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Visualizing the Possibility of Relocation: Coastal Relocation Leaf

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Abstract: The cognitive dissonance between the need for relocation as an adaptation strategy and the reluctance to consider this option among stakeholders may result in maladaptation in communities highly vulnerable to coastal hazards. This study presents an interactive communication tool, Coastal Relocation Leaf (CRL), designed to facilitate an understanding of the circumstances that may lead to relocation. The tool is designed to allow users to explore "what-if" scenarios, fostering further conversation about the complexities and trade-offs associated with the possibility of relocation in coastal communities. The tool is visualized using the Adobe Flash platform and refined using expert evaluation.

Keywords: coastal; flooding; adaptation; relocation; retreat; migration

1. Introduction

As early as the 1990s, the scientific community acknowledged that the extent and intensity of anticipated climate change may be capable of instigating mass human migration, especially from areas highly vulnerable to natural hazards (Tegart and Sheldon 1992). Impacts like sea level rise, extreme weather, recurrent flooding, food and water scarcity, and environmental degradation will likely represent significant driving forces of population movement over the next few decades (Costanza et al. 2011; De Sherbinin et al. 2011). In low-lying coastal areas, relocation may be compounded by a dynamic interplay of different stressors such as socioeconomic, cultural, demographic, institutional, and geopolitical aspects (Castles and Miller 1993; Brown 2007); the extent, intensity, and rate of climate change impacts (Fritz 2010); and the exposure, vulnerability, resilience, and adaptive capacity of at-risk households and communities (Brown 2007; Barnett and Webber 2010; McLeman and Smit 2006). Regardless of location-specific variability, climate change will likely affect extensive geographic areas simultaneously, prompting a substantial number of households to retreat within a similar time frame. To minimize the adverse outcomes of spontaneous emergency displacement following the escalation of risks, it is important to initiate dialogue on relocation and planning processes prior to worst-case scenarios playing out. A preventive approach would provide sufficient time for public engagement and participation, comprehensive assessment of community characteristics and needs, and the identification of policy and funding to support relocation.

There is growing interest in population movement as an effective climate change adaptation strategy that may generate benefits for both the sending and receiving locations (Barnett and Webber 2010; Laczko and Aghazarm 2009; Leighton et al. 2011; Gemenne 2010). However, before relocation as an adaptation option can be given serious consideration, it must first overcome sociocultural, institutional, and political barriers embedded in the current ideological, legal, and political fabric. Major shifts in attitudes and perceptions of risk and response options, as well as the ability to think the unthinkable and plan for it, will be necessary to advance climate change relocation planning. In addition, it will be equally important to engage decision-makers in a conversation on the benefits of proactive relocation and to clarify how this adaptation strategy differs from other response options, existing migration trends, and sociodemographic shifts.

Currently, adaptation is viewed as a governance concept directed at the problem of the future that operates on long- and short-wave frequencies, thus representing a disconnect between now and the future with temporal short- and long-term implications for the acknowledgement of climate change impacts and adaptation planning (Rickards 2010). Considering the rapidly evolving climate risks, there is a critical need to engage leaders and decision-makers at different governance levels in a dialogue on diverse adaptive responses and interventions (Leighton et al. 2011). Similarly, efforts to increase awareness of climate change among decision-makers and the public is hindered by the overwhelming scale of the problem, massive uncertainty, scientific abstraction, and the predominantly global nature of the available modeling and scenarios (Moser and Dilling 2007). Planning efforts should be directed at enhancing stakeholders' ability to explore multiple assumptions and futures, identifying and better comprehending the "starting conditions" of the varying paths of climate change responses (Rickards 2010). This approach is especially important when addressing high levels of uncertainty and possible surprises or wild cards (Lindgren and Bandhold 2003) that can completely change the course of the game (Ogilvy and Schwartz 1998) and initiate mass displacement and resettlement.

Traditional risk management has limited applicability, as it can miss potential major disruptions, negative outcomes, and considerable opportunities that can be generated when a threat is anticipated and faced (Randall and Ertel 2005). This is especially relevant in the case of wicked system risks, such as climate change, that are difficult to define, are multifaceted, have many inter-dependencies, deal with issues within unstable systems, and are ridden by chronic policy failures (Australian Public Service Commission 2007). Appropriate and engaging decision support tools will have a vital role in enhancing the confidence of decision-makers in anticipatory adaptation planning. For example, scenarios have been recognized as an effective instrument to assist decision-makers with understanding and managing complexity and uncertainty in the context of climate change (Biggs et al. 2011). In practice, scenario planning has led to inclusion of adaptation in the construction of long-lived infrastructure projects such as the Confederation Bridge (Canada), Deer Island sewage treatment plant in Boston Harbor (USA), Konkan Railway (India), coastal highway (Micronesia), Copenhagen Metro (Denmark), and Thames Barrier (UK) (IPCC 2007).

Households and communities usually rely on diversified natural, financial, human, and social assets to maintain their livelihoods and respond to environmental stress and crises (Kniveton et al. 2008). Relocation is more likely to occur in circumstances when either several of these backup options become disrupted and exhausted or they all collapse simultaneously within a short period. Therefore, relocation will likely be a sequential process that will unfold over different spatiotemporal and socioeconomic scales, depending on the internal resilience and adaptive capacity of individual households and communities as a whole to respond to climate change. However, it is difficult to predict with absolute confidence how people and communities will respond to future challenges. This is in part due to existing methodological limitations and research gaps in assessing people's responses to push factors that may lead to out-migration (Kniveton et al. 2008). Decision-makers should continually watch for sudden unexpected changes in present trends, even in relatively stable systems, and be prepared to embrace "a new know-how" via rapid policy adjustments (De Jouvenel 2000).

One important prerequisite for successful management of the inherent complexity and uncertainty in highly interrelated systems is an exact understanding of associated trends and all potential risks or shocks. Sellamna (2007) defines trends as driving forces that are well established and do not significantly change over planning time scales, such as population growth, while shocks represent unpredictable but crucial driving forces in the evolution of any system change influencing the scenario profiles, such as natural disasters. A global risk or "megashock" is a significant and sudden event of unpredictable timing and magnitude, such as the Asian Tsunami of 2004 (Hajkowicz and Moody 2010). Gilman et al. (2009) suggest that the convergence of systemic stresses and climate change may result in concurrent disruptions in different systems that may strain the macrosystem as a whole, leading to its collapse. However, both of these considerations are rarely, if ever, included in formal predictions and decisions, which are still largely based on extrapolation from past trends or linear models (Wiseman et al. 2011). In the context of relocation planning, shocks represent a significant concern, considering that they can deprive decision-makers of the window of opportunity to conduct relocation in a participatory and equitable manner and escalate it into emergency evacuation and forced resettlement. Therefore, it is important to include such game-changing events in the discussion on relocation and explore how the relocation process would unfold at different levels of urgency and time scales.

After reviewing the relevant literature, Paoletti et al. (2010) concluded that an oversimplification influenced the scholarly discussion on future migrations and was reflected in statistical analysis of historical occurrences, assumptions about the main relationships with several key variables, and a forecast of future migration flows. Even though past trends and migration patterns may provide some insight into future population movement, it is likely that emerging abnormalities, amplified driving forces, and unexpected feedback loops will shift traditional migration patterns off the anticipated course. Therefore, even though different communities can envision "where we are now" and "where we want to be" among different storylines, it is also possible that any number of surprises can suddenly change the game, significantly undermine their adaptation capacity, and rearrange their positioning within the scenario matrix.

The main objective of this paper is to support the aforementioned paradigm shift by presenting a visualization tool, Coastal Relocation Leaf (CRL), designed as a visual medium to facilitate comprehension and exploration of the circumstances under which relocation may emerge as a possible adaptation option in high-risk coastal locations. The tool's design captures the empirically validated trends and interactions related to coastal climate change impacts and adaptive capacity of urban jurisdictions. It responds to the need for more effective means to communicate the relationship between emerging coastal changes and adaptive responses, including permanent relocation, to local stakeholders. CRL's key features include its simplicity and potential to communicate the emergent complexities in coastal environments to a diverse audience by visually representing more advanced concepts and interactions. It is deliberately generic and not designed to advocate specific policy decisions about coastal relocation. Rather, it allows users to explore "what-if" scenarios and start a dialogue on what different outcomes would mean for their household and community, fostering further conversation about the complexities and trade-offs associated with the possibility of relocation. CRL also supports exploration of the dynamic interactions between physical and social vulnerability to chronic and episodic coastal hazards, adaptive capacity to respond to these challenges, and the need for relocation.

At multi-stakeholder meetings, audience members come from many different professional affiliations and backgrounds with varying experiences and perspectives related to flood risk and what should be done about it. In such circumstances, CRL may serve as a medium to facilitate dialogue on relocation, prompting the audience to ask questions and express concerns about what is going on in their community and what the potential implications of more frequent flooding are. This tool may also serve as an interactive visual framework that could help reduce tensions among the individual actors in the discussion, help focus the dialogue on the issue at hand, and build consensus between the converging perspectives on the issue of relocation. To strengthen CRL's internal validity and credibility, it was evaluated by experts whose recommendations for its refinement were incorporated into its final iterations presented in this paper.

Visualization tools presenting different future outcomes are especially useful when introducing controversial issues made more difficult by a lack of information and scientific certainty. They can help establish discourse between people with opposing attitudes and values, help identify the roots of conflicts and differences, and facilitate development of creative and mutually acceptable solutions (Masini and Vasquez 2000). Policy makers and practitioners are facing the immense challenges of how to devise well-informed and robust decisions about adaptation priorities, while new findings about climate trends and risks continuously expand and morph (Wiseman et al. 2011). Tools such as CRL can not only help them learn about all possible scenario outcomes, but also encourage them to think about the repercussions of inertia and inaction on a community's long-term stability.

2. Relocation Scenario Framework and Assumptions

Coastal Relocation Leaf is constructed around two main assumptions: (1) The acceleration of coastal climate change impacts, namely sea level rise, storm surge, and erosion, will instigate some level of relocation; and (2) the adaptive capacity of some households and communities in high-risk locations may not be sufficient to support in situ adaptation. Climate change impacts and adaptive capacity were selected as the most important determinants of a community's ability to adapt, cope, respond to, and recover after hazard events in coastal areas (Dolan and Walker 2006). Climate change pressures in coastal zones are expected to instigate significant population displacement and migration to areas of higher elevation or further inland (Black et al. 2011; Haer et al. 2013; Hauer et al. 2016), while adaptive capacity will have a vital role in moderating their extent and severity (McLeman and Hunter 2009; Whitney et al. 2017; Cenacchi 2008). Even though CRL's conceptual framework reduces the complexity present in most coastal settings to two key considerations, it is intentionally designed to provide the foundation for relocation discourse based on the quantifiable variables.

CRL (Figure 1) was developed using the Adobe Flash platform and is available, including its source code, at http://anamaria.bukvic.net/Flash/relocation-leaf.html. Its artistic rendition follows an intuitive logics approach (Derbyshire and Wright 2017) revolving around two main determinants of future outcomes and their association: climate change impacts (CCI) and adaptive capacity (AC). While CRL's values are merely a heuristic representation of possible scenarios, it does factor in observed deviations and trends depicted in the existing climate change and population movement literature, as described below.

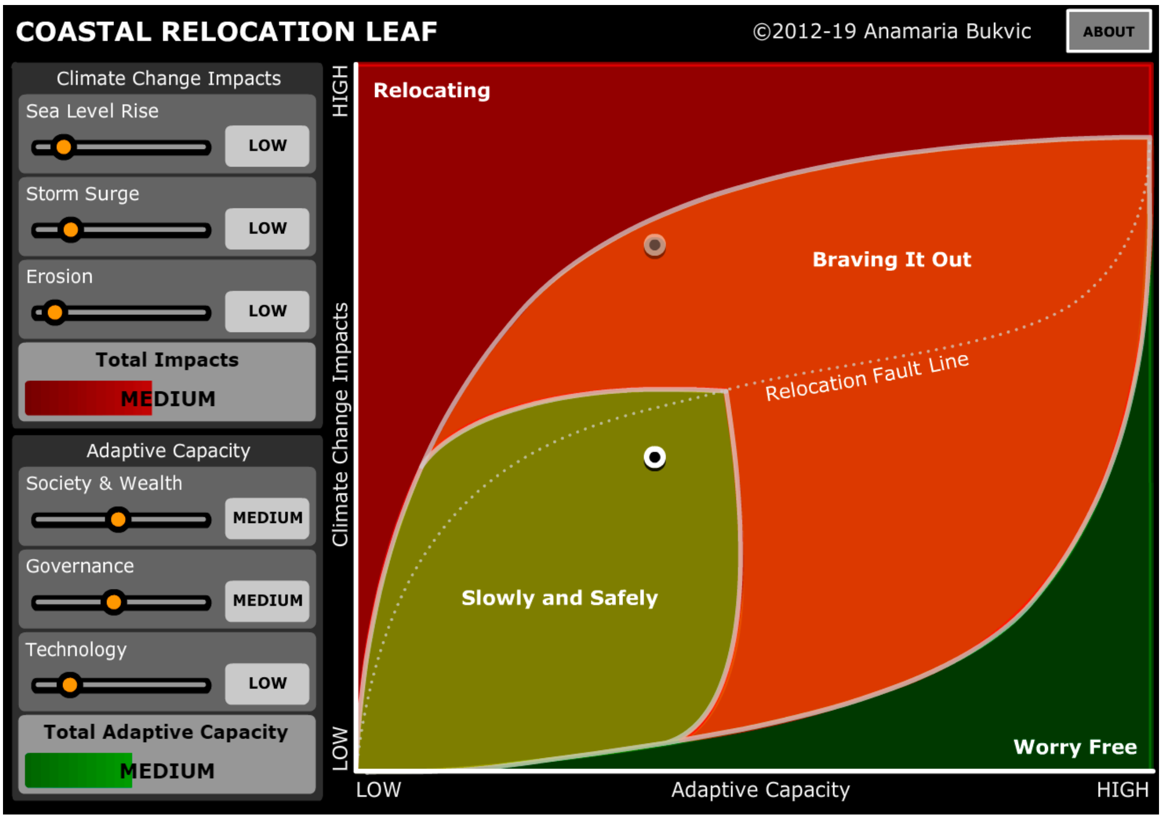

Figure 1. Coastal Relocation Leaf (CRL).

Climate Change Impacts (CCI). The persistent changes such as sea level rise (SLR), tidal inundation, loss of landmass due to erosion, and recurrent storms will have a detrimental impact on the willingness to consider relocation (Marshall 2015). Sea level rise is anticipated to induce significant population shifts, either directly via permanent inundation (Nicholls 2011; Parris et al. 2012) and more invasive storm surge from tropical storms, hurricanes, and nor'easters (Villarini and Vecchi 2013; Kim et al. 2014; Lin et al. 2012), or via chronic pressures and secondary impacts due to recurrent flooding (Moftakhari et al. 2015). Increased coastal storminess and SLR are also expected to increase the rates of coastal erosion and sedimentation processes (Orviku et al. 2003; Linham and Nicholls 2010), likely leading to significant land loss and impacts on populated areas over the next few decades (Boruff et al. 2005). The CRL tool includes three major coastal impacts: SLR, storm surge caused by meteorological events, and progressive erosion. These impacts, individually or cumulatively, can lead either to physical loss of habitable land (Nicholls et al. 2007) or limited accessibility and property damage. Even though many other factors play an important role in relocation decision-making, there is limited empirical evidence supporting their exact role in the relocation process, and thus they were not included in our considerations.

Adaptive Capacity (AC). The IPCC (2014) defines adaptive capacity as "the ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences." According to Smit and Wandel (2006), the concepts of adaptation, adaptive capacity, vulnerability, resilience, exposure, and sensitivity are all interrelated and interdependent. For example, an increase in adaptation capacity reduces vulnerability and sensitivity while enhancing the resilience of communities. Generally, a system that is more exposed and sensitive to climate change and associated hazards is also more vulnerable and needs additional investment in building adaptive capacity to stabilize impacts (Smit and Wandel 2006). Ideally, a community will reach equilibrium by balancing the level of impacts with its ability to effectively deal with them. However, considering the complexity and dynamic interactions present in most coastal urban systems, maintaining this stasis will require constant monitoring, evaluation, and adaptive interventions to maintain optimal protection. Therefore, adaptive capacity is not a static measure, but should rather be considered a dynamic, evolving system influenced by many contributing and interrelated factors.

The CRL tool depicts three key determinants of adaptive capacity:

- Society and wealth (e.g., socioeconomic and demographic characteristics; Pelling et al. 2008; Lockwood et al. 2015);
- Governance (e.g., visionary and collaborative leadership, accountable and transparent officials and institutions, and inclusion and engagement of all constituents in decision-making; Gupta et al. 2010); and
- Technology (e.g., by supporting behavioral change and implementation of adaptive practices; Hogarth and Wójcik 2016).

Design, Integration, and Simulation. CRL's rendition revolves around two main driving forces represented in the control tab area on the left-hand side: climate change impacts (CCI) and adaptive capacity (AC). While their values are merely abstract representations of possible scenario outcomes, the model does factor in observed deviations and trends depicted in the existing climate change and migration literature. The rendered CCI/AC graph is divided into four areas, representing possible future scenarios: Slowly and Safely, Worry Free, Braving It Out, and Relocating. The combination of sub-settings guides the placement of the pointer into one of the four different scenarios depicting possible futures in high-risk coastal communities:

Worry Free:	Low climate change impacts and high adaptive capacity Low risk, successful adaptation, no need for relocation
Slowly and Safely:	Low climate change impacts and low adaptive capacity Low risk, slow, gradual adaptation, relocation unlikely

Braving It Out: High climate change impacts and high adaptive capacity
High risk, intensive adaptation, relocation possible
Relocating: High climate change impacts and low adaptive capacity
High risk, inadequate adaptation, relocation likely

The visual representation resembles that of a leaf and includes a main pointer indicating a "where we are now" state determined by the integration of CCI and AC attributes. A second semi-transparent point is placed above the main marker, specifying a possible placement in the event of a surprise event or major disaster, and measures up to a 100% increase over the baseline value, a jump with a range dependent on community adaptive capacity. Each horizontal slider moves independently from low to high for each variable. Individual CCI variables affect the cumulative CCI value differently. For example, even a single impact, such as SLR increase, is capable of eliciting the highest total CCI considering that absolute inundation would not leave any possibility of in situ adaptation and inhabitation. The values of the AC sliders are equally averaged to reflect the mutual co-dependence of all factors. Similar to CCI variables, AC variables tend to be correlated, considering that higher socioeconomic status generally also suggests a higher degree of functional governance and technological advances. Since the relationships between CCI and AC variables vary based on scale, location, and context (e.g., even within single local institutions, it is possible that individual departments are not equally effective and cohesive), all sliders move independently to allow for the customization of diverse circumstances in coastal communities. For the optimal adaptive capacity, all settings need to be in the rightmost position.

The cross-section curve or Relocation Fault Line splits the leaf into two areas. The area above the curve represents conditions under which relocation should be considered as an adaptation option, while the area below depicts circumstances where other in situ adaptation measures are likely sufficient to address the impacts. For example, relocation should already be considered within the upper area of the Braving It Out scenario, as a surprise event could suddenly change the circumstances to the Relocating future. In the green area, the Worry Free scenario, climate change impacts are mild and in situ adaptation capacity is high with no compelling reason to consider relocation. However, the upper limits of this scenario are above the Fault Line, suggesting more volatile circumstances in which a sudden shift of any of the drivers due to an unforeseen megashock may override in situ adaptive capacity and move the pointer toward a different scenario. While such an event may quickly dissipate, the ensuing potentially irreversible damage and repeat frequency of such events will warrant re-evaluation of possible options.

In the Relocating area, the matching surprise pointer is already located in this scenario narrative, suggesting a high possibility of relocation. The tip of the leaf never reaches the top right corner, reflecting the fact that under close-to-maximum CCI (e.g., permanent SLR inundation or repetitive major disasters), no level of in situ adaptive capacity will be cost-effective enough to ensure adequate safety and protection, therefore leaving relocation as the only viable response option. The scenarios are not linear but rather slightly extended or curtailed to account for the lag/reactive nature of policy responses, investment in adaptation, and/or public engagement with the issue until it reaches crisis proportions. In addition, this shape is suggestive of subtle transitions between different scenarios to reflect the complexity and dynamic nature of the whole system, where transitions often emerge in a more organic manner. In situations where SLR represents a major threat to a coastal community with very low in situ adaptation capacity, the pointer and corresponding indicator are located in the red area, indicating the need for community relocation.

3. Expert Evaluation

A group of experts (five individual responses and one via a panel of six additional participants) was invited to evaluate CRL for its applicability, relevance, validity, and usability and provide suggestions for its improvement and refinement (Virginia Tech IRB# 15-341). Experts were selected based on their expertise in coastal resilience and climate change communication, and their suggestions have been incorporated into the current version of CRL, such as changing the scale display to low, medium, and high; correlating the SLR, storm surge, and erosion sliders; and emphasizing the coastal context in the title and description. A few experts suggested removing the metrics (percentages, feet, and any numerical values), as they "rightfully stole the attention from a more important point, which is capturing interactions and relationships between different system components." Some observed that the valuable purpose of CRL is to understand the relationships in this context rather than to have definite quantitative scenario projections. Regarding CRL's usability and simplicity, the experts generally noted that CRL is engaging, simple, transparent, user-friendly, visually compelling, and understandable to multiple stakeholders in any coastal context. Further, a few observed that manipulation of the CCI sliders accurately represents general trends noted in the scientific literature, while the selection of AC variables reflects what experts would expect to see at an aggregate level. One expert suggested that CRL may be too simplistic for certain coastal stakeholders who may prefer to see supporting empirical data, and thus its effectiveness will depend on the target audience. A few experts suggested the inclusion of specific metrics to reflect CCI variables (and their conversion to percentages or other units). However, as one expert noted, the question "How would a community decide what numbers to plug in?" would likely dominate the dialogue on the appropriate values, associated uncertainty, and metrics' validity, potentially distracting the audience from the true purpose and benefits of this tool. Another expert proposed the inclusion of a specific timeline for CCI. Temporal considerations are already generically reflected in the sliders' performance under the assumption that movement from low to high mode reflects their impacts' intensification.

The experts noted that CRL measures what it is supposed to measure according to the purpose statement and clearly represents the interconnectedness among variables. The key comments revolved around CRL's complexity, with some experts suggesting that it should incorporate additional contextual variables, while others noted that a more complex system may be more difficult for users to understand. It would be difficult to account for all possible contextual factors that may influence the scenario outcomes within CRL's framework. Nonetheless, such location-specific aspects could be identified by local stakeholders during supplemental activities through workshops and similar participatory efforts and interactively tested against CRL's system or adjusted using a weighting scheme. One participant noted that "the outcome will depend heavily on how users assign a value to the factors included in the lead plot," indicating that subjective reasoning may influence the scenario outcome. This could be observed as a tendency to deliberately manipulate scrollbars to avoid critical scenarios illustrating the worst-case outcomes for the community. To prevent such manipulation, especially between different stakeholders, a quantitative data input for each variable would provide more objective results. Another potential way of minimizing data bias would be crowdsourcing data and averaging the community's perceptions. Such broader engagement may serve as a foundation for the "joint fact-finding" process that supports integration of scientific observations with non-scientific perspectives and collective learning. This approach would help people with opposing perspectives on the issue converge on mutually acceptable solutions or understandings, starting with the accurate identification of key questions or uncertainties and their implications. This, in turn, would help shape a consensus-building process and help create new knowledge that is scientifically sound, publicly accepted, and policy-relevant (Karl et al. 2007).

4. Discussion

The expert evaluation indicated there is dissonance even among experts on what CRL should really represent that seems to be rooted in disciplinary perspectives and culture. It reveals there are two opposing opinions: one driven by a need for inclusion of quantitative values with spatiotemporal meaning for individual localities, and another reflecting a preference that the framework remain more abstract and focused on relationships and causation instead of absolute numbers. Data about the exact values for each of the CRL variables across different spatiotemporal scales are at this point still encumbered by high uncertainty and often represented as a range of values or scenarios.

This estimation gets even more complicated in the context of measuring adaptive capacity metrics, considering many responding variables can be represented only by proxy measures, and whether they represent appropriate measures is still a topic of scientific discourse. On the other hand, the literature shows that simple abstract games and interactive exercises and scenarios may broaden users' perceptions about issues, encourage them to conceive nonconventional possibilities, provide a platform within which they can experiment and play with options and consequences of interventions (Ringland 2006), challenge conventional mental maps of the future, recognize signals of change, and test responses under different circumstances (Beery et al. 1997).

Also, one important distinction is that CRL is not designed to help users make finite decisions but rather to pave the road to participatory learning that will enable users to ask the right questions, think about multidimensional aspects of this problem, and eventually be able to make informed decisions. Further, it encourages users to think more broadly about their individual role in collective community efforts to adapt to changes in coastal environments. People living in coastal communities who do not have direct personal experience with flooding are often unwilling to support policy change and flood control interventions, as they seem irrelevant to their personal circumstances. However, showing them progression of change and outcomes may help them see a broader picture. Therefore, CRL does not answer the questions of when, where, and how people should relocate, as these answers depend on complex community- and household-level decision-making and moreover on individual and collective willingness and capacity to engage in in situ adaptation. But it does respond to the social science problem stemming from the inability of some people to proactively engage with a problem they are facing due to cognitive and psychological barriers that favor emergency and reactive responses (Godet 2000). Considering CRL is envisioned more as a conversation starter, it could be combined with other social science methods such as focus groups, participatory mapping, or GIS storytelling to foster dialogue in a more specific context using spatiotemporally relevant data.

The key potential for the future development of CRL is in the inclusion of qualitative contextual data for each variable into its currently heuristic configuration to improve its accuracy, meaning, and relevance. However, this effort would raise many new questions regarding the validity of interactions and co-dependencies, such as the interaction between sociodemographic parameters and support or access to technology and how they empirically co-vary. Scientific consensus on some of these interactions is still limited, and the debate on the actual risk of SLR and storm surge is still ongoing. Moreover, additional expertise would be required to select appropriate indicators of AC and justify their aggregation from the available datasets. It would also be required to ensure that there is a sufficient level of consistency supportive of cross-comparison for strategic regional planning and transferability to other sites. In addition, little is known about relationships between household and collective resilience in coastal locations, and how bottom-up efforts may contribute to AC of more complex urban systems with many additional considerations feeding into the risk of relocation (e.g., quality and robustness of infrastructure, housing, business, services, social capital, and markets).

Another innovation of CRL's framework that should be further explored is its capability to reflect collective integrated circumstances on community- and individual household-level estimates. Considering that risk perceptions play an important role in coastal decision-making, they could be reflected on CRL via household or community surveys in high-risk coastal communities. Here, public participants would be asked to add mapping points to the point cloud, pinpointing where they feel they are now in respect to the four different scenarios. Therefore, in addition to potential expert and empirical validation of data points that would define the contours of CRL, different users could also self-report where they believe they are situated on the leaf, individually or as a community, and provide additional data on their roles in decision-making and the socioeconomic profile. This approach would help validate the framework and identify any potential gaps between expert and non-expert user groups, as well as between risk perceptions and the actual risks in a given location.

5. Conclusions

Even though an increasing number of scientific studies corroborate the imminence of climate change impacts, the slow progress on adaptation in the policy and planning arenas points to a disconnect between "what should be done" and "the ability to do it" (Robinson 2009). Decision-makers have to overcome significant cognitive and psychological barriers "to replace emergency and reaction with foresight and proactiveness" and reposition their thinking to act before it is too late (Godet 2000). The dominant reactive approach is especially problematic in the context of relocation, which, with respect to individual geospatial and temporal distinctions, represents a complex and extensive process where timely action will be of crucial importance for its success and outcomes. Building stakeholder awareness of the worst-case scenario that could instigate relocation in coastal communities using interactive digital scenarios may represent a valuable strategy to facilitate transformative learning of all possible outcomes. Consequently, CRL is designed as a user-friendly and dynamic digital object allowing decision-makers to test it against their own local circumstances and explore at which intersection of conditions they should start considering, discussing, proactively planning, and eventually implementing this adaptation strategy. It offers a novel approach of framing the possibility of relocation and is intentionally generalizable and applicable to circumstances in many coastal communities.

CRL integrates variables critical to the possibility of relocation in coastal settings by grouping them into more manageable meta-variables that can effectively convey complex information to a diverse audience. The tool's code and framework are freely available to users, encouraging further exploration of its usefulness and functions to conceptually capture the relationship between climate change stressors, adaptive capacity, and possible relocation outcomes. CRL's potential to alert users to the possibility of relocation under different CCI and AC circumstances may represent a powerful tool to initiate dialogue on specific programmatic and policy interventions needed to change undesirable scenario outcomes. CRL can also be used to reach diverse audiences that are facing the decision to relocate but lack the broader knowledge to make an informed decision on how and when to proceed. As a "conversation starter," CRL may help engage a multi-stakeholder audience in a discussion on "where we stand as a community," "where we want to be in a few decades," "what we need to do," and "what we can do" to end up in the desired scenario a few decades from now.

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