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Models and Trades: Strategies to Improve Community Engaged Research in the Environmental Sciences

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Efforts to meet the needs of a growing global population while ensuring ample resources for future generations are at the heart of sustainable development. The defining challenges of the 21st-century involve a complex set of interconnected social, economic, and environmental factors. Innovation in education and research will be essential in helping society address these challenges. To do so requires individuals working collaboratively across science, technology, and engineering as well as with the social science disciplines. Such teams of researchers need to engage with members of the public and be guided by specific, real-world problems. I argue that community- engaged research (hereafter CER; see below) is a means by which these collaborative, trans-disciplinary efforts can be effectively harnessed to meet the challenges of sustainability; especially in cities.

Collaborative team research and community-involvement present challenges, however, and guidelines and best practices for how to best prepare researchers for convergent team science are minimal; causing National Research Council[1] to recommend “opportunities to enhance the effectiveness of collaborative research.” Certainly, collaborative research has been a growing trend over the past 20 years (e.g.,[2]). With numerous attempts to do this work, a number of barriers were identified. Such barriers include institutional and administrative norms, departmental organization structure, and the largely discipline-based training that is available to researchers[3]. At the heart of many of these issues, I argue, is that there is a fundamental limitation in the means to merge discipline-based epistemologies. Below I suggest that CER implement both formalized modeling and trading to maximize project success.

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Modeling

Certainly the 21st century challenges described above are nested within a complex socio-ecological system (SES)[4], where humans and nature interact across various levels of organization. These interactions result in complexity across different scales[5] and can result in catastrophic changes in social and ecological state of the system[6]. The capacity to avoid collapse in the face of change pressures can be thought of as the resilience of the system[7, 8].

System level resilience is dependent on system characteristics. Efforts to manage SES's for resiliency, therefore, include creating system-level models. Therefore, it is the collective development of a system model that helps researchers to think across disciplines in order to address the wicked problems facing society today. These models aim to not only understand the structure and dynamics of the SES but also serve as "sandboxes" in which decisions and their implications can be tested through simulation.

Models like these can further decision-making (e.g.,[9]), particularly in environments in which a real-world test would be technically impossible, too costly, overly time-consuming or unethical. In CER projects, community members can further increase model quality and accuracy by providing local knowledge, resulting from their daily interactions with the system, their observations, and their interpretations. Problem-solving, in CER contexts, thus builds on more adequate representations of local conditions. With this, the use of system models and simulations are expected to identify leverage points through which the sustainability and resilience of the SES can be improved.

Models also function as a kind of boundary object[10] by providing the means or bridging ideas across disciplines and between local and disciplinary expertise. In this manner, the model semantics are learned as a type of common language, which is critical for convergence research. Models provide opportunities for researchers to make their ideas visible and open for discussion, negotiation, revision, and extension and can support constructive discourse. Such discourse has been associated with positive learning outcomes for novices[11; 12]. It is likely that these outcomes occur because models allow cognition to be distributed by offloading parts of difficult tasks into the physical environment, where thinking can be organized and discussed. Furthermore, because models often include a small number of semantic representations, individuals coming from different backgrounds, once familiar with model terms, can communicate in a standardized space. Thus, researchers and stakeholders from different disciplines are given a common language for discourse, which provides opportunities for agency in the authentic investigations that are personally meaningful[13]. Such standardized terms also provide a unifying frame for assessing social learning. This is important in the context of trading; described below.

Trading

Borrowed from the anthropological literature, trading zones are characterized by intellectual spaces where ideas are exchanged despite disciplinary differences. One researcher described a case where physicists and engineers who worked together through the gradual development of simplified new language where concepts could be jointly represented in an effort to solve a problem[14]. This author encouraged the use of 'agents' or individuals who could mediate this knowledge exchange. These individuals are called 'traders.' Traders develop a type of expertise akin to Collins and Evans[15] interactional expertise, where individuals are able to converse and translate across disciplines. I argue that the development of this type of expertise can happen along a trajectory where traders work with each other to form a community of practice and then bring in newcomers who engage in low-stake tasks such as those that do not affect system outcomes. They would advance to high-stakes tasks as competence develops. From there, and with ongoing exposure, these newcomers become central traders and the process continues. This trajectory is similar to Lave and Wenger[16] describe as a process of legitimate peripheral participation.

In addition to trading, individuals need to collaborate in a manner that encourages absorptive capacity. Absorptive capacity can be thought of as the ability to seek new information in an effort to adapt it and put it to direct use. Similar to resilience, absorptive capacity can be measured and thought of as a tool to help communities deal with potential negative changes. Cohen and Levinthal[17] argue that it is the diversity of prior knowledge and the ability to modify thinking in real-time that characterize the adaptive capacity of a group. Absorptive capacity in context of business innovation has been shown to predict idea innovation and knowledge transfer and that social factors that support collaboration can enhance this effect[18].

In conclusion, research institutions and individual researchers differ in their motivations for engaging in CER and, accordingly, use different approaches. However, a common theme of CER is the desire to do impactful work that solves real-world problems, to act ethically and overcome inequities, to serve the communities in which the research is embedded in, and to attract public support and goodwill. Such support is important as researchers greatly benefit from the access to in situ problems when working in real-world situations. In addition, these researchers will benefit from the opportunity to work with stakeholders who are ultimately responsible for championing action. Using both modeling and trading as described here, researchers can engage local stakeholders in the development of system models, where they provide expertise about the context of the project. This level of participatory modeling has been used as a tool to supplement traditional research to enable better understanding of SESs[19] and improve model quality. Further, involvement of stakeholders in the modeling processes can enable enhanced individual and social learning as well as adaptive co-management and decision-making[20; 21]. To ensure that such projects with the general public are successful, I suggest that formalizing the modeling language to be semantically accessible to the public and implementing (and subsequently training) traders in the research process will increase the likelihood of project success. Future research directions should include the study of best practices in the areas of modeling and trading with stakeholders.

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