Participatory Geographic Information Science

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INTRODUCTION

A majority of governmental problems are geographical in character and are becoming more complex as citizens/residents expect more for less. Governance, among many things, involves allocating human, natural, monetary, and infrastructure resources within and across jurisdictional boundaries in an efficient, effective, and equitable manner. Such allocations are becoming increasingly more challenging under budget constraints. Many public policy problems are called "wicked" and "ill-structured" (Rittel & Webber, 1973) because they contain intangibles not easily quantified and modelled. The scoping of such problems includes structures only partially known or burdened by uncertainties, and potential solutions mired by competing interests. Examples of such problems in a geographic domain include locally unwanted land uses (LULUs) such as landfill and hazardous waste facility siting, and more recently, polluted urban land use (so-called brownfield) redevelopment projects called into question due to the potential for increasing neighbourhood contamination. Dealing with locational conflict in an open manner is becoming more important as citizen-stakeholder participation increases in public policy/problem circumstances (Crowfoot & Wondolleck 1990).

BACKGROUND

The primary rationale for enhanced stakeholder participation in public land and resource planning is based on the democratic maxim that those affected by a decision should participate directly in the decision-making process (Smith, 1982). Poole (1985) provides motivation for research on group decision making by saying "we [should] focus on groups because they are basic (many social theorists have called the small-group the building block of society), because they are important (many consequential decisions in government and business are made by groups), and because they are interesting (group behaviour is considerably more complex than the dyadic case). ... [Although] decision-making represents only a small portion of group behaviour, it is perhaps the most important behaviour groups undertake. As well as being significant in its own right, decision making sets the course for other group activities" (p. 206).

To add to that, Zey (1992) states "that decisions [in society] are most frequently made by groups within the context of larger social collectives" (p. 22). Following up in the same book on decision making, Simon, Dantzig, Hogarth, Piott, Raiffa, Schelling, et al. (1992) conclude that "the resolution of conflicts of values (individual and group) and of inconsistencies in belief will continue to be highly productive directions of inquiry, addressed to issues of great importance to society" (p. 53). Events across the world show that the motivation is stronger now that ever before.

Over the past 3 decades, geographic (geospatial) information systems (GIS) have been developed and used to address geospatial problems of all kinds, including some of those described above. GIS has for a long time been touted as a type of *decision support system* (Cowen, 1988). In the late 1980s researchers started to recognize that a conceptual foundation was needed for continuing the maturation of GIS, which emerged as a field called geographic information science (GIScience; Longley, Goodchild, Maguire, & Rhind, 2001). For the most part, GIS grew as a single-user technology; that is, a technology that considered a single-user (group and/or organization) perspective only, even when dealing with many complex decision problems described earlier. Based on research about groups (McGrath, 1984) and group decision support (DeSanctis & Gallupe, 1987), in the early 1990s, GIS researchers began to recognize the shortcomings of a single-user perspective in the GIS technology and started to explore the use of GIS for addressing group-based, wicked, ill-structured, public issues (Armstrong, 1993). That technology is now referred to as participatory GIS (Harris, Weiner, Warner, & Levin, 1995) or public participation GIS (Nyerges, Barndt, & Brooks, 1997). Many researchers realized that the single-user GIS technology was inadequate to the task—although the technology is still used in many places. Consequently, Participatory GIScience, as a subfield of GIScience, is emerging as an area of study that provides systematic, *conceptual foundations* for development and use of Participatory GIS (PGISystem) technology including data, software, hardware and group process (Jankowski & Nyerges, 2001). A recent review of PGISystems appears elsewhere (Rinner, 2003).

A FOUNDATION FOR PGISystem-BASED DECISION SUPPORT

A major concern within PGIScience is bridging a gap between theory and application of PGISystems, as sound frameworks can lead to more robust as well as flexible technologies that can address some of the complex geospatial decision support problems described earlier. Information needs and the associated decision support tool requirements can be addressed by a good understanding of the decision situation at the time and place (context) within which it occurs. As an example, we can offer the six-phase landscape modeling process elucidated by Steinitz (1990), used as a framework agenda in several large landscape planning projects across the world. That six-phase process involves: (1) database representation modeling, (2) land development process modeling, (3) scenario evaluation modeling, (4) change of landscape modeling, (5) impact on landscape modeling, and (6) decision evaluation modelling. Each model description feeds to the next phase, but the entire process is iterative to "catch" aspects overlooked. The flow of information in participatory decision processes can be addressed by a two-level description of process, what we call a macro–micro strategy (Jankowski & Nyerges, 2001). To use a macro-micro strategy for characterizing participatory decision situations imagine a matrix comprised of six columns representing the macrophases defined by the Steinitz's six-phase process, and four rows representing microactivities: (1) gather, (2) organize, (3) select, (4) review. Those microactivities derive from Simon's (1979) work on management decision making. For any given decision task, Simon found that people perform some amount of intelligence gathering, design a problem structure, select a choice of options among the design, and review their work before proceeding. Consequently, the six macrophases together with four microactivities constitute 24 "phase-activity" steps of the particular version of the macro-macro framework, at least in terms of a systematic articulation of what Steinitz (1990) outlined.

The significance of "phase-activity" labeling is that a *phase* speaks to the issue of what is expected as an outcome in the overall strategy, while an *activity* is an action (i.e., use of a GIS tool) that fosters creation of the outcome. Thus, the attractiveness of the macro-micro approach is that a group could use any GIS-supported project agenda (plan) to articulate macrophases, while asking themselves what information tools are needed to support the microactivity processing. The macro-micro strategy for analysing decision situations is a normative description of an expected decision process. Of course, decision processes are not likely to proceed in a rational way, mostly because people's judgments often depart from normative rationality (Kahneman, 1974). However, if a group (or multiple groups) was (were) dealing with rather complicated geographic decision situations like transportation improvement or hazardous waste cleanup, such a process could be used as an agenda to outline an analytic-deliberative decision process as a recommended way to proceed (National Research Council, 1996). Whether groups follow their own project/meeting agendas is up to them. Balanced agenda plans are more often useful than not, as a balanced discourse agenda fosters communicative rationality in building a shared understanding about discourse within an analytic-deliberative process (Habermas, 1984).

Keeping the "actual" versus "normative" view in mind, it is important to understand how people undertake decision making while making use of geographic information technologies. That understanding, particularly if developed in a systematic way through social science research, provides an important contribution to PGIScience. In order to provide a more in-depth articulation of what can transpire during a participatory decision-making process involving the use of PGISystems and other decision support technologies, Nyerges and Jankowski (1997) developed Enhanced Adaptive Structuration Theory (EAST), which is now in a second version as EAST2 (Jankowski & Nyerges, 2001). EAST2 is a network of constructs and their relationships providing a theoretical framework to organise and subsequently help explain *each macrophase* of a participatory decision process. That means that EAST2 as a framework is re-applied to each of the six modeling phases in the Steinitz (1990) landscape planning process. Applying the framework is a way of easily unpacking complexity by articulating each macrophase in terms of the most salient aspects of the phase. Thus, when more aspects change as a process moves forward from phase to phase, we can say that a decision situation becomes more complex. As such, EAST2 has both a research and a practical value. From the research perspective, EAST2 helps to explain the expected and observed realizations of participatory decision processes involving inter- and intraorganizational groups and human-computer-human interaction. From the practical/application perspective EAST2 helps set up group decision support systems for specific decision situations. But how can a theoretical framework comprised of constructs and their relationships effectively contribute to building PGISystems?

EAST2 provides the basis for developing PGISystems and selecting tools appropriate for a given task due to its comprehensive character. In Figure 1, the EAST2 framework consists of a set of eight constructs, with 25 *aspects* as the basic elements (bulleted items) of the theory that outline significant issues for characterising group decision making, and a set of seven premises (the P's) that describe the *relations* between the eight constructs (hence the aspects contained within those constructs). The 25 aspects in different combinations for each premise can "map" different relationships, which may occur during a group decision-making process that involves human-computer-human interactions. The aspects in conjunction with the premises, allow us not only to formulate research hypotheses about the use of PGISystems and its likely outcomes but also help us assess which methods and decision support tools will likely address decision support needs.

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