EPOC Extended Abstract

Identifying Equity-Related Decisions in Flood Management Infrastructure Design: Insights from Practitioner Interviews

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Problem Statement

As the Environmental Justice movement progresses, the importance of pursuing equity in the design of the built environment is increasingly recognized. Technical professionals who were not previously trained, incentivized, or expected to prioritize equity in their work are now being encouraged, and even required, to do so [1]. This transition is motivated in part by social dynamics, but also by progressive trends in American public policy that specifically designate the incorporation of socially vulnerable populations into funding for climate infrastructure projects. Prominent examples include the Biden administration's 2021 Bipartisan Infrastructure Law, the 2019 New York State Climate Leadership and Community Protection Act (CLCPA), and the 2021 Washington State Healthy Environment for All (HEAL) Act [2,3,4]. This policy trend is an important step in the Environmental Justice movement that has generated new challenges specifically relevant to civil engineering and disaster mitigation work. For example, the new legislation provides little guidance for practitioners as to how the design of the built environment may be adapted to appropriately address inequities and better serve vulnerable populations, which provides an opportunity for further research.

One application of this research is on the function of the built environment in disaster mitigation and resilience. As anthropogenic climate change continues to increase the frequency and severity of storm events, attention is directed towards the uneven distribution of natural disaster impacts, particularly in connection to failures in mitigation infrastructure [5]. Under the predicted storm conditions of the next several decades, disaster planning and equity shortcomings in infrastructure design will only become more obvious.

This study focuses specifically on the context of stormwater management infrastructure and its role in protecting against flooding hazards. Flooding is the most commonly experienced natural hazard in the United States, and the most costly recovery for property value and human health [6]. An essential function of stormwater management infrastructure is to control flood waters in the event of major storms and, as a result, to protect people and property from harm. However, existing American stormwater infrastructure suffers from underinvestment and delayed maintenance, and as storm patterns evolve with climate change, much of that infrastructure is now in need of redevelopment. In fact, the most recent American Society of Civil Engineers (ASCE) Infrastructure Report Card rates our national stormwater infrastructure as D-grade, citing "few dedicated funding sources, complicated governance and ownership structures, expansive networks of aging assets, increasingly stringent water quality regulations, and concerning climate change projections" as reasons for declining performance [7]. With each

passing year, more and more Americans are at risk of harm from catastrophic flooding in the event of stormwater system failure.

However, we know from the extant literature that this vulnerability is not evenly distributed in the American population [8]. Rather, communities with entrenched social vulnerabilities face a compounded risk of harm, as other forms of marginalization increase their physical vulnerability to natural hazards. Understanding social vulnerability involves identifying which facets of the American population are systematically marginalized by societal regimes that favor privileges such as wealth, whiteness, physical ability, education, masculinity, documentation, and English fluency [9]. The Environmental Justice movement recognizes that those at the margins of society experience an additional risk to their health and safety because they lack the resources to prepare for and recover from hazardous events such as flooding [9]. By historically devaluing the needs of socially vulnerable individuals in the stormwater infrastructure design process, civil engineers have perpetually failed to achieve equity outcomes in disaster mitigation and the built environment.

In order to overcome these shortcomings in the traditional design process, meet newly legislated demands, and better protect all members of the public, this project aims to answer the research question: “How can equity outcomes be improved in the design of stormwater management infrastructure?” As research progress in this area is rapidly evolving, particularly in engineering contexts, the extant literature has relied predominantly on quantitative data collection from participants within vulnerable populations. However, as research on the dynamics of social vulnerability becomes more common, some academics and community representatives critique the practice of designing studies that perpetuate the same power relations they claim to investigate [10,11,12]. These methodologies contribute to the existing burden of socially vulnerable populations without considering the systemic sources of that vulnerability [10]. In contrast, this research project aims to “reverse the gaze,” or shift the burden of focus off of communities experiencing harm and onto those complicit in inflicting it [10]. In the context of this study, this requires analyzing the practices of design professionals rather than socially vulnerable infrastructure “end-users,” so that the findings of the study might mitigate harmful action at its source.

Therefore, this study will begin to address the question of how equity outcomes can be improved in the design of stormwater management infrastructure by performing semi-structured interviews with engineering practitioners. These interviews will be designed to establish practitioner perceptions on professional motivations and the role of equity in the design of water infrastructure. The results of the study will be analyzed to identify high-impact decision-making points in the design process and inform the development of future interventions that may be applied and tested to improve equity objectives.

Methods

This study will conduct a series of semi-structured interviews with stormwater engineering practitioners. The interviews will be designed to generate a holistic understanding of the stormwater infrastructure development process from the perspective of the practitioner, and

provide guidance for future work that investigates potential interventions to design decision-making.

Semi-structured interviews are appropriate in this study, as our research objectives rely on a more thorough understanding of the stormwater infrastructure design process, which is best achieved by allowing practitioners to fully relate their expertise and decision-making process with context. Semi-structured interviews have been used extensively in applied behavioral research focused on transferring knowledge from expert technical professionals, including in limited instances by engineering researchers in related fields [13].

The participants of this study will be stormwater infrastructure design professionals. The authors plan to partner with a private engineering corporation doing related stormwater infrastructure design work in or near Seattle, Washington, where the research team is located. Practitioners will then be sampled from the pool of relevant designers in the partner corporation. The researchers recognize that sampling from a single organization of engineers introduces limitations to the generalizability of the findings of this study, as internal factors (i.e., demographic makeup, management structure) are not necessarily generalizable to the civil engineering field as a whole. However, working with one firm has reliability advantages, such as communication ease and continuity, that facilitate accurate data collection. Depending on the sample size and quality of the first round of interviews, the researchers may expand the sample pool by partnering with additional firms or public agencies.

All interviews will be conducted remotely, and their content will be recorded and transcribed. These transcripts will be qualitatively analyzed according to Hsieh and Shannon (2005) methods for directed content analysis [14]. The applied coding scheme will be designed to isolate practitioner perceptions of end-user identity, professional motivations, and the value of equity objectives in infrastructure design work, as well as to identify high-impact decision-making points in the design process. The interview and analysis methods employed in this study will be foundational to future research, where findings will be compared to practitioner data collection at a larger scale and used to develop and test practical interventions to adapt the infrastructure design process.

Key Findings and Implications

This study aims to identify decision-making points in the stormwater infrastructure design process that are best suited to improve equity outcomes in the flood protection capacity of the built environment. Additionally, practitioner perceptions of end-user identity, professional motivations, and the value of equity objectives in the engineering design process will be identified to inform the design of future interventions.

Based on existing built environment equity theory and the findings of related research, the authors expect that insights gleaned from the practitioner interviews will highlight the need to transform a) the professional engineering identity, which is historically rooted in isolationist, apolitical, technical expertise; and b) the professional engineering motivations system, which is dominated by priorities of financial and temporal efficiency reinforced by the capital incentives market [15]. Additionally, in line with the extant literature, we expect that high-impact

decision-making points will be related to methods of interdisciplinary knowledge generation and small-scale data collection [16,17].

Findings from this study will be used to inform future research projects that develop and test specific interventions for flood control infrastructure design that can be used to achieve downstream equity objectives. By improving our understanding of *why* such equity discrepancies exist, we can transition to addressing *how* those discrepancies might be effectively resolved. Ultimately, this research aims to be consequential in improving the protection capacity of stormwater infrastructure in the face of increasing storm severity, and to help equitably protect the health and welfare of all members of the public.

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