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Geodesign dynamics for sustainable urban watershed development

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ABSTRACT

Sustainable urban development is considered a complex problem. Geodesign applies systems thinking to such problems using a dynamic and collaborative process wherein iteration is necessary to address diverse objectives. Preparation and execution of a two-day research workshop explored two aspects of geodesign dynamics using a new software platform called GeodesignHub.com. One aspect of dynamics concerned the cross-systems influence of proposed projects and policies as related to ten systems (e.g. transportation, housing, surface water, forest preserves etc.) influencing watershed sustainability in King County, Washington. A second aspect investigated the interaction among six multi-disciplinary design teams and each pursuing different considerations in decision workflow processes. A decision workflow called the Steinitz Geodesign Framework was scoped, designed, and implemented to address meaningful and substantive policy and project proposals for achieving consensus on a 40-year plan design. Workshop participants addressed targets among ten subsystems for sustainable urban development. Findings suggest the software provided support for high-performance collaboration when teams moved toward their targets and when negotiating to achieve a single plan outcome, but the urban growth areas and or housing densities established through policy are likely in need of reconsideration to accommodate population growth. Conclusions about findings and prospects for future research are provided.

1. Introduction

Urban-regional decision problems are often called “wicked” problems because of their multi-dimensional character, including the diverse institutional-political perspectives involved in negotiating solutions that come in the form of agendas, stakeholder values and interests (Rittel & Webber, 1973). To better characterize urban-regional decision problems, Nyerges and Jankowski (2010) developed a framework for differentiating, simple, difficult, complicated and complex problems, considering wicked a synonym for complex. A complex problem is one wherein any one or more of the content, structure, process, and context of subsystems within a larger system can change over time, due to the open system character of urban-regional landscapes. As such, meta-dimensions of content include institutional-political, social, economic, and ecological from which structural relationships emerge with process and context adding to the dynamic. Sustainable urban development (SUD) involves complex decision problems based on a sustainable systems perspective, wherein these meta-dimensions, and their more detailed sub-dimensions, interact (Nyerges, Roderick, Prager, Bennett, & Lam, 2014).

Conventional planning approaches involve separate consideration of functional subsystems such as housing, transportation, or utilities. In contrast, SUD decision problems are challenging because a multi-system perspective is used, i.e. subsystems are considered functionally dependent. Watersheds are functional units composed of many subsystems; e.g., the systems mentioned earlier plus others such as industry, agriculture, surface and groundwater etc., that influence one another. Consequently, sustainable urban watershed development (SUWD) involves complex decision making as many subsystems are simultaneously involved. Two types of dynamics are often of interest for complex decision making

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involving SUWD. First, there are relationships between and/or among elements of systems that constitute system structure. Structure can change over time resulting in a structural dynamic. Based on structural change, subsystem processes can change over time as per natural and/or human agency. Thus, each subsystem might be considered an external context for situating other subsystems. Second, people commonly collaborate in decision workflow guided by 'stakeholder values' (Eikelboom & Janssen, 2015), wherein sequence of treatment matters. Concurrency of treatment (called concurrency management in growth management) matters, as this motivation stems from system element interactions that try to avoid capacity shortfalls. For example, residential growth without adequate transportation infrastructure results in congestion, which is a complex problem in most metropolitan areas.

Whether through natural growth and/or migration, human population growth (including decline) together with consumption drives much of the dynamics within SUWD. Climate change and energy use are other drivers of change. This research uses population growth as a driver for SUWD, as human population growth particularly in coastal areas (NOAA News, 2013), motivates concerns about growth management. Motivation for investigating decision dynamics of SUWD emerges from growth management laws involving concurrency management, wherein land use development must be accompanied with concurrent transportation improvements. Although housing, commercial, and industrial development have higher stakeholder values for most of the public, transportation and utilities can directly impact the former. As such, the capacity of roadways and utilities should be built before (or at least concurrently with) housing, commercial and industrial development. Consequently, in light of cross-system influences, SUWD decision processes play out as a sequencing of plan design proposal recommendations.

Current research about decision process workflow can be tracked to suggestions by Simon (1977) about a rational sequence of intelligence, design, choice, and reflection. Reviews of effective geospatial decision workflows have appeared over the decades including those that use GIS for group decision making (Jankowski & Nyerges, 2001; Nyerges & Jankowski, 2010). 'Design' as a second step in Simon's workflow is fundamental to decision creativity. Kenney's (1992) value-focused thinking in decision processes added insight for diversifying decision perspectives within groups, such that getting the right values as well as the values right for 'intelligence' is critical to addressing fundamental concerns that feed into design.

Steinitz at Harvard University developed and applied some early and fundamental ideas about macro-scale design in what is now called the Steinitz Geodesign Framework (Steinitz & Rogers, 1970; Steinitz, 1990, 2012, 2013, 2014a). The result is a multisystem framework of models of landscape change that enable assessment and design of alternative futures. The framework addresses problems that are novel from both a design and from an analysis perspective, and has been put into practice for a number of years on large landscape change problems, often in the form of intense two- or three-day workshops using a mix of manual and computer support. The Steinitz (2012) Geodesign Framework is fully compatible with both Simon's and Kenney's frameworks, but offers further insight. Geodesign workflow is fundamentally different from conventional planning decision process. Geodesign is normally a multidisciplinary collaboration with direct interaction among design professionals, geographically-oriented scientists, and the people of the place, using available information technologies.

If complex problems like SUWD could be addressed by simple decision workflows then many problems about sustainable systems could be addressed by extant software. However, much of this software is designed with a single system focus, or hard-coded for a specific set of subsystem interactions (Sugumaran & Degroote, 2010). Solutions will be more viable when complex decision workflows are made transparent extensible, and flexible with system-agnostic, simple-to-use software, the basis of the research challenge explored herein. Most software systems that are easy to use are often complex 'under the hood' because complexity is hidden by effective software capabilities presented through the human-computer interface. Since SUD complex problems involve multi-threaded decision workflows, it makes sense that information tools are now emerging that can provide support for open-ended and collaborative decision workflows. This article reports on geodesign research motivated by Steinitz, with software called GeodesignHub.com implemented by Ballal (2015), and used in a research workshop organized by Nyerges based on many years of experience with designing, developing and evaluating participatory tools (Jankowski & Nyerges, 2001; Nyerges & Jankowski, 2010). The following research question considers two dynamics for geodesign, a substantive dynamic about the interaction among system elements that influence each other in the world and a methodological dynamic about the way teams of decision analysts address the system interactions within a geodesign decision workflow.

1.1. Research question

Given the dynamics of interaction within a complex urban system that occur among elements, how do decision analysts prioritize consideration of subsystem elements (values) and sequence their treatment using diagrams for synthesizing plan designs that address sustainable urban watershed development?

Findings about that research question are reported as follows. In Section 2 we present the Steinitz Geodesign Framework by characterizing sustainable urban development problems, decision workflow, and workflow information tools which together motivated our study. Section 3 presents the research design of the study. In Section 4 we report on findings as results from the three iterations of the geodesign decision workflow. Section 5 presents conclusions as insights about those results and prospects for research directions.

2. Steintiz geodesign framework

Addressing SUWD decision making involves many dimensions. Three of the main dimensions are the character of the problem, the nature of the workflow, and the information tools used to support complex decision workflow. Each dimension is treated in turn below to explicate the Steinitz geodesign framework for this research study.

2.1. Decision problems about sustainable urban development

Research about SUD has received significant attention over the past couple of decades to improve our understanding about transitioning to sustainability. Haughton and Hunter (1994) synthesized and outlined a multi-tier collection of principles for fostering sustainable cities. Kates (2011) and Kates et al. (2001) investigating sustainability science, with an emphasis on urban sustainability, use a derivative of *Our Common Future* report's definition of sustainable development to help focus the research (Brundtland Commission, 1987). Social, economic, and environmental conditions play a role in environmental assessment for SUD (Curwell, Deakin, & Symes, 2005, Deakin, Mitchell, Nijkamp, & Vreeker, 2007; Vreeker, Deakin, & Curwell, 2009) and for linking sustainability and resilience policy (Lizarralde, Chmutina, Bosher, & Dainty, 2015). Simultaneous consideration of social, economic, and environmental conditions can help characterize housing, transportation, surface water and other systems when addressing the