Examining the scalar knowledge politics of risk within coastal sea level rise adaptation planning knowledge systems

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ABSTRACT

As cities around the world experience rapid sea level rise (SLR), institutions and actors classify and measure SLR “risks” through discourse and specifying practices for adaptation. These risk, discourses, and practices occur at multiple scales that are embedded within one another and draw their significance from cross-scale connections; from global estimates of ocean density and emission scenarios, local design criteria for flood management, networks of tidal gauges, and individual and collective experiences of loss and change. Thus social actors responding to the complex physical challenges posed by climate change across space and time must deal with an inherent politics of building shared understanding and agreeing on (or not) desirable courses of action. These dynamics produce ‘scalar politics,’ i.e. strategies for defining and managing perceived risks at specific scales, resulting in more or less equitable and effective responses to the uneven consequences of SLR. To highlight the scalar politics of knowledge systems in adaptation planning, we present findings from two case studies of the Pacific Islands and coastal areas of Florida, USA. Drawing on our findings, we propose the concept ‘scalar knowledge politics of risk.’ As knowledge claims flow between global, regional, and local decision-making spaces, we identify five scales at which knowledge systems experience friction: 1) construction of the global climate; 2) regional downscaling of climate impacts; 3) local definition of risks; 4) transformation of on-the-ground social-ecological-technical systems and infrastructures; and, 5) evaluation of interventions. Through our case study investigation of the scalar politics of SLR adaptation, we hope to help illuminate and inform strategies to overcome long-standing barriers to effective and inclusive urban adaptation.

1. Introduction

Over the past century, anthropogenic climate change has induced rapid sea level rise (SLR) projected to significantly impact the social, ecological, and technological dimensions of urban systems (or SETS - see Grabowski et al., 2017) with profound implications for the health and safety of billions of urban residents (IPCC and Field, 2012). In two vulnerable regions— the South Pacific and South Florida USA— SLR is expected to be around 80 in. by 2100 ((Compact) Southeast Florida Regional Climate Change Compact Sea Level Rise Work Group, 2015; Sweet et al., 2017); this rise is expected to contribute significantly to extreme weather related risks (IPCC and Field, 2012). In response, coastal governments work to manage threats posed to urban life through development of adaptation strategies (e.g. expanding stormwater drainage in Florida and planned retreat and relocation in Kiribati).

While part of seemingly apolitical technical processes, SLR adaptations are inherently political in their processes, indicators, and outcomes, often reinforcing long-standing unequal development and power relations (Kaika, 2017). For instance, different metrics used in decision-making inherently ignore some risks and favor others (Gross, 2010), often through the framing and utilization of particular spatial and temporal scales by different actors legitimating their activities (Bulkeley, 2005; Braun, 2006; Nightingale, 2017).

Such social barriers to inclusive knowledge generation and utilization have been examined by the emergent field of knowledge systems...
analysis (KSA), which has primarily focused on epistemological practices and institutional arrangements that designate norms for evaluating and using certain forms of knowledge (Munoz-Erickson, 2014), however the treatment of scale within KSA is currently underdeveloped. For instance, while Cash et al. (2006a) acknowledge of the role of scale in preventing effective knowledge transfer for climate oscillation preparedness, urging a more co-productive model and the use of ‘scale crossing’ actors, they do not examine the inherent politics of scale that can hinder or affect such co-production. Similarly, while Cash et al. (2006b) recognize the centrality of addressing scale in designing knowledge systems, they focus largely on the technical and social dimensions of how information crosses scales. Such an emphasis on pre-configured scales is not surprising, given the physical science basis of attempting to better merge local observations with global climatic models and vice versa (Cash, 2000). In contrast, other recent work treats the designation of appropriate scales as a key subjective and politicized process of analyzing knowledge needs meriting further elaboration in specific cases (Manuel-Navarrete, 2015; Grabowski et al., 2017). For our purposes here, it is clear that the knowledge required for SLR adaptation, requires that we confront the various institutional arrangements of producing knowledge, the material consequences of using knowledge produced at different spatial, material, and social scales, and the inherent politics of designating and choosing scales of analysis and social action.

Using two case studies of SLR adaptation planning in the Pacific Islands and Miami-Dade County, USA, we identify the scales at which participating institutions formulate information and technical expertise, as well as the spatial and temporal extents of knowledge produced to guide adaptation. Drawing upon these case studies, we propose a preliminary framework of five major scalar arenas that the knowledge systems literature can engage to make progress in addressing scalar issues.

1.1. Integrating scalar politics to knowledge systems analysis in resilience research

KSA examines how knowledge is conceived and constructed for decision-making, rejecting the concept of the “logic of discovery” that assumes knowledge is found, pre-formed and ready for use (Miller and Munoz-Erickson, 2018). As KSA for climate resilience evolves, it continues to incorporate both prescriptive and descriptive analyses (e.g. Cutter et al., 2008), as well as process-based approaches that understand resilience as an emergent property of risk negotiation between social actors (Adger et al., 2005). KSA builds on the concept that different disciplinary practices designate rules, standards, and norms for producing legitimate and useful knowledge (Wynne and Wynne, 2003) often questioning what constitutes the ‘public’ for whom such knowledge is relevant (Rogers and Hall, 2003). KSA also greatly concerns itself with knowledge integration challenges manifesting at different stages of knowledge production and dissemination; as when problem framings exclude or prioritize particular forms of knowledge (Munoz-Erickson, 2014) or exclude certain social groups (Finewood, 2016). KSA is thus a useful way of identifying how, where, and by whom knowledge is produced and utilized in addressing matters of social concern. While this is a powerful approach, it has had limited engagement with the extensive literature on issues of scale in knowledge production and social decision making, and runs the risk of falling into a ‘scale free’ trap.

In contrast, scalar issues have been long debated by human geographers (Mackinnon, 2011) with most noting that scale is both an inherently political concept demarcating the social authority of different actors and institutions, as well as bounding social and material matters of concern (Bulkeley, 2005). Others go so far as to reject the concept of scale entirely, instead focusing on networked relations and how they influence our experience of time, space, and social power (Marston et al., 2005). Critics have noted how this rejection ignores the compatibility between networked and semi-hierarchical dimensions of scale in the co-production of material and social reality, and the persistence of scale in shaping actor relations in ongoing contestations around the coordination of global climate change adaptation (Mackinnon, 2011; Kettle and Dow, 2014; Murphy, 2015; Beck and Mahony, 2018). For instance, powerful actors organize knowledge around specific spatial scales, including national borders (Anderson, 2006); ‘natural’ scalar breaks, such as watersheds (Molle, 2009); and large-scale socio-technical systems, such as interdependent infrastructure systems (Graham and Marvin, 2001; Pritchard, 2011; Murphy, 2015). At the same time, physical geographers and other ‘natural scientists’ have long been concerned with understanding the influence of scales of measurement and delineation of research areas on how they perceive and understand the physical world (e.g. Mandelbrot, 1983).

Bringing these strains of literature together, we expand KSA approaches by focusing on the politics of scale that shape knowledge integration into decision-making, described as ‘scalar politics’ (Bulkeley, 2005; MacKinnon, 2011), or the processes by which actors construct and use “scale” as a mechanism to achieve their goals and priorities (Gruby and Campbell, 2013; Sievanen et al., 2013). Following the literature above, we do so in three major domains: physical, social, and political.

Physically, scale shapes how we perceive particular phenomena, as well as how those phenomena occur without our perception or influence, and over varied time frames (e.g. Capra, 1996), including ‘more than human’ processes that affect the world regardless of human influence (Coole and Frost, 2010; Connolly, 2013). In this sense, biophysical processes and non-human organisms operate at distinct spatial and temporal scales, such as the tidal processes resulting from an interplay of solar, lunar, and planetary level physical processes (Melchior, 1983) and the coastal and riverine dynamics of freshwater and sediment circulation vital to building, maintaining, and moving barrier islands and coastal marshes (Yanagi, 1999). Lack of attention to the physical processes of scale can hinder effective adaptation, as considering sea level as only a long term and global process ignores local and regional geological processes influencing variations in experienced SLR, and the short time frame of synergies between SLR and extreme weather events (Tamisiea and Mitrovica, 2011).

Acknowledging physical and temporal dimensions of scale does not eliminate the importance of understanding scale as socially constructed in how social actors delineate and connect social units (e.g. neighborhoods, homes, cities - see Bulkeley, 2005; Marston et al., 2005; MacKinnon, 2011). Social construction also highlights ways in which actors in a society make meaning out of complex physical and ecological environments. As part of this meaning-making, actors place boundaries, as in the designation of nations (Anderson, 2006), the ‘global’ climate (Edwards, 2001; Jasanoff and Long-Martello, 2004; Mahony and Hulme, 2018), or ‘urban’ nature (Braun, 2006), all of which solidify particular units of analysis (e.g. the ‘Mid-Atlantic,’ or ‘the city’). Within SLR projections, actors also place boundaries around temporal scales when using and interpreting data from the past and when projecting climate trends into the future (Edwards, 2001). In SLR research, where risks are both regional (e.g. regional infrastructure failure), and local (e.g. a neighborhood being washed away), such an understanding avoids valorizing the ‘local trap’ (Jasanoff and Long-Martello, 2004), which equates locality with spatial smallness, social homogeneity, and norm similarity (Agrawal and Gibson, 1999). Instead, it acknowledges that any given scalar arrangement empowers particular actors and excludes others, as each scale is inherently embedded within the others (Purcell and Brown, 2005).

Scale also clearly serves as a political tool by which actors gain authority over particular spaces (e.g. Adger et al., 2005). Authority also coincides with the responsibility for problems at a particular scale, prefiguring solutions and loci of action (Kurtz, 2003). This choice of scale may be driven by political economy (Mackinnon, 2011), the need to navigate particular bureaucratic environments (Abers and Reck, 2001), or for control maintaining non-discursive narratives (Lash and Urry, 1994) that provide actors with leverage through their constructions of local places as symbolic representations of social power (Tannen, 1994). As such, scalar politics is not a matter of politics about scales, but a matter of politics for scales, as scales are produced through collective action at different temporal and social scales (Mackinnon, 2011).

Socially, scale refers to the conceptual frameworks that direct our experience of time, space, and social power (Bulkeley, 2005). Actors themselves use various scales to make sense of the physical environment, including economic and political scales that a
2013), or a concerted effort to re-localize and/or prioritize indigenous knowledge practices (Bobensky and Maru, 2011). In each situation, actors seek to gain authority over particular spaces by advocating for a scale they deem appropriate to manage their concerns. Taking into account these power dynamics dispels the myth that institutional design can guarantee adaptation outcomes, or that there is an a priori fit between institutions and their physical environments (e.g. Folke et al., 2007; Molle, 2009), and focuses on the multi-scalar politics shaping institutions and networks (Nightingale, 2017). Decision-making thus does not simply down-scale from international, to national, to local; rather scales co-constitute one another as networks of agents across scales, often in decision-making arenas that transcend territorial and jurisdictional hierarchies (Bulkeley, 2005).

Consideration of the materiality, social construction, and political choice of scale provides a comprehensive approach to scale to support and shape KSA literature. The multifaceted nature of scale means that various knowledge systems are brought to bear based on an actor’s understanding of the physical environment, social meaning, and problem framing in a particular situation. Inevitably boundaries differ between different constructions of scale, such as the migration patterns of animals, which do not adhere to national borders (Lejano et al., 2013). Even within a particular territorial space, multiple competing ecological, social, and political forces can be at play seeking to define scale. Therefore, while scales may become sedimented, they are not permanently fixed.

2. Case studies of SLR adaptation

To highlight issues of scale in KSA, we examine scalar politics in SLR adaptation planning in the Pacific Islands and Miami-Dade County, Florida, USA, two regions that are undergoing SLR and adaptation. The case studies draw upon empirical work of two authors of this paper (for full methods and case studies see Denton, 2018 and Rozance, 2019). In the Pacific Islands (PIs), 52 semi-structured in-person interviews were conducted with individuals from government agencies, international and locally based NGOs, and regional governance bodies. In Miami-Dade County (MDC), 59 semi-structured in-person and phone interviews were conducted with planners, policy-makers, community organizers, environmental NGOs, and the business community. Scalar politics were evident in the selection and analysis of case studies; each was initialized with geopolitical definitions of place, and then researchers worked outwards and inwards to track the knowledge and institutional flows shaping how SLR risks were understood and addressed. For both the PIs and MDC, interviews covered experiences and understandings of SLR and climate change impacts and adaptation strategies, including policies, programs, and management decisions. Interviews were transcribed and coded, using thematic analysis outlined in Braun and Clarke (2006). Each case also used document analysis and literature reviews to examine conceptions of SLR risk. In each case, we identify key challenges for knowledge systems related to scale affecting the framing of vulnerabilities and solutions to climate change. Results from each case study do not address all of the multi-scalar, actors, practices, and tensions that occur in the PIs and MDC, but rather provide a brief overview to illuminate specific particular scalar knowledge system tensions that rose to the fore.

2.1. Pacific Islands

The environmental vulnerabilities experienced by the PIs continue to escalate as SLR wears away low-lying atolls, threatens fresh water supplies, erodes coastlines and coral reefs, increases the prevalence and strength of storms, and jeopardizes food systems of agriculture and fishing (Keener et al., 2012). While Islanders have transformed their practices for thousands of years to deal with environmental changes (Barnett and Campbell, 2010), rapid anthropogenic climate change forces an accelerated rate of adaptation. In response, the PIs have been a target of large-scale research projects, resource-intensive environmental interventions funded by external states and international environmental NGOs, and a general global interest (knowledge systems, actors, and material processes summarized in Fig. 3).

As PIs are shaped by global financial flows and narratives, regional and intergovernmental bodies as well as NGOs take up the process of governing (Denton, 2018). These regional bodies work as liaisons between global and local bodies for both the financial and scientific investments in the region, as well as global and local ways of knowing (Denton, 2017). As they engage with local actors for implementation, these regional organizations must interpret risks that continuously shift due to the ecologically adaptive nature of the islands, as well as the changing social and political landscape. This has fostered inconsistent and, at times, counterproductive infrastructure interventions, such as newly built seawalls deflecting wave forces in a way that damages mangroves, which are also receiving investment. Yet, even with global pressure for a scientific and technical focus in SLR adaptation, rigorous evaluation and certification play relatively small roles in SLR governance, while individuals at the local level have more traditional ways of monitoring their environment, including using storytelling and proverbs as a way to understand natural patterns and see change over time. While tensions exist between actors at every scale of governance, this section will focus on the tensions between local and global actors in the PIs in efforts to address SLR.

2.1.1. Knowledge system challenges in the Pacific Islands between global and local evaluation

Lower levels of scientific and technical capacity require many PI meteorological and environmental government agencies to rely on IPCC projections of SLR—staffed by predominantly Northern, white, male scientists (Barnett and Campbell, 2010)—yet are tasked with monitoring localized SLR risks to feed into global projections and models. While traditional donors including the US, Australia, New Zealand, France, Germany, and others have provided access to advanced technologies for the PIs to monitor SLR, the fragmented nature of project-based development in the region has limited the capabilities of PI states to streamline their data inputs to understand their own localized SLR risks. Imbedded in these choices is a colonial history and system of international aid that shapes the flows of finance in the region (Atteridge and Canales, 2017). As one individual who had worked both within PI states and externally described the situation:

… you may have New Zealand select a particular brand of automatic weather station and install it in multiple countries. Then you have another donor that says “No, I prefer to go with instrumentation that comes from my country.” So, you’ve got a bit of a mismatch… which creates complications in reference to having to train people at the national MET (Meteorological) services… you can’t say to a donor, “Yes we’d be happy to take money from you …but we won’t necessarily accept something from your country.” You know what I mean. It’s a complicated space. Very complicated space.

This “complicated space” challenges the authority of PI state agencies in their efforts to control the knowledge systems in their own countries. Capacity challenges can already be overwhelming for many of the Small Island Developing States and Least Developed Countries that make up the PIs due to their small populations and economies. However, these capacity challenges are vastly exacerbated by state agents having to learn multiple technologies, reporting mechanisms, etc., in efforts to meet donor requirements for knowledge production. Exacerbating the situation, many funders, including post-colonial states and international NGOs, prefer to fund pilot projects and other short-term interventions, as well as data gathering exercises such as surveys. Not only does this limit the ability of PI government agencies to evaluate change over time, it has forced the already overburdened staff of government agencies to juggle multiple projects at a time with multiple funders, interventions, and reporting strategies. As one participant from...
a regional organization described the pressure that puts on practitioners:

All these things are an inverted pyramid that lands on one particular person’s head on the ground. That person has to have the pyramid stuck on his head and goes down to the community level to try and translate all those results from all those projects and all those technical interventions to make it work at the ground level. It’s hard… So, all these fancy people like myself that might say, “Yeah, you need to drop a good work plan, and these are the things we think you need to do.” But at the end of the day, that poor sap’s gotta go out and figure out how to do it on his or her own.

This pressure on practitioners—particularly those within government agencies—has exacerbated existing capacity challenges within the region, and exemplifies the ‘global’ burden that individual and local actors can be made to bear. Additionally, the risks constructed by post-colonial states and international NGOs can often be out of alignment with local ways of understanding the environment. As one individual described her work with a regional NGO:

… one community we went to said, ‘we need more knives.’ And they were talking about climate change, and we were like, ‘what?’ And then we realized it’s because they associate money coming from big institutions…so they are like, ‘we should ask for knives so we can use this for fishing, agriculture or whatever.’ So, for them, this is a holistic way of looking at the issues. It’s not like they’re worried about sea level risk. The way we break down issues, I don’t think it’s the same at all because ‘this is my life, this is my experience, so it doesn’t really matter what it affects… whether the soil is eroding or whether the sea level is rising. No matter is happening, this is how I experience this problem in my life.’

In this case, local participants questioned the relevance of climate change to their lives at all. In fact, the focus on climate change may be seen as deferring resources away from more immediate needs—knives. In this way, local framings of risk can be at odds with global, scientific narratives.

2.2. Miami-Dade County, Florida, USA

On the global scale, MDC is portrayed as highly vulnerable to SLR because of high-value coastal development, low elevation, and long-standing flood issues (Hine et al., 2016; Sweet et al., 2017). Framing risks around high-value regional economic importance can overshadow discussions of vulnerable and marginalized communities. Historically, to enable growth, and driven by strong local actors, the region has undergone extensive hydrological engineering projects, comprising of a system of canals and pumps transporting water from the Everglades to the coast (Grunwald, 2006). Despite these engineering interventions, the region regularly experiences flooding (Sweet et al., 2014; Wdowinski et al., 2016), historically occurring during intensive rain and storm surge events. Today however, “sunny day flooding” has become commonplace in low elevation communities when tides increased in height by SLR, push water up through storm drains and porous substrate (Sweet et al., 2014).

In MDC, global and regional SLR projections show inundation impacts pose a threat to regional economic dependence on development, tourism, and flooding infrastructure ((Compact) Southeast Florida Regional Climate Change Compact Sea Level Rise Work Group, 2015; Hine et al., 2016; Wdowinski et al., 2016). Perversely, some local actors have refused to accept risks of continued SLR as doing so conflicts with their political and economic interests. In response, local planners tend to emphasize infrastructure adaptation practices supporting ongoing economic activity, and paying less attention to landscape level social and ecological risks. As modern engineering expertise has enabled growth and development by mitigating historical flooding risks, engineering-oriented planning departments and agencies continue to be pushed by local communities and developers to addressing emerging SLR risks. Many of these planning departments in turn, hire international, national, and locally based consultants working across different material and political scales. MDC as a region, takes on global importance as a case study in adaptation, and is where sense is made from global and regional projections by decision-makers and communities, who must also contend with localized (city and neighborhood) narratives of risk and adaptation need.

Overall, different actors, including scientists, policymakers, private industries, planners, and community and environmental organizations frame the risks that SLR poses to their communities (see Fig. 4). While tensions exist across many scales of governance in MDC, the region is notable for its regional response and coordinated effort to address SLR, and the next section emphasizes the scalar politics of regional downscaling of global SLR projections and the creation of risks and vulnerabilities.

2.2.1. Knowledge system challenges between regional downscaling and the creation of risks and vulnerabilities

In response to global narratives and projections around SLR, regional authorities faced growing pressure to identify locally specific information regarding rates and projections in the mid-2000s, leading MDC to enlist scientists to create and interpret regional projections. This effort was shaped by political choice and scientific uncertainty around which material processes were relevant to include, which also intersected with local political uncertainty of acknowledging SLR as a regional threat. As one scientist shared,

“The politicians, most of them, are interested in reducing the projections… [They] suspected…that if the rate of rise was too aggressive, the people on the County Commission would just tune the whole thing out and not do anything.”

A regional planner elaborated on this point when discussing the initial reaction to global projections: “there [was] frankly no known experience for dealing with this… back then… we were unsure about how those numbers would work.” In reflecting on these early assessment activities, planners discussed that having a strategy to address anticipated SLR needed to be coupled with acknowledging the projections. As one commented, “we have to have a recommendation really that is commensurate with [the projections]…” and planners shared that developing an “enhanced capital plan...” has been discussed “from the very beginning.”

The tight coupling of SLR projections to an enhanced capital plan and infrastructure strategy has persisted in planning through risk and vulnerability assessments. The four southeast Florida counties (Broward, Monroe, Miami-Dade, and Palm Beach), formed the Southeast Florida Regional Climate Change Compact (Compact) in 2009 and adopted regional unified projections, ranging from 6′-12′ by 2030, 14′-34′ by 2060, and 31′-81′ by 2100 ((Compact) Southeast Florida Regional Climate Change Compact Sea Level Rise Work Group, 2015). These unified regional projections must then be interpreted through knowledge systems surrounding localized risks and vulnerabilities across the landscape. Municipal, regional and federal institutions responsible for managing infrastructure are directed by policies and task force mandates from federal to municipal scales that emphasize elevation and other material processes and economic components of vulnerability for infrastructure planning (e.g. the National Flood Insurance Program; MDC’s Climate Change Advisory Task Force; (Vulnerability Assessment) Southeast Florida Regional Climate Change Compact Inundation Mapping and Vulnerability Assessment Work Group, 2012; NOAA Coastal Services Center, 2010; (Compact) Southeast Florida Regional Climate Change Compact Sea Level Rise Work Group, 2015).

In addition to existing mandates and policies, some interviewees discussed how the emphasis on infrastructure is needed as a way to secure ongoing development and investments viewed as needed to pay
for adaptation strategies. Interviewees from the private sector were vocal about this link, as one shared,

"Guess what? We’re going to bust up your street... But it’s all for the greater good, and you’re going to have better services, and we’re improving the system. There are temporary impacts to greater benefits... helpful for the economy. The [business community] comes in and understands that and wants to build."

This notion of adaptation as a mechanism to continue growth in the region was often linked to emphasizing material components of risk, where the ability to use infrastructure to control flows of water will allow for ongoing growth and development. As one planner shared,

"We are not thinking about abandoning any areas at all. We already live on reclaimed land so we will keep reclaiming... It’s all reclaimed land anyways so it’s not an issue. So then, you have to abandon this area and say ‘Why? China can make an island in the middle of the ocean, we can build some more.’"

At the same time, several planners articulate some of the political challenges in addressing adaptation within the development community and point to how private sector influences the way in which vulnerabilities and risks are understood in government assessments, limiting how risks are presented on the landscape. For example, one planner shared:

"...industry is not changing much, even though when we meet with them, they say that they are willing to make changes... when we did the previous plan we wanted to put maps out and put areas vulnerable to sea level rise, the building industry was opposed to that. They don't want to see maps because property is going to get evaluated... You have to keep a balance with that... At the same time, don't sound an alarm because we will not get much support if we do that."

Despite the adoption of regional projections, there are still disagreements regarding how those should be applied and understood through the creation of risks and vulnerabilities. While the county is focused on infrastructure, they receive criticism for not addressing ongoing development in vulnerable regions. Many scientists and environmental organizations criticized what they view as short-term risk and vulnerability assessments and infrastructure investments as “Band-Aid” solutions that will build the region into more risk. One scientist shared,

"...we're putting all our money into this basket of infrastructure protection, and it's going to keep driving our property values down and keep more social inequity, higher cost, poor quality of life, and then finally, we're going to start getting hit with serial Katrina and Sandy style events... it's going to be bad... We're going to build ourselves into a disaster."

Though the unified projections extend to 2100, several scientists and environmental organizations crititized local governments for adopting shorter planning horizons for vulnerability assessments and adaptation projects. These critics also brought up that the adopted projections fail to integrate accelerating global glacier loss, which would be considered a global processes that scientists argue will lead to higher SLR than projections currently used in planning.

Additionally, interviewees from several community organizations emphasized that the emphasis placed on the economy and infrastructure, largely taking place at regional and city scales, overshadows other social risks and vulnerabilities, primarily taking place at the community level. When discussing a planning meeting regarding vulnerability and adaptation practices, one community organizer shared,

"One conversation, for the greater part of three hours, revolved around changes that can be applied to new developments. Now, there are not a whole lot of people in Miami that can afford the new developments that are being built, but you know who definitely can't afford them? People under a certain income. So, to me, it was another example of them addressing something that's not very important [to low income communities]."

Such contestations among different actors demonstrate how risk framing embeds certain political choices around what gets measured and how SLR projections are translated into risks. Beyond the translation of SLR impacts into risks at different scales, SETs transformations primarily take place material at neighborhood scales with the adoption of resilient buildings and stormwater projects, whereas the knowledge produced about how to prioritize projects takes place at city and regional scales.

2.3. Tensions and flows across sites and scales

While the PIs are largely making decisions in transnational space about SLR knowledge and adaptation, MDC’s work at the urban scale mirrors many of the same politics. Global constructions of a vulnerable and victimized PI have prioritized scientific and technical approaches to risk abatement, while largely ignoring the knowledges, discourses, and capacities used by the Islanders, themselves. Alternatively, regional projections in MDC generate political will towards adaptation action, yet the way in which knowledge about risks are constructed are often motivated by the desire to protect ongoing urban development in the region, ignoring calls from scientific, environmental, and community organizations. The globalized, ‘objective’ approaches to SLR in these areas obscure rights and knowledges from non-expert and local communities in attempts to scale up knowledges, practices, and discourses in SLR adaptation. As local populations are written off as powerless in a global, technical space (e.g. PIs) or ignored in favor of supporting economic priorities (e.g. MDC) they are left out of SLR projections and models.

It is in these spaces that scalar politics of risk play out as knowledge systems interact and compete across scales, from global to local and back again. These tensions are cascading—global constructions of the climate victimize both Pacific Islanders and MDC residents, which then causes regional approaches to emphasize scientific measurement over local understanding, which then constructs risks as technical concerns that transform SETs and leave legacy infrastructures, which then pose challenges for evaluation of effectiveness and quality. These dynamics also work in reverse, however, as legacy infrastructures impact global SLR measurements and opportunities for policy change. Additionally, regional policy changes can transform the processes by which data is collected for global models and what risk abatements are evaluated. Without addressing each scale within the system, hidden struggles over knowledge, discourses, and practices can remain just that—hidden.

3. A framework for the scalar knowledge politics of risk in sea level rise adaptation planning

To better organize the scalar struggles and tensions found in our case studies, we developed a preliminary conceptual framework for examining a scalar knowledge politics of risk with KSA. In our case studies, knowledge did not only cross over from global and local scales, the focus of much of KSA literature. Rather our case studies highlight key intermediate scalar arenas influencing how knowledge transfers from global to local, and back again, which we refer to as the ‘scalar knowledge politics of risk’ (see Table 1 and below). In this sense, each scalar arena of the framework we propose is co-constitutive of the others that operate at both larger and longer and smaller and shorter scales (Fig. 1). As actors and institutions translate knowledge (Latour, 2012) between each arena, these actors must make knowledge claims originating in one arena relevant to the others, often to make material processes legible for specific institutions (Fig. 2). At the same time, scalar interactions among different actors and institutions are not linear and can “jump” across boundaries (see Marston et al., 2005), as each case study highlights how different knowledge systems, actors, and material processes operate and interact across different scales (Figs. 3
Table 1
Summary of definitions, processes, and key tensions within the five hypothesized arenas of scalar knowledge politics of risk.

<table>
<thead>
<tr>
<th>Definition and Actors:</th>
<th>Processes:</th>
<th>Key Knowledge Systems Challenges:</th>
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<tbody>
<tr>
<td>Scalar Work 1: Construction of global climate from local and planetary observations</td>
<td>Global bodies (IPCC, etc.) shape climate knowledge requirements and discourses. Local data collection procedures are shaped by global requirements and shape global data. As local data is aggregated and taken up into scenario building processes, discourses and ways of knowing compete for authority.</td>
<td>Issues of temporal and spatial scale, resolution, and sensitivity; limitations of translation from predictions to reality; displacement of local voices and needs.</td>
</tr>
<tr>
<td>Local data collection, data aggregation, scenario building, and local and global discourses. Actors that operate at the global scale producing and managing climate models and global and local observations.</td>
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<tr>
<td>Scalar Work 2: Regional downscaling of climate impacts</td>
<td>The creation of SLR knowledge relevant to localized governance strategies from global climate measurements and regional biophysical processes. Actors that work to downscale climate data and create regional projections (e.g. NOAA, USACE, Regional Intergovernmental organizations, NGOs)</td>
<td>Top-down agenda-setting—regional adaptation policies structured by global knowledge decisions. Downscaling data challenges—globally-produced models lack specificity for local decisions. Politics of temporal choice—political contestation over planning horizons for adaptations and infrastructures.</td>
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<tr>
<td>The creation of SLR knowledge relevant to localized governance strategies from global climate measurements and regional biophysical processes. Actors that work to downscale climate data and create regional projections (e.g. NOAA, USACE, Regional Intergovernmental organizations, NGOs)</td>
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<tr>
<td>Scalar Work 3: The creation of risks and vulnerabilities out of biophysical impacts</td>
<td>Institutional and social players at the global and regional level set SLR adaptation priorities and lend authority to particular ways of knowing. Based on prioritization practices, historic and scenario-based modelled outputs are often used to project future infrastructure and local policy needs. Biophysical impacts</td>
<td>Political economy of expertise—authorization and prioritization of particular ways of knowing by groups with power. Social constructions of risk—the spatial and social re-apportioning of SLR impacts through discourse and knowledge practices may not address local issues.</td>
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<tr>
<td>Scalar Work 4: SETs transformation via adaptation actions on-the-ground</td>
<td>Institutional processes prioritize the ecological, economic, technological, and social dimensions of risk according to existing expertise and SETs structures. Risk discourse shaped by what is known and valued.</td>
<td>Expert vs. lived experience—the ‘inevitability’ of adaptation can prioritize engineering expertise above grassroots input. Adaptation vs. legacy—climate changes demand shifts in SETs and financial systems, yet legacy impacts can be resistant to change.</td>
</tr>
<tr>
<td>On-the-ground adaptation actions transform the social, ecological, and technological systems (SETs) of a local place. Actors that create policies and projects that transform material processes (e.g. planners, policy makers, managers, private firms, engineers)</td>
<td>Political power exerted via technical proposals for adaptation. Different solutions are legitimized and/or delegitimized through technical decision-making procedures around infrastructure. Local prioritization, authorization, and enactment of adaptations transform material reality on the ground, leaving legacy impacts.</td>
<td>Legitimization of risk management—expertise embedded in existing institutional practices is prioritized in determining which risks to evaluate and what knowledge to use to evaluate them. Temporal issues: outputs/outcomes of one-off or pilot projects deemed acceptable, while long-term impacts are not assessed. Scalar challenges: global and local constructions of risk may be considered separately, if at all.</td>
</tr>
<tr>
<td>Scalar Work 5: Evaluation and certification of best practices for addressing risks</td>
<td>Evaluation procedures may or may not exist, based on the institutional value placed on assessment. Institutions that do put evaluation procedures in place set up procedures to determine the local effectiveness of interventions based on constructions of risk and prioritization of expertise. Infrastructures are then evaluated for how they fit with global certification procedures as strategies for effectively managing risk.</td>
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<tr>
<td>Ways in which local initiatives to manage risk are monitored, as well as how they interact with local-global strategies for managing risk. Actors that evaluate policies and projects (e.g. scientists, NGOs, governments, private firms, community organizations)</td>
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Fig. 1. Distribution of five hypothesized scalar arenas across spatial, biophysical, and administrative time.
We find tensions of scale to be fundamental to the concept of KSA, in particular where institutions, boundaries, and physical demarcations at all scales shape knowledge flows between institutions and actors. This moves KSA away from assuming scales are fixed and pre-determined towards a more nuanced understanding of the knowledge systems processes that create scale and how scale shapes knowledge systems. Below, we begin to define the scope of each arena in terms of our theoretical framing of scale, briefly describe existing work that has uncovered each arena, and identify key knowledge challenges within each.

### 3.1. Scalar work 1: construction of global climate from local and planetary observations

SLR is known in part through global projections based on complex coupled social, technological and environmental models to project climate and oceanographic conditions in the near and distant future. These modelled projections rely on ongoing local (e.g. tidal gauges, buoys), remote (e.g. satellite measurements of mean sea level), and historical (e.g. stratigraphic records) data construction (Miller, 2004), aggregated to construct climate models evaluated by their ability to reproduce observed climatic conditions and combined with socio-economic and technological scenarios to project possible future conditions (Edwards, 2001). In this arena, global institutions such as the IPCC work to present a unified body of knowledge that can misrepresent the contention inherent in knowledge legitimation processes (Hulme, 2013), the uncertainty of future projections (Hansen, 2007), and the complexity of socio-economic and technological scenarios that guide emissions projections (Edwards, 2001). Despite the acknowledgment of such modelling exercises as heuristics rather than predictions of future conditions (Oreskes et al., 1994), global climate and SLR projections are routinely employed by global political and scientific institutions to compel global strategies and legitimize their efforts in this arena.

![Diagram of knowledge systems processes, actors, and material processes that cross scalar knowledge politics of risk for SLR adaptation planning.](image)

![Diagram of relevant knowledge systems processes, actors, and material processes that cross scalar knowledge politics of risk for SLR adaptation planning in the Pacific Islands.](image)
including nations (Denton, 2017), large environmental NGOs and research institutions (Denton, 2018), the IPCC (Hulme, 2013), and networks of climate scientists (Edwards, 2001). We see this in the PIs case example as international funding bodies use climate projections to shape funding for the region. However, while driving much of the international agenda, global models can have limited relevance for local and regional decision-makers due to a mismatch in scales of data aggregation and analysis (Jasanoff and Long-Martello, 2004). Such mismatch can contribute to a distrust of international scientific, political, and humanitarian actors when models fail to align with local experiences (Mahony, 2014), or take into account uneven vulnerabilities (Nicholls and Mimura, 1998) and longer standing place-based practices supporting community resilience (Spencer et al., 2016).

### 3.2. Scalar work 2: regional downscaling of climate impacts

Regional downscaling includes the creation of regional SLR rates and projections from global projections (e.g. mean SLR, tidal variance, extreme weather patterns) and regional biophysical processes (e.g. tectonic uplift, sediment accretion, tidal geometries). The assessment of biophysical processes come with their own sets of assumptions, uncertainties, and social decisions about what constitutes the region (Fawn, 2009) and what material and social processes are considered relevant by different social actors involved in their creation. Instead, existing institutional arrangements are utilized (or dismantled) in efforts to make regional impacts legible as matters of social concern or risk (Barnett, 2001; Wildavsky, 1988). Regional downscaling is often performed by actors working at the global scale and received by actors working at the regional scale (Miller, 2004), pushing global institutions’ knowledge systems and the knowledge system needs of regional decision-makers into contestation. In MDC, disagreements around which projections to incorporate were connected to knowledge politics around what global and localized processes are relevant and pushed planners to adopt SLR rates that were socially acceptable to powerful local and regional actors. Such contestations can be shaped by political and financial pressures, rather than by best available science (Edwards, 2001), while also being constrained by gatekeeping organizations (Lejano et al., 2013) working between global and regional levels.

### 3.3. Scalar work 3: the creation of risks and vulnerabilities out of biophysical impacts

Articulating risks require translating biophysical impacts into operational and functional damage to regional and local SETS and communities (Adger et al., 2009), including potential loss of life, infrastructure disruption, and the destruction of property. The technical practice of risk translation relies on high precision models of localized impacts of anticipated events, yet in order to be robust, requires recognizing diverse knowledges around risk and vulnerability (Barnett, 2001; Dovers et al., 1996). However, decision-makers weigh potential risks against their own institutional priorities and knowledge (Short and Clark, 1992; Wisner et al., 2014), and can be influenced by powerful interests who can strategically exploit uncertainties to further their own agendas (Kelman, 2014; McCubbin et al., 2015), causing a loss of confidence in decision-makers who require public trust in order to be effective (Campbell, 1997; McCubbin et al., 2015). In MDC, for example, SLR risks are primarily understood as economic hazards to be managed by infrastructure investments.

### 3.4. Scalar work 4: SETs transformation through on the ground adaptation actions

The material impacts of SLR and climate change make SETs transformation inevitable. The legacy of SETs decisions significantly influences the trajectory of future SETs transformations, as the sunk costs of previous infrastructure choices impact future adaptation proposals and create infrastructural path dependencies (Grabowski et al., 2017). How individuals and institutions choose to anticipate or react to SLR requires coordinated social activity, and the addressing of past and current inequality in planning power, to adequately translate risks into material interventions to address SLR, requires moving from socio-political processes of planning and into the seemingly apolitical technical practices of SETs engineering and design. In MDC, for example, historical pathways favoring grey infrastructure systems for flood...
management are favored in a context where on-going land reclamation is considered possible. However, the politics still remain in these technical arenas as proposed and enacted material actions distribute risks, benefits, and costs differentially through the “hidden” work of project finance and design (Heynen et al., 2006), and in the consequences of uneven infrastructure development.

3.5. Scalar work 5: evaluation and certification of best practices for addressing risks

As urban SETs are transformed by SLR and adaptation, their success or failure of managing risk may be monitored and evaluated and scaled up to act as best practices and generalizable strategies within the other four scalar arenas. Mechanisms for evaluation are constrained by limited control comparisons for one-off or local projects, as exemplified in the PIs; procedural justice considerations; risk shifting (e.g. sea walls transferring risk to adjacent communities); and disregard of large-scale processes (e.g. the impacts of large scale construction projects on rates of climate change). However, as was the case in the PIs, the scale of these monitoring and evaluation procedures are often determined by programs and funding streams of national and international bodies (Denton, 2018). The push for adaptation that can be scaled-up as to act as best practices and generalizable strategies is often in tension with robust monitoring and evaluation programs, which consider contextual process and distributional concerns alongside assessments of the effectiveness of interventions and comparisons to global municipal peers (Holling and Meffe, 1996).

4. Conclusion

While KSA can provide critical insight into the knowledge system politics of adaptation decision-making, we argue here that this analysis is incomplete without thoroughly addressing the multiple scales at play within adaptation, an approach we refer to as scalar knowledge politics of risk. Using case studies in the PIs and MDC to guide our approach, we consider KSA imbued with a scalar politics of SLR risk framing to question the role of materiality, social construction, and political choice of scale in SLR adaptation science and planning. Viewing our case studies under a scalar understanding of KSA led us to develop a framework of five hypothesized arenas of scalar knowledge politics where knowledge systems challenges emerge: 1) the construction of the global climate; 2) the regional downscaling of climate impacts; 3) the local definition of risks; 4) the transformation of on-the-ground social-ecological-technical systems (SETS) and infrastructures; and, 5) the evaluation of intervention efficacy. We hope this framework can provide a guide for assessing the scalar knowledge politics of risk inherent in SLR adaptation. We encourage future work to further refine our organizing framework to better explicate the influence of the scalar knowledge politics of risk on our lives and planet.

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References

Climate Assessment. Island Press.
Miller, C., Munoz-Erickson, T., 2018. Designing knowledge. The Rightful Place of Science in 11 Consortium for Science, Policy & Outcomes, Tempe, AZ.