Geodesign to Tame Wicked Problems

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Abstract: The challenges of designing within the coupled natural-human systems of contemporary cities and landscapes to respond to climate change, the risk of natural disasters and equal access to healthy environments are often termed “wicked” problems – where many interacting systems are in play, the outcomes uncertain, and the implications ambiguous. The Geodesign addresses such problems well but many participants are ill-prepared to participate; planners, scientists, policy-makers and citizens are unfamiliar with each other’s core principles, values, methods and metrics for success. An introductory phase of planning comprising geo-inspired story-telling, game-playing and exploration has been proposed as a solution. With undergraduate landscape architecture students as test respondents, readily available Weebly® and Google Docs®, Esri GeoPlanner® and Story Maps® and a variety of other web- and app-based tools were used to develop a web-based story-telling structure to address the problem of concurrently protecting and developing adjacent to the Rock and Shoals Outcrop Natural Area near Athens, Georgia, USA, a regionally-significant yet fragile biodiversity resource. The site selection for a hypothetical snail farm was used to introduce GeoPlanner® as the Geodesign platform, the unfamiliar topic chosen deliberately to engage students in bringing fresh thought to design scenarios. The RSONA project provided a “double-loop” learning structure in which student participants, through repeated attempts to solve problems, modified their original goal and learned to act from the perspective of their own expertise while maintaining explicit awareness of the many others in play.

Keywords: Suitability analysis, land use change, interactivity, public participation, games

1 Introduction

The expression “wicked problem” was coined by Horst Rittel (RITTEL & WEBBER 1973, BUCHANAN 1992) to describe problems too complex, and engaging too many realms of knowledge, to be easily solved by small teams. Solutions to climate change, to provision of equitable healthy environments, and to the risk of natural disasters are wicked problems and among our greatest societal challenges. Solutions must acknowledge the gravity of the problems, respond in ways that are socially as well as scientifically feasible, and operate at both small, local scale and large, regional scale (YUSOFF & GABRYS 2011, CHUN 2015, JACKSON 2015). The Rock and Shoals Outcrop Natural Area (RSONA) near Athens, Georgia, USA, is small scale and local, but representative of many parcels of land adjacent to urban areas. Microhabitats of shallow depressions in exposed granite support many rare and endangered species. RSONA is surrounded by privately owned land that was once cropland but is now forested, contributing to extensive woodland habitat. The owner of the private land seeks some economic benefit by either selling for development or granting an easement for conservation. The land is zoned for agriculture or for low density housing with a minimum parcel size of 4.5ha. It could be more valuable as more numerous smaller parcels that might free more land for conservation but would add infrastructure demands far from the town’s core. Resolving competing values and governance issues are keys to the future of the land.
BRONDIZIO, OSTROM & YOUNG (2009) argued that even in the relatively constrained situation of the Xingu Indigenous Park in Brazil, the increasing connectivity of resource-use systems – water, food, energy – across scales as well as locations, calls for environmental governance that also operates across scales for the long-term protection of ecosystems and populations. In complex urban and suburban settings, the burdens on governance and the need for guidance from the design and science and communities are yet greater. CUMMING et al. (2014) observed that increasing urbanization, acting at the same time as climate change, further adds to exploitation of ecosystems as urban populations prioritize socio-economic services over ecosystem services. Specifically addressing social vulnerability to climate change in Georgia, KC, SHEPHERD & GAITHER (2015) found climate vulnerability to be highest in metropolitan and coastal counties. While the science of such problems is critical to their solution, so is the social, political and cultural milieu in which the problem is situated. Solutions will not emerge until all facets are addressed simultaneously and with equal seriousness (YOUNG & STEFFEN 2009, CHAPIN et al. 2011). A growing number of prominent scientists call for much greater efforts to address such change, and propose that higher education has an obligation to take a leading role (CHAPIN et al. 2011, YARIME et al. 2012).

2 Background: Methods for Tackling Wicked Problems

BUCHANAN (1992) observed that most of the problems addressed by designers are wicked, a "class of social system problems which are ill-formulated, where the information is confusing, where there are many clients and decision makers with conflicting values, and where the ramifications in the whole system are thoroughly confusing." The wicked problems approach, he advances, accepts that even small problems possess a fundamental indeterminacy that is not amenable to linear solutions. ARGYRIS (1996), writing from a business management perspective, claimed that the causal relationships identified by empirical research are insufficient to translate directly into action and must be modified through a process he described as “design causality.” “Double-loop” learning is a key component of the process he proposed. In contrast to “single-loop” learning, double-loop thinking does not simply observe and apply cause-effect observations, but includes the thinking processes used to design actions and implementations. Iterative double-loop learning processes are central to design teaching (BUCHANAN 1992) and are especially embedded in the rapid development and testing of ideas that are characteristic of design studio methods. Reflecting on successes and failures, accepting the latter as additions to knowledge and reiterating the process armed with this new
knowledge, double-loop learning is increasingly involved in solving challenging environmental problems at massive scale (ZHANG, MAO & ZHANG 2015.) SYNNOTT (2013) demonstrated the successful use of the approach in design of HS2, a proposed high-speed rail corridor through the heart of the UK. PETERSEN, MONTAMBAULT & KOOPMAN (2014) demonstrated its use in the management of Landscape Conservation Cooperatives: multi-agency, cross-boundary and multi-stakeholder planning and management agreements encompassing large areas of the USA, Mexico and Canada. Prominent ecologists have independently suggested the necessity of engaging such design thinking in the solution of problems of climate change resilience and urban sustainability (PICKETT et al. 2014; CHILDERS et al. 2015).

While processes of this kind have been successful, they nevertheless may have been biased toward “expert” knowledge and have under-valued the place-based knowledge of local stakeholders and citizens (SCHÖN 1995). Local stakeholders rarely possess the required knowledge of the scientific systems in play to fully participate (ORLAND 2015) although participation could lead to closer engagement with the design process, ownership of the outcomes, and future involvement in ensuring that plans are implemented (VOINOV & BOUSQUET 2010, PHILIPSON et al. 2012). As expert planners, SCHÖN (1995) and DZUR & OLSON (2004) observed that scientific and professional knowledge alone cannot solve complex design and planning issues, and called for expert scientists and planners to move away from working “for” the public towards working “with” the public using narrative place-making, participatory design and action research approaches to capture local knowledge. Other authors have suggested a hybrid approach where informed participants entrust highly structured and technocratic planning to experts, and focus on the unstructured decisions that can only be resolved through dialog and discourse (HURLBERT & GUPTA 2015). Our design and planning processes should respond to these concerns.

3 Extending the Geodesign Framework

Collaborative design and planning platforms must provide for information of all kinds to be shared; for participants in the process to share their own insights equitably; and for outcomes to be traced back to the evidence on which they are based. The Geodesign framework (STEINITZ 2012) (Fig. 2a) is an example of such a general-purpose, decision-support tool for landscape-scale design and planning. It arrives at a time of great demands for stakeholder engagement in design and planning decisions, and for evidence-based design. GeodesignHub® is software derived directly from the framework to support iterative and collaborative planning via a sketch-based interface (BALLAL 2015) (Fig. 2b) RIVERO et al. (2015) described the successful operation of GeodesignHub in the context of futures planning for Chatham County, Georgia, a coastal county with significant environmental assets, threatened by sea-level rise and climate change, and targeted for economic development.
Despite the benefits of the Geodesign framework, in specific problem-solving settings two challenges emerge. First, it is impossible to archive all the data that is needed to support all possible lines of questioning – there must be easy ways to add additional and project-relevant data. Volunteered Geographic Information (VGI) (GOODCHILD 2007), crowdsourced geographic knowledge (SUI, ELWOOD & GOODCHILD 2013) and Big Data (BATTY 2012) offer ways to develop rich and extensive data but are largely missing means to make the data accessible and meaningful to non-experts. Second, even experts may be unfamiliar with the key issues in areas other than their own when addressing trans-disciplinary concepts such as “climate change” or “ecosystem services.” To both challenges, there is a growing body of literature to support the use of game-like strategies for communicating scientific concepts (KLOPFER 2008, CONNOLLY et al. 2012). BROCK & DECHERT (2008) and UMPHLETT et al. (2009) specifically point to the value of games for exploring ecosystem dynamics while BISHOP (2011) and SCHROTH, POND & SHEPPARD (2015) describe game-like environments to communicate the design and planning implications of anticipated change.

ORLAND (2015) proposed an extension to precede the STEINITZ framework (2012) (Fig. 2a) comprising three elements: Storytelling, System exploration games, and Group interactions (ORLAND & MURTHA 2015, VERVOORT et al. 2014). Storytelling reveals the values and beliefs of participants in decision-making, encouraging them to acknowledge each other’s viewpoints. Stories connect individual experience of the landscape to the circumstances and environments around and conveys meaning as well as location and physical composition. System exploration provides insights into the internal mechanisms of systems – how change in one area affects outcomes in others. Discovering how landscape systems work is essential to meaningful participation in landscape design and planning, and thus Geodesign. Group interactions via games or workshops have been in use for many years for investigation of policy interventions in landscape planning – learning from the group interactions that occur as participants seek consensus among competing views and values.
4 The Snail Farming Example

My teaching assignment for fall 2015 provided the opportunity to test this extended framework with 24 undergraduate students in their penultimate year of study, focusing on planning for the development of the private land adjoining the RSONA, treating the students as surrogates for residents of the area. All had taken introductory design classes but were relatively new to land suitability assessment, as the residents would be. To model the path students would follow, two graduate students developed a website “Linna and Mackenzie’s Escargots” describing our fictitious niche agricultural enterprise, including a gallery of snail portraits, recipes, and “Our Location”, a portal to class Geodesign tutorials.

![Fig. 3: The snail farm website](image)

How should the study area be described? Having visited, hiked and photographed the site students developed personal stories that imagined the role that RSONA might play in their lives. The story assignment was modelled on the environmental autobiography, a tool used by educators in many fields to engage students in active reflection on experience (BOSCHETTI 1987, CORCORAN 1999, MEYER & MUNSON 2005). In this case the goal was to reveal the values students held for the site. We explored crowd-sourced narratives to the same end but the few on-line responses we found were technical rather than experiential in nature so this direction was not pursued. Student responses were recorded as the introductory component of individual webpages assembled using a student account with Weebly® a web-hosting site. Weebly has numerous ready-made templates and an easy-to-learn interface, thus minimizing the intrusion of website design into the work of the class.

![Fig. 4a: Wordle for student narratives](image) ![Fig. 4b: i-Tree (USDA 2014)](image)
In this first iteration of the model, the content of students’ responses was manually coded for saliency: “Being in the woods is great whenever, but this spot is special. It may be the slight change of cover between tall baby oaks and early succession grasses...or the surprise of crossing the creek over mossy rocks before the water takes a ride on a small waterfall...or the novelty of seeing the preserved errors of our past as we made our way up a terraced hill...or it could be all of these things! It was so much fun to explore!” The underscored words might then be chosen as cues to elements to be preserved, enhanced or mitigated. A second strategy, only attempted later with the data, is to use tools such as Wordle®, www.wordle.net, to create word clouds that identify common themes across numerous stories (McNaught & Lam 2010) (Fig. 4a).

How does the study area operate? In previous work the author and colleagues have had sufficient resources available to custom-make games to explore the system interactions at play in the problem (Orland et al. 2014, Orland 2015). In this classroom case neither time nor funds were available so free and on-line resources were sought. In this case, i-Tree Site® and i-Tree Canopy®, on-line tools created by the USDA Forest Service (2014), were used to learn ecosystem services relationships at small and large scales (Fig. 4b) (Hilde & Paterson 2014). The i-Tree suite reveals the relationships between land cover and ecosystem services such as provision of shade, carbon sequestration and water storage, each accompanied by an estimate of the monetary implications of changes in services generated.

How might the area be altered, how should it be changed? Addressing these questions demands an interactive environment. While the GeodesignHub® (Fig. 2b) (Ballal 2015; Rivero et al. 2015) would have been an ideal tool for scenario sketching and evaluation, arrangements could not be made for local server support so an alternate approach was used. For the initial consensus-building step, a modified Delphi process (Wellar & Novakowski 2008) was adopted, using Google Docs®.

The on-line interactive spreadsheet allows each participant to remain anonymous, yet see all of the choices made by their counterparts, and change their own evaluations, or add items, to reinforce or provide alternative answers to emerging consensus.

Scenario development and evaluation: To assess the capability of the land to support the prioritized land uses, another GoogleDocs spreadsheet was used to support a land suitability
matrix to identify the factors that constitute acceptable ranges of values for each of the previously identified landscape characteristics, e.g., soils, slope, access to water, access to roads etc. To develop design scenarios based on the values identified, we used the Esri GeoPlanner® tool released in 2014. Because the existing on-line tutorials were written for urban development using urban design-relevant symbol sets, tutorials were edited and new symbol templates developed that were better suited to natural area, recreational and agricultural development. To minimize the likelihood of solutions emerging from student projects based on prior knowledge, the snail farm was introduced as a land use goal for training in the tool’s use, one unlikely to be familiar to an American student.

Students were required to identify three land uses for the site, e.g., snail enclosures, sales and educational areas, recreational trails and conduct suitability analyses for each of those uses (Fig. 6a). They were then required to design at least two land use allocation scenarios, conduct evaluations of each of those according to metrics such as ecosystem services and compare the two using Esri Story Maps® (Fig. 6b). GeoPlanner accesses data via Arc-GIS Online for most of its functions. As a result, each product developed in GeoPlanner can be made available to all other students in the class, resulting in the ability to share valuable products such as a soil suitability re-classification without each student replicating the laborious assignment of values to numerous soil types. It also allows all map products to be available to a range of other tools, notably Esri Story Maps, a suite of presentation templates that supplement map tools with the ability to create stories embedding still images, video and a number of map comparison tools. Unlike conventional websites this means that map layers can be queried via the web interface enabling users to validate the results of analyses by directly accessing the underlying data. The final products of the class were websites integrating the originating stories where student values were identified and expressed; the results of interactive on-line priority-setting; the analyses that emerged; alternative scenarios interactively compared; and conclusions all presented in a single web presentation.

5 Conclusion

Snail farms are rare in the United States (an internet search in February 2016 yielded just one listing, little gray farms in Quilcene, Washington). While growing conditions seem appropriate, escargots are not common on menus and snails are generally regarded as pests.
The exercise reported here was a first proof-of-concept of a proposal advanced in 2014. It used available tools that were not designed to work together; there are advantages and disadvantages to this approach. First, the tools would be more satisfying and accessible for students if they were robustly linked, with consistent look-and-feel, albeit with substantial development costs to achieve an integrated system. On the other hand, new ideas and tools are constantly emerging that may offer better ways to conduct thought-experiments to understand ecosystem interactions. NetLogo®, an agent-based modelling application, has been used to represent a wide range of natural and social systems simulations (WILENSKY & RAND 2015). i-Tree, used in this class, is a robust set of tools based on substantial research and designed to address the broadest range of interested citizens. The next iteration of this class will consider these two questions. There will be a new version of GeoPlanner (release Spring, 2016) with a different interface and new capabilities, we hopefully will be able to implement GeoDesignHub as a classroom tool, and we will inevitably discover new system simulation tools to consider for inclusion. Anecdotally, the forward extension of the geodesign framework provided for identification and consideration of a broader range of values than is typical in a design studio, and the ease of re-iterating via multiple scenarios supports a key requirement of double-loop learning; all students created at least two distinct scenarios. Future classes will evaluate student (user) experience more systematically in anticipation of adopting some of these tools and approaches in community workshops.

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References

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