Community-based Adaptation through Ecological Design: Lessons from Negril, Jamaica. The Journal of Urban Design.

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Community-based adaptation through ecological design: lessons from Negril, Jamaica

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ABSTRACT
This paper identifies the conceptual similarities between ecological designs and ecosystem-based adaptations to climate change. The former includes approaches grounded in expert knowledge, such as landscape ecological urbanism, while the latter is rooted in local experiential knowledge and relies on community-based adaptations. This paper bridges these expert and experiential knowledge forms through a transactive planning model by deploying design charrettes in the context of Negril, Jamaica. The findings reveal that local people are aware of ecosystems and prefer ecologically sensitive adaptation interventions. This study concludes with planning and design recommendations for climate change adaptation in Negril.

Introduction

Global sea levels are expected to rise between 0.45 m to 0.82 m by the end of the twenty-first century (Field et al. 2014). Even with a minimum sea-level rise of 0.5 m, up to 38% of existing beach areas will be lost in the Caribbean region alone (Mimura et al. 2007), therefore placing coastal settlements, livelihoods and entire ecosystems at risk. Adaptations to these impacts occur at different spatial and temporal scales that range from hard-engineered solutions to soft ecologically-based ones, from top-down scientific models to bottom-up approaches involving community participation, and from short- to long-term interventions. Large-scale hard interventions have been particularly criticized for having indelible impacts on environments and ecosystems that would further reduce the resilience of coastal communities to climate change (Mycoo and Chadwick 2012). In contrast, ecosystem-based adaptation (EbA), increasingly favoured as providing no-or low-regret adaptation options, capitalizes on natural resources to increase the resilience of human communities in adapting to climate change, and simultaneously advocates the sustainable delivery of ecosystem-related services (Chatenoux and Wolf 2013). The links between EbA and urban design and planning, however, have been rare if not absent altogether, notwithstanding the fact that all the urban design projects that adopt an ecological design approach share similar themes with EbA. Therefore, this paper explores the potential links between EbA and ecological design,

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particularly through landscape urbanism, which is a notion that considers landscape and green spaces as the fundamental units of (urban) design.

Accordingly, this paper identifies the conceptual links between landscape urbanism and EbA, namely how they similarly advocate reversibility, biodegradability and sensitivity to the environment and ecosystems. In recent years, the landscape urbanism discourse has paid more attention to the challenges posed by climate change and to the possible adaptation strategies through ecologically sensitive design. For example, a recent exhibition titled 'Rising Currents' at the Museum of Modern Art (MoMA) displayed design proposals by five architectural teams who partook in an architects-in-residence programme at P.S.1 Contemporary Art Center (MoMA 2015). In particular, proposals, such as oyster-tecture[1] address sea-level rise, pollution and the degraded coastal habitat along New York's and New Jersey's coastlines through 'soft' infrastructure that prioritizes the ecology – an approach that is similar to EbA. Likewise, a multi-stage regional design competition, 'Rebuild by Design', which was organized by the US Housing and Urban Development (HUD) between 2013 and 2014 and funded by Rockefeller Foundation, addressed resilience for the regions affected by hurricane Sandy (HUD 2015). The competition underscored five aspects, namely: resilience, climate change, ecosystems, the transformation of cities and securing livelihoods. The winning proposals, e.g. by Big U, OMA and SCAPE, encompassed several ecological design strategies, including integrating berms and mashes to protect ocean surges, reef streets as live breakwaters to build ecological resilience and improving green infrastructure measures to reduce risks from flash floods (Rebuild by Design 2015). Interestingly, the operational guidelines of EbA, which often refer to 'soft' adaptation strategies, overlook the literature on urban design, landscape design, landscape ecological design and urban planning. However, these guidelines do emphasize public participation akin to the urban planning literature, especially that most EbA projects entail community-based adaptation (CBA) – a process that capitalizes on the experiential knowledge of local communities in adapting to climate change. In contrast, the landscape urbanism literature remains mostly grounded in the expert knowledge of landscape architects and has yet to consider public participation that had been established in the urban planning literature since the 1960s.

This paper builds on Friedman's transactive planning model to construct a theoretical framework that combines the experiential knowledge from CBA and EbA, the expert knowledge from landscape ecological urbanism, and the participatory methods of urban planning in order to address climate change adaptation in vulnerable coastal communities. The proposed approach deploys the design charrette, a participatory tool, to operationalize this framework in Negril, Jamaica, a coastal area vulnerable to sea-level rise. In exploring these multi-disciplinary theoretical and empirical links between EbA, CBA, landscape ecological urbanism and urban planning, this study builds on Frederick Steiner's (2014) recommendation for the development of an integrated approach to address climate change adaptation through design. In particular, this study addresses Steiner's (2014, 308) question: "how can concepts such as resilience and green infrastructure be advanced [to] design settlements to mitigate extreme weather events?"

The next sections introduce how CBA and EbA underscore tenets such as community participation, integration of local knowledge and capitalization of ecosystems – tenets that are then juxtaposed against the discourse on public participation in the urban planning and design literature. A discussion highlighting the links between CBA and EbA on the one hand, and ecological design and landscape urbanism on the other hand, is followed by the theoretical and methodological frameworks. This paper then discusses the study's findings and presents concluding remarks.

Community-based and ecosystem-based adaptation

Community-based adaptation (CBA)

Community-based adaptation (CBA) is an approach based on human rights and represents a new field in development and climate change studies. CBA refers to "a community-led process, based on communities' priorities, needs, knowledge, and capacities", whose objective is to "empower people to plan for and cope with the impacts of climate change" (Reid et al. 2009, 13). CBA involves governance, power structures, changes and uncertainty, while simultaneously considering issues of poverty, vulnerability and the inequitable distribution of and access to resources. Two key factors dominate CBA: *who* comprises a community and *where* this community is (Reid and Schipper 2014). *Who* refers to anyone or any group of individuals affected by the impacts of climate change and, hence, is working with or without external interventions to cope with these impacts. With regard to *place*, its scope determines the scale of a community and the extent of this community's vulnerability. CBA also identifies the adaptation priorities by relying on community-based and bottom-up tools. For example, the community-based vulnerability assessment (CBVA) developed by Smit and Wandel (2006) deploys the tools of CBA to identify and document the conditions and risks of communities, and any challenges related to adaptation approaches.

Emerging empirical research on CBA underscores aspects, including social capital and rising social awareness (Allen 2006; Plush 2009), livelihood options (Rashid and Khan 2013; Wang, Brown, and Agrawal 2013) and agriculture and food security (Bradshaw, Dolan, and Smit 2004). Although the Intergovernmental Panel on Climate Change (IPCC) (2014) touts the benefits of deploying CBA for urban development and disaster risk reduction, especially in small islands, thus far the empirical studies based in CBA exclude ecological design and the planning of built environments from their debates. Several CBA studies simply allude to the incorporation of this approach in the design of human settlements. For example, Moser and Stein's (2011) study in Kenya and Nicaragua engaged local stakeholders through urban participatory climate change adaptation appraisals. These appraisals differentiated between asset-based vulnerability and the identification of operational adaptation strategies. In doing so, this study deployed several data-collection tools, including a transect walk, focus groups and participatory mapping. Similarly, Gaillard and Maceda's (2009) study introduced three-dimensional participatory mapping using physical models to assess a community's vulnerability. Both studies built on CBVA through developing visual tools. One of the few studies delving into the planning and design of built environments that are adaptive to climate change is the one by Barron et al. (2012). This study modelled, visualized and then evaluated potential flood impacts and adaptation options for the community of Delta in Vancouver's Metropolitan Area. The research team created 'visioning packages', which consisted of two- and three-dimensional visualizations for different hydrological scenarios that presented the existing dike infrastructure breaching due to sea-level rise and storm surges as well as future adaptation strategies. Using qualitative and quantitative indicators, this study asked citizen groups to assess the performance, policy implications and social acceptability of the proposed strategies (Barron et al. 2012). This study commendably incorporated CBA

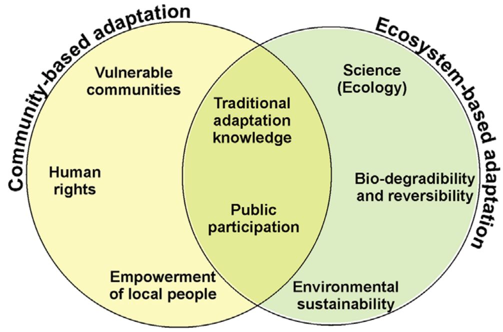

Figure 1. The relationship between CBA and EbA.

and public participation, but it overlooked the potential benefits of incorporating the ecosystem in the proposed strategies as they are laid out in ecosystem-based adaptation (EbA) and/or in ecological design approaches.

Ecosystem-based adaptation (EbA)

The Secretariat of the Convention on Biological Diversity (2009) defines EbA as "the sustainable use of biodiversity and ecosystem services into an overall adaptation strategy [that] can be cost-effective and generate social, economic and cultural co-benefits and contribute to the conservation of biodiversity". EbA research and practice typically include: (i) coastal defence through coastal vegetation maintenance and/or restoration; (ii) sustainable management of wetland floodplains; (iii) natural conservation and restoration of vegetation and forests; and/or (iv) healthy and diverse agro-forestry systems (Munroe et al. 2011). EbA ensures participatory decision making and flexible management at multiple geographical scales and combines the best available science and local experiential knowledge of CBA (Andrade et al. 2011). Perhaps that is why over 60% of EbA projects employ CBA initiatives (Doswald et al. 2014). Figure 1 summarizes the relationship between the different components of CBA and EbA. Like CBA, EbA is a relatively new concept, spearheaded by environmental and biological conservation experts who embrace multidisciplinary, participatory and culturally appropriate approaches (Andrade et al. 2011). Furthermore, EbA and CBA seem to be complementary; while EbA underscores reversibility and biodegradability simultaneously while increasing the resilience of ecosystems and humans, CBA identifies people and communities at risk and empowers them to take part in decision making (Girot, Ehrhart, and Oglethorpe 2012). Thus, EbA projects rely on local communities and ecosystems, and rank long-term, low-cost and no-regret adaptation interventions. For example, an EbA project financed by the German Ministry for Economic Cooperation and Development proposed multidisciplinary and context-specific ecosystem-based approaches in the Caribbean region (Chatenoux and Wolf 2013) that are in line with the IPCC's (2014) recommendations for small islands.

Indeed, EbA stands in stark contrast to hard engineering-based interventions that bear immediate and tangible outcomes, and which vary depending on the scale of the interventions. For example, large-scale interventions often involve irreversible engineered structures as protective measures that prevent nature from taking its course, such as seawalls, breakwaters and concrete groynes. Typically, these interventions entail a top-down decision-making process as opposed to EbA's inclusive and participatory one. Large-scale projects usually involve large-scale national and international contractors and/or foreign international donors, hence they rarely acknowledge local participation, let alone local technologies or skills (Wisner et al. 2004). Accordingly, they bear long-term impacts on ecosystems and on sustainable development (Girot, Ehrhart, and Oglethorpe 2012; Mycoo and Chadwick 2012). Conversely, small-scale hard engineered interventions, including gabion baskets, soil nailing, ripraps and surfaces covered with rocks or concrete blocks, are considered reversible. These small-scale interventions can be developed locally, permit natural ecosystem functions, and hold the potential to incorporate EbA approaches and thus may balance human and natural systems.

Moreover, EbA seems to parallel the approaches of ecological planning and design advocated by McHarg (1969) and Alexander (2002), which underscored the interconnection between nature, human-made interventions and human beings. Indeed, the notions of designing in harmony are not new, and historically humans have attempted to respond to environmental changes through the built environment. Design ideas, such as ecological fit (Ndubisi 1997), going with the natural flow and more from less (Ellin 2013), fluid exchanges between the human-made and natural interventions (Waldheim 2006a), are only a few examples that highlight this interconnection. These notions deploy ecological standards to assess the degree of interweaving among environmental, cultural and built systems. In particular, landscape urbanism that combines ecological and landscape design (Waldheim 2006b) integrates McHarg's ecological advocacy and Corner's urban design vision (Steiner 2011). Instead of focusing on urban form and function, landscape urbanism underscores the ecological process of landscape and green spaces as fundamental city development blocks that accommodate habitats, programmes and circulation both temporally and spatially (Waldheim 2006a). Moreover, by advocating indeterminism and flexibility, landscape urbanism actually addresses uncertainty, whether climatic or non-climatic. This open-ended planning and design is also known as the generative process (Hakim 2007) that incorporates the current needs while accommodating future changes and uncertainty. It is clear that the generative process of landscape urbanism signals theoretical links to EbA, although ecological design and landscape urbanism have yet to directly acknowledge climate change adaptation, EbA and CBA. Similarly, the climate change literature on adaptation, EbA and CBA fails to establish any links to any design disciplines. Finally, and notwithstanding how landscape urbanism eliminates the isolation of the ecosystems from the human systems, it also overlooks the participatory component of design.

Participatory planning and design

Public participation

The debates on participatory planning emerged in academic writings in the 1960s among various reactions against rational comprehensive planning as an expert-based and goal-oriented approach (Filion, Shipley, and Te 2007). For example, Davidoff's (1965, 332) advocacy planning underscored social justice, whereby in a bureaucratic society "great care must be taken that choices remain in the area of public view and participation". Advocacy planning also contributed to implementing the principles of social justice while challenging neutral objectivity in dealing with social problems (Hudson, Galloway, and Kaufman 1979). In solving such problems, planners often rely on knowledge through consistency of observation, logic and theoretical coherence (Friedmann 1973, 1993). John Friedmann (1973) considered the planners' professional knowledge as 'processed' and referred to it as 'expert knowledge'. He simultaneously emphasized the 'personal' or 'experiential knowledge' of the constituencies that the planners serve whereby such knowledge reflects these constituencies' experiences of problem solving. According to Friedmann, the experiential knowledge is richer in content than the expert knowledge as it reflects the daily life experiences, although it is less systematized and generalizable than the expert knowledge. In contrast to centred and comprehensive planning, Friedmann (1993) emphasized context-specific and situation-based planning and thus proposed transactive planning that combines both the expert and the experiential knowledge (Friedmann 1973). This model underscores the mutual benefits of information exchange in terms of public interest (Filion, Shipley, and Te 2007) and is often grounded in direct participation (Hudson 1979). Indeed, Fainstein (2012) asserts that good planning should simultaneously serve public interests and be guided by experts.

Therefore, the bridging of the two types of knowledge surely advances the planning process and increases its probability of achieving its objectives. The design charrette is one of the tools for bridging the experiential and the expert knowledge. A participatory tool that is borrowed from the design disciplines, the charrette holds the potential to operationalize the transactive planning model by providing a venue for combining the experts' professional knowledge and the locals' experiential knowledge.

Design charrettes

Design charrettes consist of intensive and time-constrained participatory design activities. Design experts typically serve as facilitators and work with participants representing the various sub-communities to collectively propose a vision for the community at hand (Girling 2006). Design charrettes underscore both process and outcome, hence they incorporate three chronological stages: idea generation, decision making and problem solving (Sanoff 2000). Each stage involves a series of interactive discussions (dialogue) and design (or drawing) activities. The planning experts' role becomes that of 'skilled counsellors', as in collaborative planning, in order to ensure that the process works "with rather than for" the communities (Godschalk and Mills 1966, 86).

Therefore, this study considers the design charrette as a method of community-based planning and design that provides a common platform for mediating and negotiating between Friedmann's (1993) experiential and expert knowledge. Furthermore, and akin to Godschalk and Mill's (1966) collaborative planning, the design charrette empowers the local communities to present their needs, discusses their interests, and identifies their future choices for climate change adaptation. This study maintains that the design charrette simulates and actualizes the 'mutual self-discovery' of transactive planning through dialogue and design activities, thereby expanding and discovering participant knowledge (Friedmann 1973).

Many recommend diverse expertise and backgrounds among participants of environment-oriented charrettes in particular, in order to ensure outcomes that better address the interdisciplinary challenges at hand (Sutton and Kemp 2006). This approach particularly resonates with issues related to climate change adaptation. Furthermore, through empowering communities, the process of mutual self-discovery can be associated with CBA and EbA

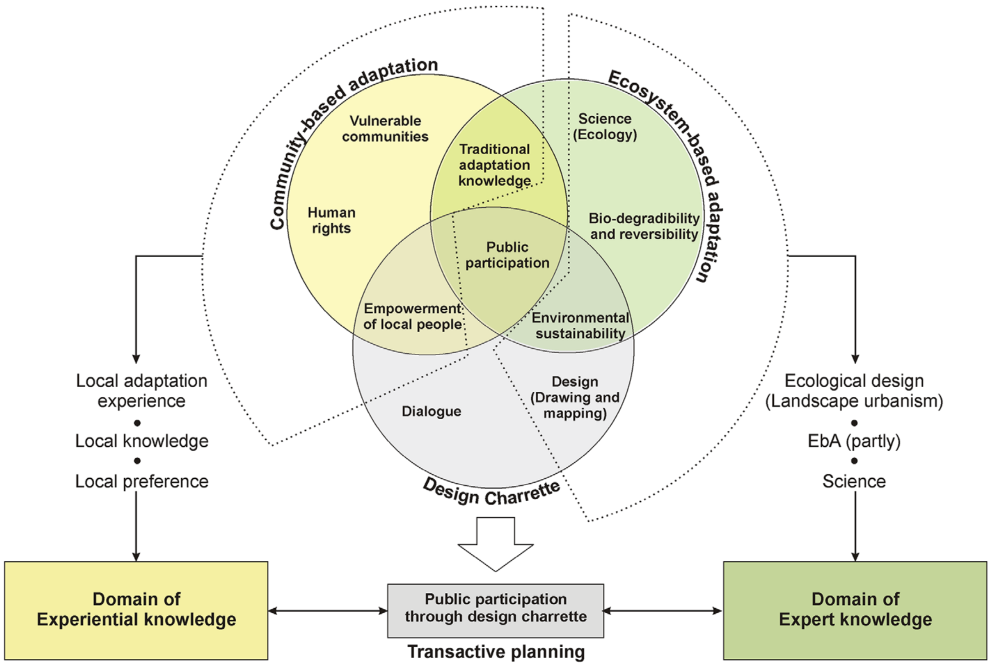

Figure 2. The design charrette as a transactive model and its links to EbA and CBA.

to assist communities to explore various adaptation strategies and identify preferred ones. Figure 2 reveals how participation, the key tenet of this process, establishes the conceptual link between the design charrette, EbA and CBA, and how design charrettes can perform as a tool of transactive planning vis-à-vis climate change adaptation. Thus, design charrettes hold the potential to incorporate transactive and collaborative planning, and to integrate expert knowledge and local experience while maintaining the significance of the planners' role.

The theoretical and conceptual frameworks

Ecological design theories underscore the interventions that integrate environmental and human systems. Such integration theoretically promotes environmental sustainability while simultaneously enabling a system (primarily an environmental system) to cope with environmental change and uncertainty. Similarly, EbA combines science and local experience and incorporates ecology and climate change to identify local natural species – humans excluded – that could potentially adapt to particular climatic impacts of any given area. Based on this scientific foundation, EbA prioritizes small-scale engineering interventions while simultaneously advocating no-regret and reversible strategies that are sensible to the environment and that generate co-benefits. While these principles are in line with ecological design strategies, including landscape urbanism, EbA differs by incorporating local experience, or Friedmann's (1993) experiential knowledge, as an integral component of human systems. Therefore, EbA deploys CBA to identify local expert knowledge and local experiential knowledge that collectively demonstrates vulnerabilities and strengths of local ecosystems, as well as local adaptation experiences and preferences. Accordingly, EbA represents a departure from landscape urbanism's reliance solely on what Friedmann identified as the realm of experts' knowledge –their opinions and on science – to determine the best design options. Furthermore, while landscape urbanism's interventions rely on spatially grounded designs, EbA's interventions can be framed more as courses of action that can potentially integrate spatially grounded designs. Both approaches underscore similar theoretical/conceptual principles and strategies for enhancing an environment's ability to cope with uncertainty.

Building on these theoretical links, this research utilizes design charrettes with local experts and local communities as a spatially grounded application of CBA. As a participatory tool that offers a platform for dialogue and debate, the design charrette empowers local communities to voice their opinions and identify their choices (Arnstein 1969), and thus complies with the key tenets of CBA. Simultaneously, the tool conforms to Friedmann's transactive planning model by providing a venue that combines both expert and experiential knowledge (Figure 2).

The next section discusses how design charrettes were deployed in this research to operationalize the transactive model while combining EbA and CBA with ecological design.

The research method

To integrate expert and experiential knowledge while ensuring public participation, this study adopted a participatory action research (PAR) approach. PAR ensures active participation of the study community throughout the research process and to pursue solutions to concrete problems (Whyte, Greenwood, and Lazes 1991). In doing so, this study adopted case study research design to investigate the local communities' awareness of Negril's vulnerability to climate change and their knowledge of adaptation. A contemporary case study, where researchers have little control over events, provides a distinct advantage for collecting and analyzing empirical evidence (Yin 1989). In investigating Negril, the research questions 'what' climatic risks occur and 'how' the community adapts to the risks lent PAR malleably to range from an explorative investigation to an explanatory (or descriptive) one.

This research project constituted three major phases: pre-fieldwork, fieldwork and post-fieldwork. The pre-fieldwork phase, between January and May 2014, concentrated on collecting secondary data, including maps, peer-reviewed publications, newspaper articles and government reports, and establishing contacts with local institutions and agencies, including the University of the West Indies (UWI), Mona Campus; Negril area Environmental Protection Trust (NEPT), Jamaica; and CaribSave, a Caribbean regional not-for-profit organization. In addition to secondary data sources, these institutions provided local networking and resources, including three graduate students from UWI who partook in the fieldwork. These secondary data informed the design of the subsequent fieldwork phase, which took place in Negril between 29 May and 8 June 2014. The fieldwork facilitated primary data collection through design charrettes, survey questionnaires, GPS and field observations.

First, two day-long design charrettes were held in Negril, the first in a local conference hall, with planners, policy makers and local activists, who collectively influenced policy formation and who shared their 'expert knowledge'. Of these experts, 17 of 39 were invited through email, phone and CaribSave to participate in the first charrette. The second was held three days later in a public community centre, with members of various local communities invited through posters, leaflets, personal communication and CaribSave. Twenty local people participated, including housewives, musicians and fishermen. Each charrette's focus and invitation methods differed, meaning there was no participant overlap.

According to Lennertz, Lutzenhiser, and Failor (2008), charrettes consist of pre-charrette, charrette and post-charrette events (Figure 3). Here, the pre-charrette included groundwork, preparation and charrette introduction – including charrette objectives, study areas and maps, and participant roles – followed by separating participants into three to four six-to-eight member groups reflecting diverse backgrounds. The researchers shared no specific evidence collected pre-fieldwork with participants to ensure bias-free discussion. Ice-breaking activities, such as pointing out participants' homes on maps, and sketching and sharing how they experience Negril, helped familiarized everyone with the project and one another, thus, ensuring their engagement and effective contribution. The second phase represented the major exercise for stimulating mutual self-discovery of Friedman's transactive model to gather, cross-reference and share information about CBA and EbA. Three to four researchers facilitated each group's discussion, including at least one from UWI, whose presence demonstrated sensitivity towards local socio-cultural values, establishing rapport with locals and constructive dialogue. To ensure internal validity, each group followed the same structure, deployed the same tools, and was guided by the same topics: the major threats posed by climate change, local coping strategies and possible adaptive strategies. The post-charrette event included managing and synthesizing information and disseminating results to participants.

Second, questionnaires surveyed local inhabitants' and international tourists' adaptation preferences for Negril's future planning and design. Questions were based on the IPCC's (Dronkers et al. 1990) three basic coastal adaptation strategies: retreat, accommodation and protection.[2] Respondents were provided with two design options for each of the latter two, one hard engineering-based and the other soft ecosystem-based (see Appendix A1, A2 and A3 in the online supplemental files at http://dx.doi.org/10.1080/13574809.2015.1133224). Retreat had one choice: coastal set-back. Thus, respondents were offered five options (i.e. retreat, accommodation – hard and soft, and protection – hard and soft) and asked to rank

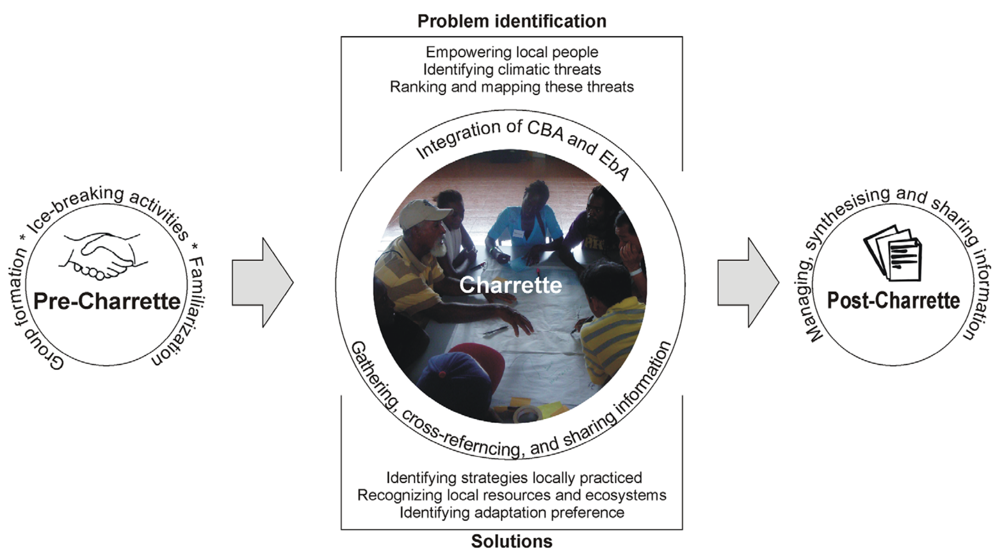

Figure 3. The design charrette process and its application in this study.

their preferences. In total, 151 questionnaires were conducted in person (i.e. $N = 151$), 97 with locals and 54 with tourists, at different times and locations, including the downtown, streets, beaches, villages and the charrette venues. Overall, respondents were generous, providing a wealth of qualitative comments about adaptation strategies.

Third, devices, including GPS and measuring tapes, were used to collect data for 19 sections along Long Bay (from north to south), identified in the literature as Negril's most vulnerable area. Long Bay is generally low-lying, but its elevation slightly varies, making some parts, including buildings, more vulnerable to sea-level rise, flood-surge and flash flood. Thus, for each section, several data points (from west to east), such as the high-water mark, building edges and the highway, were set to measure their distances from the high-water mark and elevations relative to their mark. To avoid instrument errors, three different GPS devices were simultaneously used for each data point.

Finally, photography documented direct observations of the landscapes, buildings, infrastructure and ecosystems of the Negril area. This research entailed dividing the study area into segments, walking along each segment, and photo-documenting it while taking detailed notes along the way.

Data management and analysis

The design charrettes yielded the study's largest and most significant data which were organized by several data collection and management strategies, including layered maps and information, flip charts, post-it notes and colour coding. First, each group used a standard base map, which was layered and topped with sequentially numbered trace-paper sheets as required. Colour coding was kept consistent along all media. For example, red consistently represented major climatic threats, whether on a map, chart or post-it note. Immediately after each charrette, the visual data were transcribed into diagrams using relevant software (e.g. Adobe Illustrator, ArcGIS and AutoCAD), while the textual data from the flip charts, post-it notes and discussion notes were transcribed into text. To transcribe the visual data and support data analysis, a uniform and simplified graphical language was used to standardize charrette outcomes. Significant amounts and different types of qualitative charrette data from each layer were then analyzed using visual transcriptions, layered maps and symbols portraying vulnerabilities and solutions. Finally, the data obtained through the survey questionnaires and the GPS surveys were organized into spreadsheets. Simple statistical methods were used to analyze the survey data to compare preferences among different adaptation options and between locals and tourists. GPS data were processed through GIS to obtain and analyze the different section elevations.

Negril, the case study

This study's participatory approach investigates Negril's climatic risks and the local adaptation responses – an approach that renders this investigation an exploratory case study with an explanatory component to it (Yin 1989, 2011). Among the most popular Caribbean tourism destinations, Negril, located on Jamaica north-west coast, has been designated the Negril Environmental Protection Area and Marine Park. Negril is Jamaica's third largest tourist resort after Ocho Rios and Montego Bay, but generates more income than either of them (Otuokon 2001). Jamaica's economy relies heavily on tourism, and Negril's tourism industry alone contributes approximately 5.5% to the national GDP (UNEP 2010). Nevertheless, like other Caribbean coastal-regions, Negril is at risk, particularly to beach erosion. Estimates forecast that only 1 m of sea-level rise would fully or partially damage 29% of Caribbean coastal resort developments of which nearly 55% are under threat of beach erosion (Scott, Simpson, and Sim 2012).

These estimates are troubling, especially given that over 50% of the Caribbean's population resides within 1.5 km from the shoreline (Mimura et al. 2007) and nearly 82% of Jamaica's population in particular resides in coastal settlements (Ishemo 2009). Thus, Negril's coastal communities and tourism infrastructure are highly vulnerable to sea-level rise and any associated impacts.

Negril's vulnerability and adaptation options

Negril's most dense and vulnerable built-up area is Long Bay, situated on a narrow strip along a 7 mile beach, and defined by the sea and the Great Morass (Figure 4). This morass covers over 5500 acres and accounts for 20% of Jamaican wetlands. It is a major resource of herbaceous marchlands, swamp, mangrove and other lowland forest. In addition, it protects a number of species and local ecosystems (Town and Country Planning Development Order 2013). The built environments, the morass and the entire ecosystem are highly exposed to coastal inundation and sea-level rise. This study pays particular attention to Long Bay and considers the entire ecosystem of Negril. Using primary data, the following sections discuss the different climatic threats and preferred adaptation practices for Negril, before concluding with design and policy recommendations.

Threats to Negril

Beach erosion is considered a natural phenomenon; however, the charrette discussions revealed that Negril's sand production is low, partially because of damaged ecosystems, particularly seagrass. These conditions help identify beach erosion as a major threat (Figure 5a). Over the past 30 years, the average rate of erosion has been 1–2 m per year (Veira 2014). According to Robinson et al. (2012), if this rate continues, and combines with an anticipated sea-level rise, 6–10 m beach erosion will occur by 2030 and 12–21 m by 2050.

Long Bay, a low lying region, has been experiencing relatively higher rates of erosion than neighbouring areas. Many charrette participants identified the middle to north of Long Bay as more vulnerable; however, others considered the entire area vulnerable (Figure 5b). GPS data also revealed that vulnerability varies spatially across Long Bay due to differences in elevation and slope. Accordingly, four zones (A, B, C and D) were identified along Long Bay (Figure 6). Zone A represents scenarios when the highway, Norman Manley Boulevard, lies at the same or lower elevation than the current high-water mark (the point of reference). B represents where the highway lies 0–2.5 m higher than the point. Similarly, C and D represent scenarios where the highway is positioned at least 2.5–5 m, and over 5 m, respectively, above the reference point. To assess and compare the vulnerability of these zones, this research juxtaposes these scenarios with 2100 estimations of sea-level rise and storm surges, such as the IPCC's (Mimura et al. 2007), Jevrejeva, Moore, and Grinsted's (2010) and Vermeer and Rahmstorf's (2009), as well as recent experiences of local people. Findings reveal that areas in zone A will be submerged with even 0.58 cm sea-level rise, while D is relatively safe

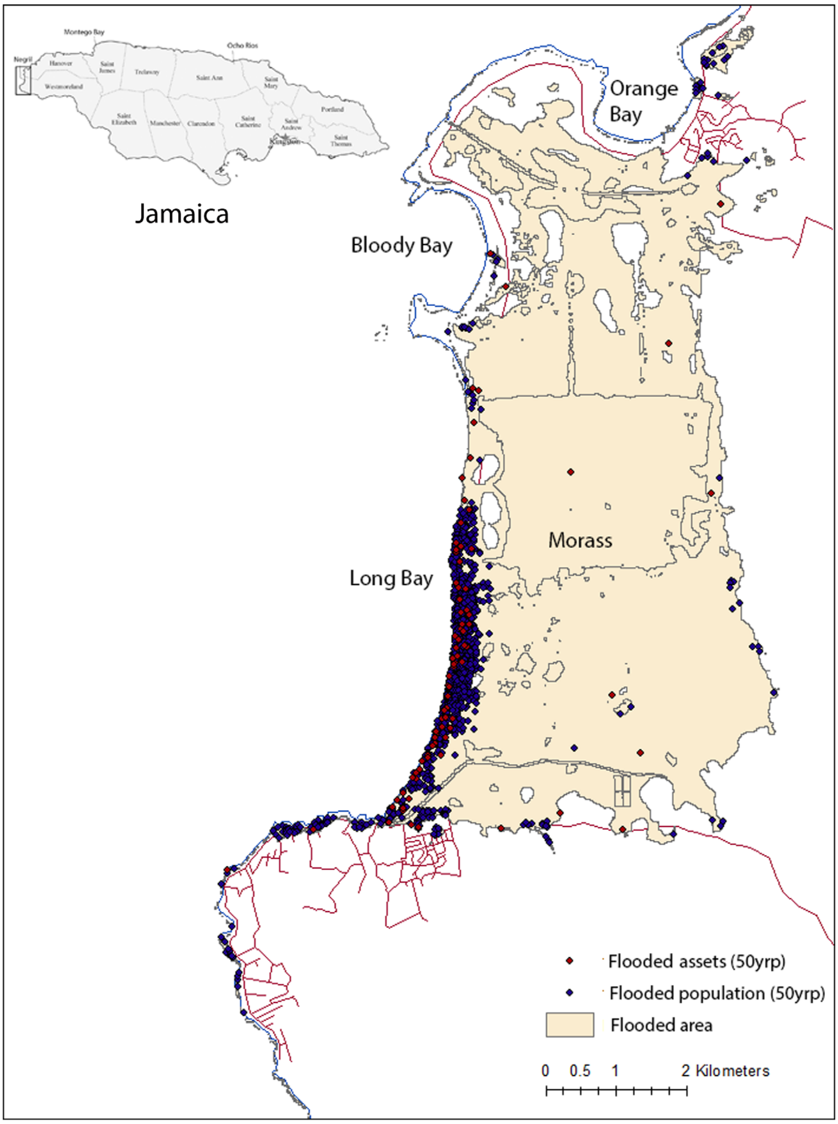

Figure 4. Long Bay and its linear pattern of coastal development.
Source: RiVAMP.

compared to others (Figure 7). Northern parts of Long Bay (zone A, the area near the hotel, Beaches) are particularly vulnerable, and include identified hot-spots that have historically lost beach cover and are inundation-prone when direct rainfall combines with sea-level changes (Robinson et al. 2012; Wilson et al. 2014).

In addition to beach erosion, the charrette exercises identified degradation of reefs, seagrass and mangroves, water scarcity in dry seasons, poor waste management, and flash flooding and runoff as secondary threats. During charrettes, local people shared their experiences of extreme flash flooding due to heavy rain in 2010 that inundated the entire Negril area for 10 days. Local professionals and environmentalists blamed anthropogenic actions, such

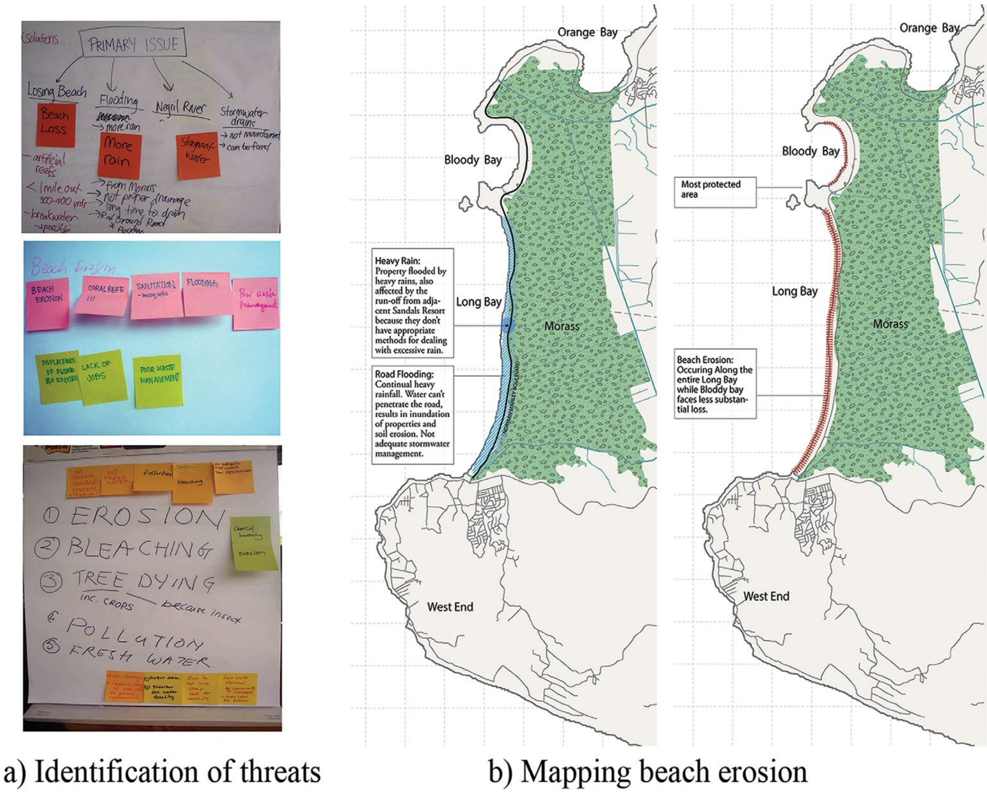

Figure 5. Beach erosion, the key threat to Long Bay.

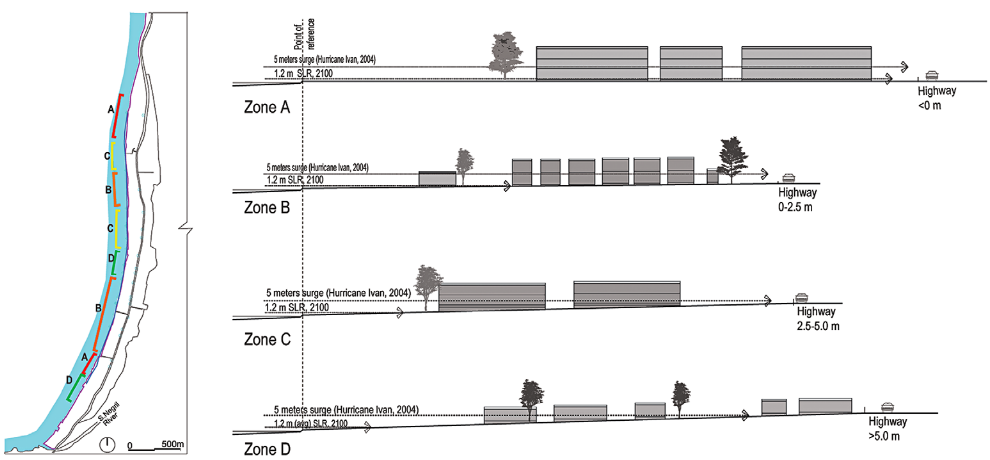

Figure 6. The four vulnerable zones at Long Bay.

as water pollution and poor waste management, which are indirectly affecting coral reefs, seagrass and ecosystems. For example, damage to coral reefs increases wave energy and beach erosion. Charrette participants also agreed with what the Negril area Environmental

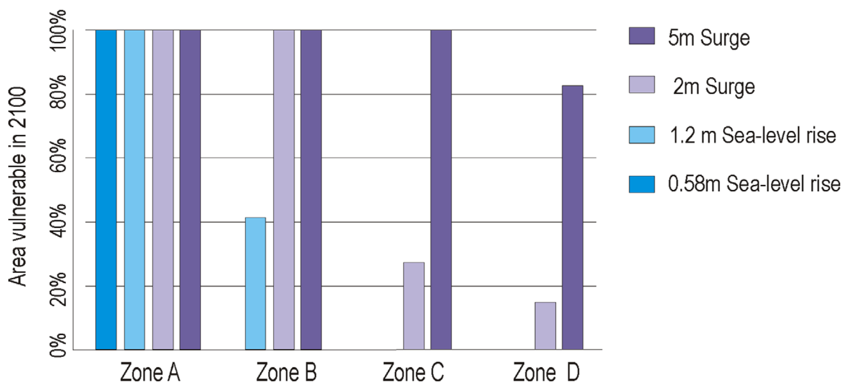

Figure 7. The degree of vulnerability at different zones.

Protection Trust (2010) concluded – the morass is slowly drying out, resulting in the loss of its basic functions, including flood alleviation and filtering of nutrients and chemicals. Furthermore, the overuse of resources, illegal farming in the morass and deforestation are also increasing vulnerability of Negril's ecosystems.

Observation and GPS data revealed that buildings along Long Bay are also exposed to climate change because of their proximity to the sea. For example, the permanent structures of the Hotel Lazy Days are located only 10 m from the high-water mark, far short of the 45.75 m legal minimum coastal setback. Apart from setback regulations, many buildings in Long Bay rarely follow the standards for flood and surge prone areas set by the Office of Disaster Preparedness and Emergency Management, Jamaica (ODPEM 2015). Typical coastal settlements in the Caribbean, including Jamaica, hardly follow planning and land use guidelines (Lewsey, Cid, and Kruse 2004; Ishemo 2009). Overall lack of awareness of the implementation of planning guidelines elevates vulnerability.

Local adaptation strategies and preference

The design charrettes and observation revealed that Negril has adopted various proactive adaptation strategies, ranging from individual to regional projects, to reduce beach erosion. Examples at the project scale include coral reef restoration (by Sandals Resorts), the use of sand bags and gabion baskets (by Hotel Lazy Days), and increasing vegetation such as coconut trees (by Charela Inn Hotel) (Figure 8). At the community scale, Orange Bay, a fishing village that has experienced over 12 m erosion in recent decades, has been restoring mangroves to reduce impact through CBA (Figure 9).

An example of a regional scale project includes a proposal for off-shore submerged breakwaters, 3600 m in length, a highly engineered and top-down planned adaptation strategy for Long Bay. Mondon and Warner's (2012) study confirmed how effectively the breakwaters would imitate nature in reducing erosion. The project exemplifies a centralized planning initiative that will be near-impossible to revise once implemented. Participants, particularly in the first charrette, raised strong opposition to the proposal due to its irreversibility and potential impacts on Negril's environment, marine ecosystems and tourism development. Local media, such as Serju (2014), also reported this perspective; however, the government

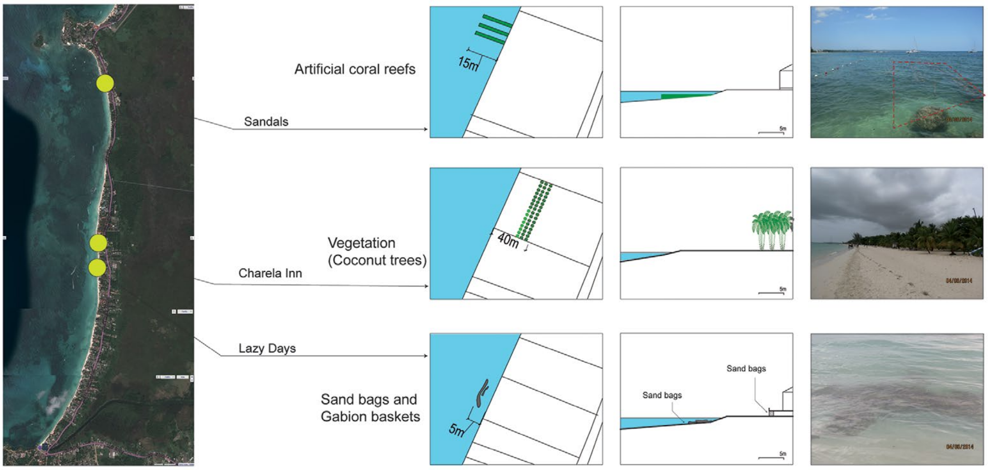

Figure 8. Local adaptation strategies along Long Bay.

Figure 9. Mangrove restoration, a CBA approach in Orange Bay.

is still pressing for approving and implementing the project (Saunders 2015). At the same scale, for managing inland flood and storm water, soft infrastructural measures, including vegetated ditches and drains, are employed along the highway. The existing ditches mostly along southern Long Bay have adequate depth and width; however, in the vulnerable north and middle sections, ditch continuity and uniformity are often disrupted. Improving eco-infrastructure integrated with new and existing ditches is important to reduce the vulnerability of these sections to heavy rain and flood.

Survey questionnaire results reflect an overall preference for soft adaptation strategies (Figure 10a, 10b). Specifically, for Long Bay, locals preferred soft protection and retreat strategies, while tourists preferred soft accommodation and retreat strategies. Referring to soft interventions by neighbouring countries such as Cuba, charrette participants discussed beach nourishment because it would provide additional room to adjust current setback deficiencies. In fact, there is insufficient room for future development on either side of the

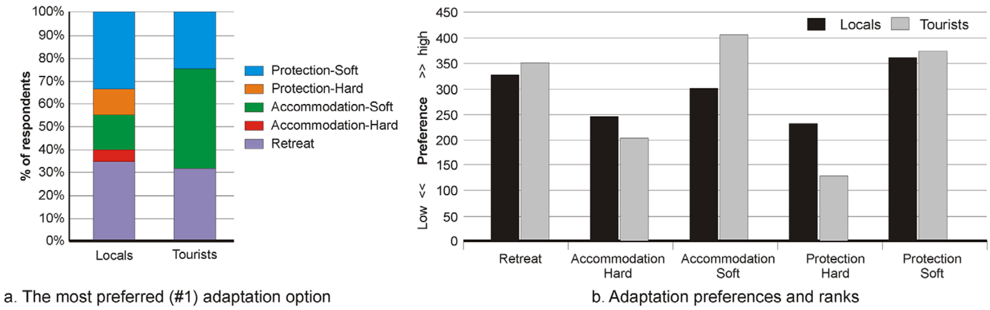

Figure 10. The adaptation preferences of the locals and the tourists in Negril.

Figure 11. An abandoned tourist centre in the Great Morass near Royal Palm Reserve Park.

highway; however, approximately 77% of locals and 44% of tourists still prefer retreat as a feasible option for Long Bay. In addition, respondents' qualitative comments and charrette discussions reveal that it is too late for retreat; however, increasing density of development away from the coast as much as possible could work. In fact, this proposal for densification and intensification along Long Bay is similar to Robinson et al.'s (2012) suggestion. Participants strongly opposed large-scale hard engineering and centralized interventions, due to their possible negative impacts on local ecosystems, as discussed by Mycoo and Chadwick (2012) in Barbados. Conversely, locals preferred decentralized systems that are easy to build and maintain, and use local resources, thus integrating CBA and EbA. For example, the resort Rock House uses solar panels as an alternative and decentralized energy source that can still run if the central system fails. Rainwater harvesting at the household level, as one charrette participant already practises, can also meet water demands in dry seasons, bypassing the central supply.

This empirical evidence exhibits preferences for soft adaptation or EbA interventions including small-scale engineering interventions whether through government, CBA or individual attempts, due to their reversibility and their minimal environmental impact. Both locals and tourists are sensitive to the need to preserve the environment and the local ecosystems while enhancing tourism development and the local economy. As beach tourism is becoming increasingly challenging due to sea-level rise, charrette discussions highlighted alternative tourism (eco-tourism) to support local livelihoods. For example, Negril's Royal Palm Reserve

Park and the morass itself used to serve tourists for many years, but the lack of integrated planning and infrastructure currently hinders alternative exploration. Figure 11 shows an abandoned tourist centre in the morass. The Town and Country Planning Provisional Order (2013) for Negril also promotes eco-tourism and man-made historic features while restricting further development on the protected morass and maintaining healthy environment and ecosystems. However, the Order omits local adaptation strategies, particularly EbA, now being practised.

Possibilities and opportunities

The findings parallel arguments posed by ecological design (e.g. landscape urbanism), EbA and CBA while ensuring effective public participation through the transactive planning tool, design charrettes. Based on these findings, the following recommendations are intended to inform future planning and design for Negril's built environments in the age of climate change.

1. *Integrated coastal adaptations strategies* are essential to reduce Long Bay's beach erosion. These strategies seek to enhance natural adaptive capacity by rejuvenating marine ecosystems through long-term EbA. Restoration of coral reefs, mangroves and sea grass might be prioritized. Set-back regulations, beach nourishment and/or combined with low-impact hard protection measures can be considered.
2. *Situation-specific land use planning* could minimize secondary threats, such as water pollution, that severely impact Long Bay when combined with climate change. Specifically, land use planning could control anthropogenic activities along the South Negril River (e.g. repairing of fishing boats) and around the morass (e.g. illegal farming) to reduce run-off pollutants, such as oil and fertilizers/chemicals, that ultimately impact marine ecosystems.
3. *Bio-degradable and reversible adaptations* are locally preferable and are advocated by landscape urbanism and EbA. Reversible and adaptable strategies promote efficient resources use, an important consideration given the uncertainty of climatic data.
4. *Landscape as eco-infrastructure* can preserve ecosystems and thus, facilitate EbA. Negril's physical infrastructure, for example, could incorporate new ditch or bioswell designs, according to the different vulnerable zones (Figure 6), along the highway integrated with existing ditches to reduce surface runoff and pollutants from entering the sea.
5. *Decentralized systems* can reduce climatic impacts during emergencies. These systems might include cluster-based and modular systems of built environment and infrastructure design, for example, the decentralized power system by Rock House.
6. *Eco-tourism* could provide economic activities additional to existing beach tourism. Negril hosts protected wetlands and marine parks and is in a good position to promote eco-tourism, as the Town and Country Planning Order for Negril has advocated.

Conclusion

Unplanned interventions and climate change are affecting the interconnection between environmental and human systems at different scales. Locals and tourists are aware of this interconnection and socio-culture values that distinguish Negril as unique and distinct from neighbouring tourism destinations (e.g. Cancun's high-rise resort development). Every area is unique in terms of its exposures to climate change and indigenous adaptation strategies using local experiences and ecosystems. The major objectives of EbA and CBA are to offer adaptation interventions that are culturally and environmentally appropriate. In addition, landscape urbanism holds the potential to promote context-specific design but does not necessarily incorporate experiential knowledge. Including EbA incorporates human experience in landscape urbanism while advancing proactive adaptation through ecological design.

The planning and design of costal developments and infrastructure in small island developing states such as Jamaica should utilize local resources in ways that are reversible and sensitive to local ecosystems and that can pre-emptively adapt to climatic change. This proactive adaptation requires an integration of inputs from different professionals – planners, environmentalists and climate change experts – and the nuanced knowledge and experience of locals. A design charrette, as a transactive planning model, incorporates local experiential knowledge through bridging EbA and CBA. Thus, the model can be applied to identify and recognize locally appropriate and preferred responses (particularly design responses) to climate change. Although the recommendations made here are site-and context-specific, their underlying concepts, including reversibility, modularity and eco-infrastructure, can be applied to other coastal areas once the input of local communities is obtained. The model can be further used to effectively apply the concepts to a particular context, not only allowing stakeholders' such input and defining the ecological design strategies, but also helping policy makers govern them. Synthesis of expert and experiential knowledge is essential to integrating CBA, EbA and ecological design while advancing landscape urbanism to link to climate change adaptation. The design charrette is a worthy tool in achieving these objectives.

Notes

1. Oyster-tecture, a proposal by Kate Orff (a landscape architect at SCAPE), acknowledges the complex biochemical and ecological process within urban ground around Brooklyn's Red Hook and Gowanus Canal. The project aims to nurture an oyster culture to deal with the issues of water quality, rising tides and community-based development (see TED 2010).
2. *Retreat* involves no effort to protect the land from the sea. The coastal zone is abandoned and ecosystems shift landward. *Accommodation* implies that people continue to use the land at risk but do not attempt to prevent the land from being flooded. *Protection* involves hard structures such as sea walls and dikes, as well as soft solutions such as dunes and vegetation, to protect the land from the sea so that existing land uses can continue (Dronkers et al. 1990, iv).

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