integrated is altered by the use of GIS remains in question, as does the influence of the visual component of GIS on this process of integration. We draw several conclusions concerning the case studies.

First, the ways in which organizations are integrated (how they communicate, whether and how they share data) is altered by the use of GIS in all three cases. In addition, the way actors communicate with one another in public policy making has changed. GIS can integrate organizations by providing new means of communication and ways of data sharing. These new connections and lines of communication have become more widespread and in some instances are even included in the formal institutional features. This ensures that in the future these lines of communication will indeed be followed. However, the opposite can be found as well: the case of TSN shows that actors were excluded. Another change in the way organizations integrate by means of GIS can be found in the case of particulate matter. Here there is not one single application; there are many actors, each of which uses its own application. Even though the GIS applications ensure that all involved actors can communicate their information, the information is not trusted and is seen as manipulable. This tension points to the fact that communication between different groups now has become possible through the use of GIS, but that the political relations between the groups have not improved. Thus, geographic information systems do influence the way organizations are integrated and connected, in terms of communication and data sharing. But what form this influence takes depends on the way the application in question is implemented, and on its context. This affects not only the number of organizations that are integrated with one another, but also their relations. In terms of public policy making, this can have a profound impact. Organizations with access to applications obtain more power than other organizations, since they have a monopoly on information. Furthermore, new information can emerge when data are shared, and the process of policy making can be enhanced by newly formed connections. These connections can ensure that policy issues are communicated with more stakeholders, and may also account for different policy outcomes. What the effect of this will be cannot yet be predicted.

Second, we conclude that the use of GIS and their visual components have a considerable effect on how organizations are integrated. We found several occurrences of this. First, the relations and connections between organizations change as a result of the visualization function of GIS. Within policy domains, organizations have always worked together. This has mostly included experts in a policy field and policy makers. Before the use of GIS, communication between the two was often difficult. Policy makers were sometimes unable to interpret and understand the data presented to them by experts. Because of the visual component of GIS, in our cases, experts are able to demonstrate effects of policy ideas to policy makers in the form of a map or animation. As a result, policy makers may be better equipped to understand these effects in a way they could not before, since they purportedly did not understand the data presented to them. This alters the relations and connections between organizations, not only because communication becomes less complex, but also because experts gain power in policy making because they are now seen as a serious partner. This is due to the observation that it is possible (at least in principle) to present predictions of the consequences of each proposal in a manner more accessible to policy makers.

Studying the values and power relations at work within visualization remains necessary to do justice to the intricacies of the actual implementation of visualizations. Echoing insights from studies of visual culture, our case studies show that visual representations need to be studied in context to understand how they influence public policy making. The visual component of GIS plays a large part in the alteration of the connections between organizations. We have shown this in terms of who is included, since information is now "opened up" and "transparent," but also in terms of who is excluded. Additionally, relations have been altered by the visual component of GIS. Experts working with GIS grow in stature through the use of visualizations, and thereby have a greater influence on the policy issue at stake. Visual representations are not neutral, and their underlying values need to be taken into account. There is no straightforward answer to the question whether GIS alone bring about the actualization of potentials, nor to the question whether they are responsible for the creation of new potentials. Regarding such potentials, our chapter proposes ways to study whether and how GIS unsettle vested interests and shake up patterns of interlocked technologies, practitioners, and institutions. We invite both policy makers and those studying the use of visual representations in public policy to examine perception and visualizations critically. In many cases, seeing and perceiving involve power relations: the observer holds some degree of power over the seen, and it is possible for one social group, class, or gender to exercise power over others through the use of visual images. In that sense, claiming that visualizations are devoid of political motives is a very political move indeed.

NOTES

1. Interviews were held in relation to TSN and policy making with several respondents in different organizations in Germany between September and December of 2008. Owing to arrangements for anonymity established before the interviews, the content of these interviews cannot be cited, quoted, or linked to.

2. Interviews were held in relation to particulate matter issues and policy making with several respondents in different organizations in the Netherlands between April and July of 2008. Owing to arrangements for anonymity established before the interviews, the content of these interviews cannot be cited, quoted, or linked to.

REFERENCES

Abrams, Janet, and Peter Hall. 2006. Where/abouts. In *Else/Where*, ed. J. Abrams and P. Hall. University of Minnesota Design Institute.

Alpers, Svetlana, Emily Apter, Carol Armstrong, Susan Buck-Morss, Tom Conley, Jonathan Crary, Thomas Crow, et al. 1996. Visual Culture Questionnaire. *October* 77 (Summer): 25–70.

Bachrach, Peter, and Morton Baratz. 1970. *Power and Poverty: Theory and Practice*. Oxford University Press.

Bekkers, Victor, and Arre Zuurmond. 2004. Achtergronden en eigenschappen van ICT. In *ICT en openbaar bestuur: Implicaties en uitdagingen van technologische toepassingen voor de overheid*, ed. M. Lips, V. Bekkers, and A. Zuurmond. Lemma.

Berger, John. 1972. *Ways of Seeing*. Penguin.

Birkland, Thomas. 1998. Focusing events, mobilization, and agenda setting. *Journal of Public Policy* 18 (1): 53–74.

Carver, Steve, Andy Evans, Richard Kingston, and Ian Turton. 2000. Accessing geographical information systems over the World Wide Web: Improving public participation in environmental decision making. *Information Infrastructure and Policy* 6 (3): 157–170.

Cobb, Roger, and Charles Elder. 1972. *Participation in American Politics: The Dynamics of Agenda-Building*. Johns Hopkins University Press.

Crary, Jonathan. 1992. *Techniques of the Observer*. MIT Press.

Dror, Yehezkel. 1968. *Public Policy-Making Reexamined*. Chandler.

Etzioni, Amitai. 1967. Mixed-scanning: A "third" approach to decision-making. *Public Administration Review* 27 (5): 385–392.

Greene, R.W. 2000. *GIS in Public Policy: Using Geographic Information for More Effective Government*. Esri.

Hall, Stuart. 1997. The work of representation. In *Cultural Representations and Signifying Practices*, ed. S. Hall. Sage.

Lindblom, Charles E. 1959. The science of "muddling through." *Public Administration Review* 19 (1): 79–88.

Lips, Miriam, Marcel Boogers, and Rodney Weterings. 2000. Reinventing territory in Dutch local government: Experiences with the development and implementation of GIS in the Amsterdam region. *Information Infrastructure and Policy* 6 (4): 171–183.

Lister, Martin, Jon Dovey, Seth Giddings, Ian Grant, and Kieran Kelly. 2003. *New Media: A Critical Introduction*. Routledge.

Lyotard, Jean-François. 1993. *The Postmodern Explained*. University of Minnesota Press.

Meijer, Albert J. 2002. Geographical information systems and public accountability. *Information Polity* 7 (1): 39–47.

Mitchell, William J. 1992. *The Reconfigured Eye: Visual Truth in the Post-Photographic Era*. MIT Press.

Moukomla, Sitthisak, and Amonpan Poomchatra. 2004. Rapid response spatial information systems: Avian influenza in Thailand. In *Building Asia: Enabling G-Lateral Ties*, Proceedings of the Map Asia 2004 Conference at the Beijing International Convention Center, Beijing (available at http://gisdevelopment.net).

Mulvey, Laura. 1973. Visual pleasure and narrative cinema. *Screen* 16 (3): 6–18.

Ostrom, Elinor, Roy Gardner, and James Walker. 1994. *Rules, Games, and Common-Pool Resources*. University of Michigan Press.

Overchuk, Alexey L., Lennart Hansen, and Niels Henrik Hansen. 2005. "Developing a farm land distribution model in Russia." In *Proceedings of Regional Workshop on Land Consolidation and Territorial Organization*, Prague (available at http://www.fao.org).

Reas, Casey, and Ben Fry. 2007. *Getting Started with Processing*. MIT Press.

Snellen, Ignace T. M. 2000. Territorialising governance and the state: Policy dimensions of geographic information systems. *Information Infrastructure and Policy* 6 (3): 131–138.

Tufte, Edward. 2001. *The Visual Display of Quantitative Information: Cheshire*. Graphics Press.

Ware, Colin. 2000. *Information Visualization: Perception for Design*. Morgan Kaufmann.

Wright, Richard. 2008. Data visualization. In *Software Studies: A Lexicon*, ed. M. Fuller. MIT Press.