URBAN VULNERABILITY IN SOUTHEAST ASIA

Summary of Vulnerability Assessments in Mekong-Building Climate Resilience in Asian Cities (M-BRACE)

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Summary of Vulnerability Assessments in Mekong-Building Climate Resilience in Asian Cities (M-BRACE)

1. OVERVIEW

LAO CAI
Tho Nguyen, ISET-Vietnam, 2014

1.1 Introduction

This report documents the process and findings of a series of participatory Vulnerability Assessments (VAs) undertaken as part of the Mekong-Building Climate Resilience in Asian Cities (M-BRACE) program. M-BRACE is a four-year collaboration to strengthen the capacity of city stakeholders to assess changing patterns of vulnerability that arise out of the combined influences of urbanization and climate change; and to put in place the institutional processes that would allow city stakeholders to deal with future uncertainties and risks. M-BRACE is funded by the United States Agency for International Development and implemented by the Institute for Social and Environmental Transition (ISET-International) in partnership with the Thailand Environment Institute (TEI) and the Vietnam National Institute for Science and Technology Policy and Strategy Studies (NISTPASS). The program works with four cities in the Mekong region—Udon Thani and Phuket, Thailand and Hue and Lao Cai, Vietnam—that are all experiencing rapid urban growth and are exposed to climate change impacts. Urbanization and climate change represent the most important global transformations of our age. In the Mekong region they are unfolding at a pace and scale never previously witnessed. Yet even so, the significance of urbanization, and the regional drivers that underpin this transformation, have not been adequately addressed in policy and practice at ether national or local levels.

The global trends in urbanization are now well established. According to the United Nations, the total global population residing in urban areas reached 3.6 billion or around 52% of the total population in 2011. This figure is expected to almost double by the year 2050 to around 6.3 billion. This would mean that in a little over 30 years the total urban population of the world will be the same in absolute terms as the current total global population[1]. Urbanization and the associated shifts away from a largely agricultural economy to one that is shaped by the growth of industrial, manufacturing and services sectors, are regarded as essential features of national economic growth. Urbanization is thus encouraged in various forms and is supported by investment flows, although often without a clear vision of an urban future.

Urbanization is also intimately linked with global climate change, and the consequences of the finite nature of our ecological resources. Urbanization and associated land use change and industrialization contribute directly to greenhouse gas emissions both locally and globally. Changes in land use that accompany urbanization alter natural hydrology, often exacerbating flood risks. At the same time, urbanization occurs in areas that are already hazardous, locating social and economic assets in places exposed to climate change impacts. With a greater concentration of people and assets in vulnerable space, the impacts and consequences of climate change-related impacts are likely to become all the more severe, with the effects cascading well beyond the geographical location of a specific climate event.

Many of the larger urban areas in Asia are frequently identified as being especially vulnerable to climate change. However, it is the secondary towns and cities that are now rapidly growing which will experience some of the most significant climate-related shocks and crises. The urban area within each of the cities under the M-BRACE program is growing at a dramatic rate. These and other rapidly growing secondary towns are linked to regional transport and communication networks, which help fuel greater regional economic integration. Urbanization in the Mekong region thus represents a move away from an exclusively rural and agricultural economy and therefore a shift in built environment, ecological and economic landscapes, as well as livelihoods, occupations and quality of life. Resilience, and more specifically urban climate change resilience, seeks to understand how cities can cope with and respond to change and then develop tools and techniques to help cities do likewise.

M-BRACE has taken a systems approach to understanding urbanization. From this perspective, urbanization is characterized by a dependence on increasingly complex, multi-scale and interlinked systems, such as water, food, energy, transport and communication. The systems bring together ecologies and physical infrastructure, the agents who access, use or manage them in some way and the institutions that shape their management, and the distribution of access and benefits. These systems, as well as the processes of urbanization and climate change, are dynamic. Thus, understanding the impacts of climate change and resilience requires understanding of the systems that are experiencing change, the nature of the processes driving change and how they all interact. In complex socio-environmental systems, such as cities, this requires looking at impacts across the whole system, rather than

1 Figures downloaded from the website of the UN Department of Economic and Social Affairs: http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

just at parts of the system. It is also critical to understand not only the physical impacts of change, but also the impacts on the people, organizations and institutions that make the city function.

Urban resilience, then, relies not only on the ability to anticipate or respond to specific, expected disturbance, but also on the ability for physical systems, agents and institutions to respond to a wide range of changes and conditions. Institutions, in particular, need to be adaptive, learning-oriented and able to access and generate new knowledge as conditions change. Agents, of all types, need to be able to access and utilize information in their own work and roles. Resilient cities will thus enable processes of collaboration and social learning where different types of knowledge and information are synthesized in order to produce solutions that more effectively address the core challenges of all stakeholders.

M-BRACE has developed a process for building resilience that builds on the learning from an earlier initiative that the core partners were involved in – The Asian Cities Climate Change Resilience Network (ACCCRN). Within M-BRACE cities conducted a vulnerability assessment, identified opportunities for modifying, changing or creating new policy to better address issues of urban growth and climate change, and implemented intervention projects to start building resilience. Based on learning from ACCCRN, all of these steps in the process focused more heavily on institutional and agent-based approaches that would build the systems and capacity to manage growth and development that are more resilient. The Climate Resilience Framework (Figure 1), developed by ISET, outlines the linkages between systems, agents and institutions within processes to understand vulnerability and build resilience.

The VAs conducted in each city within M-BRACE reflect these principles. M-BRACE Vulnerability Assessments engaged stakeholders, including local government technical experts and university researchers in a collaborative research process, which ensured that both the knowledge and new capacity generated through engaging in the process would stay within each city. Further, the assessments sought to focus not just on direct impacts of changes, but on larger implications, first looking at vulnerabilities that are the result of urban development processes and examining how those vulnerabilities may be affected by climate change. As such, the M-BRACE Vulnerability Assessments differed significantly from other kinds of VAs often conducted around questions of climate change and development.

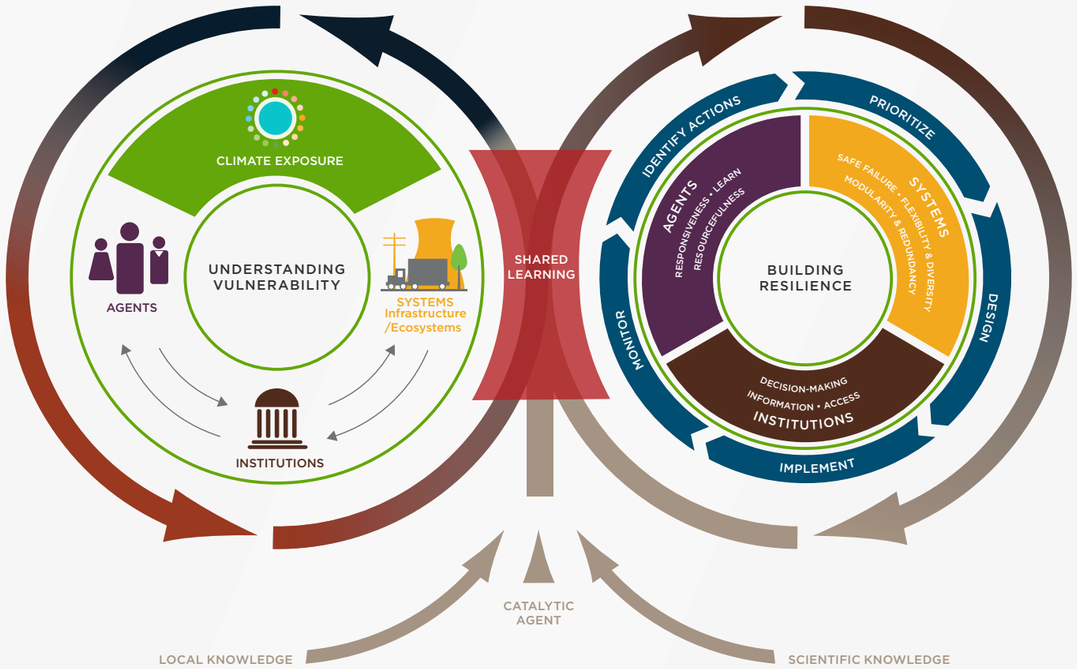
This report, prepared by ISET-International in partnership with TEI, NISTPASS and a number of city-level technical and academic partners, presents an overview of this approach to vulnerability assessment and a summary of the core findings from across all four M-BRACE cities. The similarity of the challenges faced by all four cities in M-BRACE, and the geographic diversity represented by the cities, provides a valuable indicator of the kinds of challenges that growing cities throughout the Mekong region are likely to be facing.

1.2 Vulnerability Assessment Methodology and Process Within M-BRACE

Approaches to assessing vulnerability to climate change impacts take different starting points. Generally, most assessments take climate change projections as the starting point, working with both global and downscaled projections and from them determining likely impacts on specific geographic areas and places (a city, province), sectors (water supply, agriculture) and groups of people (the poor, women, elderly).

There are well-documented challenges with these approaches. Inevitably, attempting to determine the future is fraught with difficulty. The science of climate change itself is uncertain, with projections of future climate change appearing as a range that is often difficult to interpret or apply. It is simply not possible to say categorically what changes will occur in the future or what their implications might be. In many cases, data and scientific projections or models are often unavailable or inaccessible. Being

FIGURE 1
CLIMATE RESILIENCE FRAMEWORK



The objective of M-BRACE is to develop city stakeholder capacity to address the challenges and uncertainty associated with climate change, disasters and urbanization. By stressing the uncertainty and unpredictability of all types of change and disturbance, including natural hazards, M-BRACE is helping city stakeholders build the capacity to learn and reorganize as they address these challenges.

The Climate Resilience Framework (CRF) provides a conceptual framework for assessing vulnerabilities and risk, identifying resilience strategies and creating an open, inclusive learning process to identify specific measures and processes that can address the uncertainties of climate change through action and implementation.

Institutions need to be able to take stock of changing circumstances, learn from their actions and act accordingly, moving beyond blueprint, one-off actions.

LAO CAI
Tho Nguyen, ISET-Vietnam, 2014

heavily dependent on specific knowledge (climate science) can constrain public dialogue and can steer debate towards attempting to identify specific sets of actions, rather than towards dealing with a climate future of uncertainty and risk. Because of the difficulty of grounding future projections in current realities, starting with specific changes that might occur in the future tends to steer adaptation responses to specific actions in response to specific projected impacts, rather than building capacity to deal with these future uncertainties and risks.

Starting with climate change projections tends to overlook the special significance of urbanization as a process. Similar assessments of vulnerability have ended up focusing on potential climate impacts on specific locations, sectors or groups of people – rather than opening up discussion of how the transformations associated with urbanization contribute to climate change, and generate new vulnerabilities and risks. With a focus on the specifics of urban climate challenges, the M-BRACE Vulnerability Assessments have sought to test alternative approaches that take urbanization processes as the starting point, and then factor in future climate change. This approach understands urbanization as a transformative process and asserts that assessing climate vulnerabilities needs to start with the transformations in progress, rather than climate projections. This allows attention to be directed towards the kinds of trends and trajectories of change that are already unfolding as part of urbanization, and to consider how they might contribute to climate change or create vulnerabilities that might be exacerbated by climate change. These approaches fit well with contexts of rapid change, in which climate might be one of several variables that can influence vulnerability, and in which many urbanizing areas and urban systems are already fragile and approaching critical points. Urbanization is occurring at a phenomenal pace in Southeast Asia, with cities planning to expand their area and populations, particularly along hazardous zones of coasts, deltas and river basins. These patterns of urbanization are creating new and changing existing vulnerabilities that will be exacerbated by climate change. The impacts of climate change will be felt in specific locations, but because of the nature of urbanization and associated transformations of landscapes and economies, the impacts will cascade well beyond specific urban sites.

The need to put climate change and urbanization on the public policy agenda within each of the cities was a critical consideration in designing the methods and process for the VA studies. Much of the effort of M-BRACE has been to work with local stakeholders to consider the scale, pace and significance of the urbanization that is unfolding around them. To highlight specifically the urban dimensions of climate change, the VAs and related public dialogues proceeded to focus on trends and trajectories of urbanization. By focusing in this way on existing and emerging vulnerabilities it is possible to consider how close these development trends are pushing us to crisis points or climate thresholds – and the degree of room for maneuver there might be with additional climate change. In many cases, this then leads to more critical reflection on appropriate urban development pathways and encourages approaches to planning for the future that can accommodate risk and uncertainty.

Much of the global literature on climate adaptation frames climate change as creating new uncertainties and risks, and argues the need for flexible adaptive institutions that can cope with such dynamism. This means that institutions need to able to take stock of changing circumstances, learn from their own actions and act accordingly, including moving beyond blueprint, one-off actions. M-BRACE has sought to contribute to new approaches to assessing vulnerability that shift from 'predict and act' towards considering thresholds, and building adaptive capacity based on iterative processes of assessing vulnerability and taking resilience building actions. The VAs conducted under M-BRACE are thus something of an experiment, introducing a new set of methodologies based around local stakeholder participation and dialogue. The M-BRACE cities had never before adopted these kinds of approaches to address these kinds of challenges. As such there are clearly areas in the findings of the assessments that warrant further research and analysis. The cities have thus identified follow-up actions to both address information gaps, but to do so in ways that engage citizens in generating and analyzing information.

The VAs in M-BRACE have supported building stakeholder awareness of how urbanization

patterns and climate change might come together, and creating dialogue platforms for how these challenges might be addressed. We are confident that this is the legacy created by the M-BRACE Vulnerability Assessments and the teams of local stakeholders who led the assessment process.

1.3 Process

The VAs in M-BRACE cities were conducted through a shared learning process that engaged government officials, private sector and civil society leaders, and top technical experts and academics. Together, this collection of stakeholders from the city directed and led the core components of the process. ISET, TEI and NISTPASS, as program implementers, facilitated the overall process and provided technical assistance as necessary. The process consisted of three core activities: two shared learning dialogues—one at the beginning of the assessment process and a second at the end—and a series of studies conducted by actors in the city.

Shared Learning Dialogue: Identifying Priority Vulnerabilities

The first shared learning dialogue in the M-BRACE process occurred very early in the program. This dialogue engaged a broad spectrum of stakeholders and served two purposes: to introduce concepts of urban climate change resilience and to discuss core areas of vulnerability in the city. The starting point for these dialogues was a facilitated process of reflecting on the changes that had occurred with urbanization and the implications of such changes. Climate change was factored in as discussions around potential thresholds that cities might reach in light of future climate change projections. These dialogues identified priority areas for further research—essentially around changes in land and water use.

Collaborative Assessments

Following the first shared learning dialogue, a series of studies were designed and conducted by teams of local stakeholders in each city based on priority areas from the first shared learning dialogue. These studies combined analysis of secondary data with primary research, drawing on experience of dealing with historical events. In all cases, these studies examined current areas of vulnerability based on recent and ongoing development. Drawing on a suite of climate change projections, researchers also adopted a climate thresholds approach, looking at the impacts that future climate change might have on the identified vulnerability. Throughout this process, researchers shared intermediate findings with groups of other stakeholders as a peer review process, and to elicit feedback and guide further steps in the research.

Each of the collaborative assessments included case studies of recent events of climate-related shocks and crises, largely floods. These events represent certain thresholds that have already been crossed. The use of case studies allowed research teams and other stakeholders to assess weaknesses in urban systems, including in the design, maintenance and operation of infrastructure as well as in institutional arrangements such as early warning systems, and to consider the ways in which different groups of people were impacted. The case studies also drew attention to deeper underlying causes of vulnerability, such as large observed changes in land use related to urbanization. Drawing on recent case studies is an important component of assessing vulnerability as it directs attention to actual impacts and responses that have occurred, rather than more idealized notions of how cities might respond to possible shocks in the future.

Shared Learning Dialogue: Feedback on VA Findings

After the studies were completed, the stakeholders from the first dialogue reconvened for presentations of research findings and outcomes. During this dialogue, they were able to consider the implications of the findings of the collaborative assessments. Their interaction served as the foundation for designing resilience activities in each city, including public dialogue and shared vision planning processes, action planning and city intervention projects.

TABLE 1
STUDIES CONDUCTED IN M-BRACE VULNERABILITY ASSESSMENTS

City	Assessment Studies	Lead Researcher	Institution
UDON THANI	Study of water management guildelines and use it assessing Udon Thani's vulnerability	Ms. Pattcharin Chairob	Thailand Research Fund
	Study of catchment area's condition and floodways of Udon Thani	Mr. Santipab Siriwattanapiboon	Rajabhat Udon Thani University
	Study and Analyze of an impact of floods in BC 2543 in order to get communities readiness for their own management	Dr. Arunsri Uasriwong	Rajabhat Udon Thani University
	Analyse of an impact of Udon Thani's strategy and policy focusing on land use and to create a participatory management plan	Dr. Arunsri Uasriwong	Rajabhat Udon Thani University
	Assessment on change of land use pattern and social vulnerability	Professor Dr. Buaphan Prompakping	Khon Kaen University
PHUKET	Phuket flood vulnerability study; a case study from Klong Yai basin management	Dr. Wiroj Phutong	Prince of Songkhla University, Phuket
	Study of water management guidelines of Phuket to assess on its vulnerability	Prof. Dr. Naiyana Srichai	Prince of Songkhla University, Phuket
	Study of an impact on change of land use pattern	Assoc Prof. Nisa Chadchakul	Prince of Songkhla University, Phuket
LAO CAI	Flash Flood and Erosion in Ta Phoi Commune	• Mr. Luu Duc Cuong - Sub-Division of Environmental Protection, Department of Natural Resources and Environment (DONRE) • Mr. Pham Duc Dung – Provinicial Committee for Flood and Storm Control • Mr. Pham Hong Thang - Lao Cai city People's Committee • Mr. Hoang Gia Nghieu – Department of Construction • Mr. Nguyen Duy Hung – DONRE • Mr. Luu Minh Hai – Hydrometeorology Forcasting Center • Ms. Pham Thi Thu Huong - Sub-Division of Environmental Protection, DONRE • Ms. Dang Thi Huong - Environmental Monitoring Center, DONRE	
	Case Study of Cam Dong Commune		
	Case Study of Kim Tan Commune		
	Case Study of Xuan Tang Ward		
HUE	Case Study of Phu Thuong Commune	Ms. Tran Lan Anh	General Division, Department of Planning and Investment
	Case Study of Thuan Loc ward	Mr. Tran Viet Luc	Tourism Planning and Development Division, Department of Culture, Sports and Tourism
	Case Study of Xuan Phu Commune	Mr. Ho Hoang Tung	Transport Management Division, Department of Transport
	Case Study of Phu Hau ward	Mr. Le Dien Minh	Flood and Storm control Division, Hue Department of Irrigation and Flood and Storm control
	Case Study of An Dong ward	PhD. Tran Huu Tuyen	Geography-Geology Department, Hue University of Science

UNISDR LOCAL GOVERNMENT SELF-ASSESSMENT TOOL

The LGSAT engages cities in a process of dialogue in order to assess key areas of institutional capacity related to disaster risk reduction. The tool assesses capacity in ten 'essential elements' that make a city resilient.

1. Put in place organization and coordination to clarify everyone's roles and responsibilities
2. Assign a budget and provide incentives for homeowners, low-income families and the private sector to invest in risk reduction
3. Update data on hazards and vulnerabilities; prepare and share risk assessments
4. Invest in and maintain risk reducing infrastructure, such as storm drainage
5. Assess the safety of all schools and health facilities and upgrade these as necessary
6. Enforce risk-compliant building regulations and land use planning, identify safe land for low-income citizens
7. Ensure education programs and training on disaster risk reduction are in place in schools and communities
8. Protect ecosystems and natural buffers to mitigate hazards and adapt to climate change
9. Install early warning systems and emergency management capacities
10. Ensure that the needs and participation of the affected population are at the center of reconstruction

For each element, city stakeholders are asked to assess the progress they have made towards achieving success. Stakeholders are asked to record the assessment in two ways. First, cities are asked to assign a numeric value to their progress, with the scores of 1 to 5 representing different levels of progress:

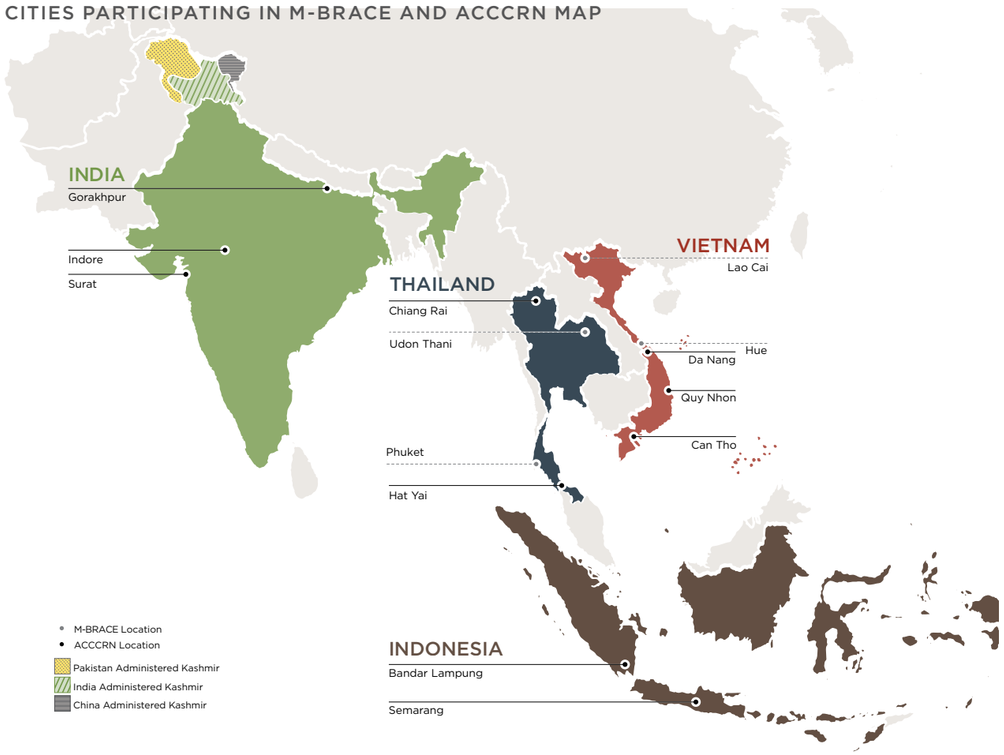
1	2	3	4	5
Achievements are minor and there are few signs of planning or forward action to improve the situation	Achievements have been made but are incomplete, and while improvements are planned, the commitment and capacities are limited	There is some institutional commitment and capacities to achieving DRR, but progress is not comprehensive or substantial	Substantial achievement has been attained, but with some recognized deficiencies in commitment, financial resources or operational capacities	Comprehensive achievement has been attained, with the commitment and capacities to sustain efforts at all levels

In addition, cities are asked to develop a short narrative description of their progress, achievements, ongoing activities and plans in the context of each element. Together, the score and the narrative provide both quantitative and qualitative benchmarks that can help cities assess their resilience.

1.4 Local Government Self-Assessment Tool

In addition to the steps outlined above, the M-BRACE Vulnerability Assessments were supplemented by the use of the United Nations Office for Disaster Risk Reduction's (UNISDR) Local Government Self-Assessment Tool (LGSAT). The LGSAT is based around Ten Essential Elements for Making Cities Resilient derived from the agreements outlined in the Hyogo Framework for Action. The LGSAT is a core element of the UNISDR global campaign "Making Cities Resilient – My City is Getting Ready," a campaign that both Hue and Patong Municipality (in Phuket) are also participating in. Within M-BRACE, the LGSAT helped cities assess institutional capacity in order to determine where institutional gaps exist that might contribute to overall urban climate vulnerability. The Ten Essential Elements primarily address disaster risk reduction, but also factor in climate change considerations. The M-BRACE experience with the LGSAT has also contributed to an ongoing debate around how the LGSAT tool and other resilience and disaster risk reduction programs can address climate change resilience more directly.

FIGURE 2
CITIES PARTICIPATING IN M-BRACE AND ACCCRN MAP



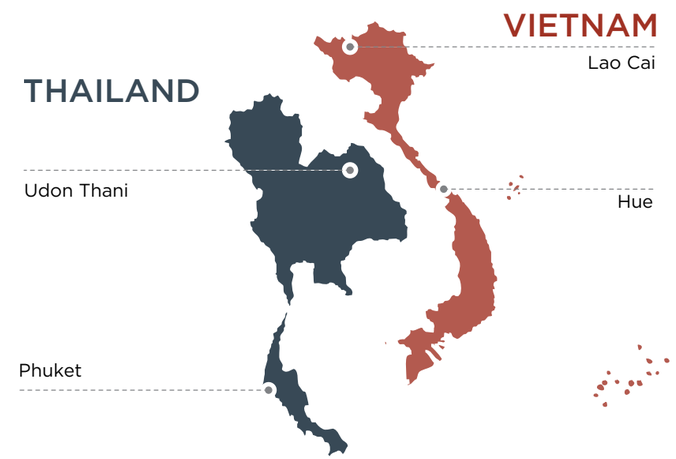
2. CITIES

THAILAND

Udon Thani
Phuket

VIETNAM

Lao Cai
Hue



2.1 Phuket

Phuket is a renowned tourist destination along Thailand's Andaman Coast that attracts visitors from all over the world. The island's recent efforts to increase the number of tourists have been incredibly successful, with tourist visits growing from approximately 2.5 million in 2009 to almost nine million in 2013. By 2015, the island aims to attract over 12 million visitors per year. This rapid growth in tourist visits has been accompanied by a significant increase in people residing on the island and a dramatic expansion of the built, or urbanized, land across the island. This growth has helped to fuel significant economic development in Phuket—the island has the second highest GDP of all provinces in Thailand after the capital city of Bangkok—but it has also served to exacerbate existing pressures and create new vulnerabilities, particularly relating to land use, water management and flooding, transport and waste management.

The rapid expansion of the tourist industry has been accompanied by new construction, such as hotels, housing estates and condominium projects, shopping malls, and other tourist infrastructure like restaurants and shops; there has also been expansion of infrastructure and increased residential areas for workers, resulting in a doubling of the urbanized area in less than a decade. As the developments stretched beyond traditional city and village boundaries, they have often encroached on public land, agricultural land, forest reserves and green spaces. In addition, land that has been zoned for other purposes, such as for rubber plantations where permanent developments are not typically allowed, has been developed for tourism purposes Both forested hillsides and important coastal areas have experienced such development for resorts and housing estates. Housing for migrant laborers, particularly those who are unregistered and thus in a precarious position with regard to immigration laws, has often been constructed illegally on marginal public land, such as mangrove forests. For Phuket, the combined effects of these encroachments have not just been on important and natural resources, they have increased vulnerability across the island by dramatically altering the ecological and hydrological landscapes in ways that threaten ecosystem services, and contribute to overall risks. Further, while land use plans have often noted some of these dangers and outlined development that would mitigate against these impacts, these plans are rarely enforced fully.

Much of the effects of climate change will be felt through water, and it is around water resources that Phuket's climate vulnerability, and the linkages with urbanization, are most apparent. Recent years have seen instances where some parts of the island have faced water shortages, with private service providers using trucks to transport water from private water bodies on the island or from other provinces. There is still no effective mechanism for generating the kind of comprehensive assessment of water balance across the island that would allow for government officials, the private sector and local stakeholders to assess current and future vulnerabilities and risks, or to consider options to address these challenges.

At the same time that demand for water is increasing, Phuket is also experiencing changes in precipitation, often highly localized across the island, that are associated with climate change projections. The dramatic changes to the island and expansion of urbanized areas appear to have placed Phuket close to some critical thresholds. The review of flooding during 2012 in Phuket City conducted as part of the Vulnerability Assessment, pointed out that many canals and floodways, including the city's largest, Khlong Bang Yai Canal, have witnessed significant development and encroachment along their banks. These floodways, then, have less capacity for draining flood water from the city, while the developments in the upper watershed and along their banks include significant economic and social resources, including individual homes, small and medium enterprises, and key roads. Poor solid waste management has led to further blockage in these canals. In addition, the storm water drainage systems that move water from the city into floodways have not grown in parallel with the city – while recent rainfall rates have topped 170 mm per hour, the system only has capacity to drain about 120 mm per hour.

Historically, there have been few issues with flooding in Phuket. The phenomenon of flooding in Phuket City is relatively recent, and the city is noting further increases in frequency and intensity. However they have not yet reached the proportions of a major disaster, although the economic costs are significant. Even so, institutional capacity to support and manage flood prevention and response remains weak. Precise weather and flood forecasts are difficult to develop—while the island has highly variable weather across different watersheds, there are only two weather monitoring stations. Further, early warning and emergency communications systems are not always effective in practice, and administrative sub-districts within a single basin have no mechanism to communicate or collaborate with each other.

The VA studies concluded that across Phuket, climate vulnerability is closely related to urban growth and associated land use changes, along with weak institutional capacity to address these challenges. Yet, the island continues to be highly vulnerable to climate change. Across all of these issues—land use, water management and flooding—the growing risk and uncertainty associated with climate change will further exacerbate the challenges faced by Phuket.

PHUKET
Thailand Environment Institute, 2013

The growing risk and uncertainty associated with climate change will further exacerbate the challenges faced by Phuket.

CHANGES IN UDON THANI
Thailand Environment Institute, 2013

2.2 Udon Thani

Udon Thani is emerging as a key city in northeastern Thailand and the Greater Mekong Sub-region. Within only a decade, Udon Thani has shifted from a relatively poor and remote province, to positioning itself as an economic, trading and transportation hub, serving as a key link between Thailand, Lao PDR, Vietnam and Southwestern China. As the city prepares for this future, the urban area has been growing quickly and beyond its administrative boundaries; neighboring local administrations are also urbanizing rapidly. However, the city's location in Northeastern Thailand, with very wet rainy seasons and very dry summers, means that the growing urban area faces climate-related problems from both water shortage and flooding. As a growing city, Udon Thani has many water needs, but management and planning processes are not yet able to account for the complexity of such rapid growth.

The city is dependent on one main water source, the Huay Luang Reservoir that was built over 40 years ago and designed to meet the largely rural irrigation needs of small-scale rice farmers. The demands on the reservoir have intensified, with the expansion of irrigated rice and other crops, and growing demand to meet the domestic water needs of the growing, increasingly urban population. This demand is only set to rise again, as urban populations increase further, and as industry becomes established in the area. While demand has increased water availability has become more variable. Recent conditions appear to be consistent with climate projections—dry seasons becoming longer and dryer and precipitation in the rainy season becoming less predictable, with more intense rainfall often in a shorter space of time.

Longer term planning processes for water management are not yet sufficiently informed about anticipated demand from newly planned industrial estates that will require significant amounts of water, or by climate change considerations. Water use and demand data are often limited or incomplete and, where they do exist, are not widely available to the public. As such, there is no current process for linking urban development to landscape-level water processes, and by extension for understanding urban development's impact on water quality. Finally, mechanisms for dealing with water shortages or crises, and responses, are developed in an ad-hoc way during and after water crises. In recent periods of water shortage, urban uses have been prioritized over agriculture and ecosystem uses, but the lack of informed institutional processes around this greatly constrains the ability of the city and its citizens and stakeholders to anticipate and respond effectively.

During the time in which the VA was being conducted, Udon experienced a widely reported water crisis in the dry season. Water levels in the reservoir dropped so low that pumps had to be used to pump water up to the outflow canals. Domestic water supply for the city was maintained, but as a result many farmers were unable to access water for irrigation. After such an intense dry season, reservoir managers were keen to ensure that they were able to store enough water in the rainy season to meet the demand of the dry season. However precipitation patterns are also proving less reliable than historical trends. In 2013, reservoir managers were aiming to reach maximum storage capacity only for a tropical storm to move towards Udon. This led the central Royal Irrigation Department in Bangkok to order preemptive release from the reservoir to avoid flooding risks in the city, only for the storm to pass without any rainfall, leaving the reservoir well below capacity. Fortunately, a subsequent, but unexpected, storm did pass through Udon with enough rainfall to refill the reservoir. Even so, in 2014 there remains the likelihood of water shortages throughout the dry season.

One of the collaborative assessments conducted under the M-BRACE Vulnerability Assessment has examined the viability for flood retention and water supply of the many existing natural water bodies in the area around the expanding city. These water sources, which historically have provided water for rural communities, are now often poorly maintained and have low water quality. They are increasingly being targeted for infilling to sustain the development of housing estates and developments. Other urban developments, such as the expansion of roads, further encroach on the network of water bodies, wetlands and streams that characterize the landscape of the area. As a result, more people are increasingly relying on the Huay Luang Reservoir, which has struggled to

More transparency, accountability and participation in dialogue about the future of development in Udon will help the city better understand and address a future characterized by both growth and growing uncertainty.

meet demand in each year, and there are fewer alternative water bodies for the city to utilize.

With climate change projections indicating growing flood risks due to shifting precipitation patterns, there is concern that Udon's urban expansion is also increasing the likelihood of flooding. Udon is located in a shallow depression in a watershed that is by way of natural drainage already susceptible to floods. New development in outer rings of the city has occurred in areas that were traditionally floodways. Further, the construction of highways along floodways and the infilling of canals have restricted flood drainage capacity. In addition, the canals are not often managed with optimum efficiency due to lack of coordination amongst different administrative districts with responsibility for different canals. The city has addressed some of these challenges by improving flood management infrastructure, such as developing bypass floodways or installing additional water pumps. However this also creates some challenges, In addition to the need for regular maintenance, in some cases, where these measures divert water towards other communities, they may actually be shifting flood risk to areas on the outskirts of the city.

Both the increasing vulnerability to floods and water shortages can be linked to gaps in city planning and forecasting. Udon Thani City has a four-year comprehensive development plan covering the years 2010 to 2014, and the province has a land use plan that is currently in the approval process at the Ministry of the Interior. However, these plans are not comprehensive enough to guide the specifically urban nature of local development, or the climate change dimensions. The city plan does not outline a specifically urban vision for the future of the city. Planning and enforcement law is quite vague and regulatory agencies have expressed difficulty in fully implementing it. As a result, development has occurred rapidly, without adequate consideration of issues such as flooding, the environment or transportation.

The city planning process itself does not allow for significant consideration of different perspectives, data and stakeholder visions. The city planning process as it exists now relies on a less-than-comprehensive set of data. Local stakeholders are keen to promote a process that can help build a mutually agreed-upon and enforced city plan; this would require greater dissemination of information, increased participation from all stakeholders and more transparency in decision-making processes. It would also need to be accompanied by new methods for monitoring and enforcing decisions made by the government.

As in other cities, climate change in Udon will only aggravate these challenges. Longer dry seasons and wetter, but shorter, rainy seasons will only worsen the flooding and water shortage problems the city is already facing. Being prepared for climate change, therefore, will require addressing the current major challenges in the city. Improved planning processes that consider all dimensions of development and change in Udon are needed. Stakeholders and government officials in the city recognize the need to develop their capacity to engage in these long-term planning and decision-making processes. Further, mechanisms to support NGO and private sector engagement in governance will ensure that decisions are applicable across sectors. Finally, more transparency and dissemination of data and information will allow for individuals and organizations to develop their own plans and activities for addressing climate change. More transparency, accountability and participation in dialogue about the future of development in Udon will help the city better understand and address a future characterized by both growth and growing uncertainty.

2.3 Lao Cai

Located on the Chinese border, Lao Cai is a key city supporting interaction, trading and travel between Vietnam and China. Rapid economic growth in both of those countries has had a significant impact on Lao Cai, where economic growth, fueled by trade as well as mining in the surrounding mountains, is leading to rapid expansion of the urban area. Within this context, climate change, rapid changes in demographics and the landscape, and urban plans that do not appropriately accommodate a changing climate create new risks for Lao Cai.

Rapid urbanization has led to a fluctuating hazard profile in the city. Inundation, particularly from the Hong River, flash flooding and landslides have intensified over the past few years. Along the Red River, recent floods have seen houses inundated for seven to ten days at a time. Dangerous flash floods have occurred following heavy rains, leading to serious financial losses for low-income communities in the area. Historically the most dangerous time for hazards is the rainy season from May to October, but this is shifting along with changing patterns of precipitation so that hazards now occur at different times of the year.

Increasing risks from these hazards are strongly associated with changes to the landscape. Development in the river floodplain has exacerbated existing flood risk, with new construction being located in places that used to serve as flood retention areas. Infilling of lakes has created new flood zones, while the construction of new roads has displaced floodwaters towards new locations, increasing the severity of flooding. Mining works have created small pockets of severe inundation by increasing the quantity of soil movement downhill that inhibits water flow during storms. Upstream deforestation has contributed to the severity of flooding events. In some communes and wards this type of inundation has served to create temporary dams, causing flooding to spread throughout certain wards. The new construction of a highway that will link Hanoi to China via Lao Cai is also reshaping and altering flood patterns in ways that might threaten certain wards.

LAO CAI
Thanh Ngo, ISET-Vietnam, 2013

Moreover, ongoing demographic and socio-economic changes are altering livelihood patterns for city dwellers. The transition from a rural to urban economy has meant the loss of traditional livelihoods for many farming households that have struggled to adapt to changing economic circumstances. Many farming families are being displaced, but new land allocations in resettlement areas are smaller than traditional landholdings, and the government's standard compensation of VND10 million per household (US$500) is insufficient to cover even basic needs. Resettled farmers, as a result, have limited financial ability to change livelihood strategies or diversify their incomes, even while the city urbanizes around them. Further, homes in resettlement areas often lack basic amenities such as water and electricity. Despite these challenges, official development plans call for continued expropriation of farmland, so more and more households will encounter these problems in the future unless new solutions are identified.

As the city grows, infrastructure will increasingly play an important role in promoting and sustaining economic activity. However, some of this infrastructure, including roads and drainage systems, may be inadequate for increased risk under future climate change impacts. Intense floods generated by changing precipitation patterns and ongoing deforestation may soon exceed city infrastructure capacity. The river dike system was designed to withstand a one-in-twenty five year-flood;[1] however, the changing patterns of floods have produced multiple one-in-fifty and on-in-one hundred-year floods in the recent past. Further, only 60% of the total 20 km of river and stream dikes in the city boundaries are considered to be reliable (i.e. not susceptible to breakage). In addition, existing drainage systems in some wards are already in a critical condition as a result of age and poor maintenance, and a new drainage system currently under construction is likewise not designed to cope with extreme events, which means it will be obsolete shortly after construction is finished in 2015.

Climate change has not been a priority consideration for planned new urban development along the Hong River. The current Master Plan envisions high-value business activities and urban infrastructure built narrowly alongside the Hong River behind the protection of river dikes. There are of course risks in such a high level of dependency on dikes. International experience (for example from Bangkok, Ho Chi Minh City and New Orleans) suggests that dikes may create perverse incentives to invest in high-risk areas by giving a sense of security, with

1 This measurement signals the magnitude of flooding based on the historical probability of such a flood occurring within a certain number of years. While still the primary reference used for infrastructure planning in Vietnam, this measurement is increasingly difficult to use because of the uncertainty associated with climate change impacts. Climate change and urban planning specialists advocate shifting standards to reflect extreme events rather than historical probabilities.

While Lao Cai often struggles with issues related to too much water, there is a possibility that the city may face constraints related to freshwater availability.

widely held assumptions that such dikes will not fail – a phenomenon known as the levée effect. Experience suggests that even the best designed, constructed and maintained dikes can fail, particularly in the face of what are likely to be extreme events. Alternative approaches argue the importance of maintaining rather than obstructing floodways, such as through open green spaces like parks and recreation areas on riverbanks. Further, inundation in the city center may become more frequent with longer duration, due to the inadequate drainage system.

Finally, while Lao Cai often struggles with issues related to too much water, there is a possibility that the city may face constraints related to freshwater availability. A growing population and an expanding urban area will require increased water, while some new economic developments, particularly in mining and industry, create the need for better management to protect existing water sources from pollution. With an annual dry season, there is real concern that water availability shortages may soon constrain development or city activity during certain parts of the year.

Though the Hue City Government and its people have a strong awareness of climate change risks, the city has only just developed a climate change resilience plan.

HUE

HUE
Richard Friend, ISET-International, 2013

2.4 Hue

Hue, the ancient capital of Vietnam, is an important cultural and historic city on the central coast of Vietnam. Recent economic development throughout Vietnam has also placed an important emphasis on Hue as a key economic city in the central region that will be linked to the Mekong region. However, Hue's position on the coast and its exposure to a wide range of climate events means that it is highly vulnerable to climate change.

In Hue, changes are already taking place that are in line with climate change projections. Precipitation levels from the Hue Monitoring Station have increased constantly over recent years, with some very intense rain events that led to unusual flooding situations. There has also been an increase in the frequency of droughts and water shortages in the dry season. On the social side, such changes have negative impacts on infrastructure, tourism services and the life of most Hue residents. However, the most obvious evidence of climate change now and also in the future is the increase in both precipitation levels and rainfall intensity.

At the same time, changing patterns of urbanization are influencing how people experience climate-related events, amplifying and distributing risk in new ways. Hue residents are familiar with annual flooding, with roughly half of the population residing in low-lying areas; they have high awareness and understanding of ways to adapt to flood situations. However, flood levels and duration are increasing in some areas, especially new urban and low-lying areas. Floods no longer develop the way they did before, so old adaptive approaches no longer work. In Hue, precipitation of some days of heavy rain could be equivalent to half a year's rainfall. According to the most recent research project by the provincial Department of Transportation, rains with frequency of 50% (i.e. happening every two years with three hours of downpour at a level of 72 mm) will cause 70% of the city's roads to lie under 0.1 to 0.5 m of floodwater. Land raising and infilling as well as road construction for building new urban zones in lowland areas and floodways induce local waterlogging and prolonged drainage duration.

While city planning is influenced by climate considerations, one of the challenges is to ensure that climate projections reflect a full range of possible future scenarios. Hue has a particular geography that means that the Intergovernmental Panel on Climate Change's global climate change B2 scenario, which is applied across the country, might not accurately reflect local circumstances. Results of analysis show that precipitation data of recent years have already surpassed projections of the B2 scenario, and suggest that future planning will need to consider an additional range of scenarios.

Future flood risks in the city are also dependent on the management of a number of upstream reservoirs in the Hue area. Upstream reservoirs serve multiple purposes that include provision of water for urban and agricultural uses, releasing enough water for environmental protection, hydropower generation and as flood protection measures. However, competing demands amongst these priority areas means that water released into downstream channels may vary greatly. Reconciling these different needs will become increasingly difficult as precipitation patterns become less predictable. Via the regulation of large upstream reservoirs, downstream flood levels will be lowered (if reservoirs are operated properly) in the future. Future flood levels in expanded urban areas of Hue will be attributable mainly to the increase of rainfall in the city and its poor drainage system. However, recent instances where reservoirs have had to release water during flood periods because they were in danger of failing, suggest that reservoir management is a critical variable in understanding flooding in the city. With a greater concentration of economic assets to be located downstream in the urbanizing area, the costs of such sudden releases will be all the greater.

The urbanization of Hue, as in other coastal cities in Vietnam, faces especially acute constraints and challenges. The available land suitable for expansion tends to be along the coastal areas that are themselves of very low elevation and exposed to a range of climate-related shocks. As Hue expands into these coastal belts a greater concentration of critical assets will be located in hazardous space. Reducing climate vulnerability will therefore be of enormous importance.

The risks of such expansion may also be felt in other locations. Development of new urban areas also reduces drainage capacity of the city to the east, the main drainage direction of the city. Discrepancies in project planning and implementation of urban clusters has also had localized effects on floods and waterlogging. Recognizing and addressing such development challenges, inevitably places additional demands on different tiers of government and different agencies in order for them to coordinate urban planning, urban management and urban flood management. In addition, guidelines and regulations on integration of climate change and extreme weather developments into development projects and plans will also be needed. While Hue, with its long history of dealing with natural disasters, such as storms, has a strong institutional mechanism for disaster risk reduction, institutional arrangements and capacity for climate change are less well advanced. Limitations in finance, technology and expertise in climate change are major challenges in building resilience for the city. Further, ward- and commune-level survey results show that many citizens are unaware of how domestic and public construction might contribute to increasing the risk of local flooding and waterlogging, and how these risks might be addressed.

Though the Hue City Government and its people have a strong awareness of climate change risks, the city has only just developed a climate change resilience plan. Sector plans (socio-economic development plans, construction plans, land use plans, etc.) do not integrate information about the impacts of climate change or urban growth. In fact, when using historical flood data as the basis for construction of infrastructure and construction in floodway areas, solutions on how to respond to potential extreme weather developments in the future have not been adequately considered. Within M-BRACE, therefore, the interventions are focusing on developing scientific and technical data to better understand the risks associated with urbanization and climate change. These projects can then feed into policy dialogue about urban development and climate change planning.

3. KEY ISSUES EMERGING FROM THE M-BRACE VULNERABILITY ASSESSMENTS

In cities, the tendency is to focus on engineered and infrastructure-based approaches to specific impacts. There is an additional need to consider institutional mechanisms for management and planning that contribute to resilience.

Each city in M-BRACE is unique and is experiencing its own specific sets of challenges. The final reports from each of the studies, as well as other M-BRACE program documents, outline some of the specific findings and challenges in each city. However, when examining the findings from the suite of cities, there are a number of common issues and concerns.

Across the cities, urbanization processes are creating new vulnerabilities as the built-up areas are expanding, leading to the conversion of land, including changes to natural hydrology and drainage. Demand for urban services, particularly water, is increasing as urban populations are increasing. Meanwhile, many of the cities are already experiencing the kinds of climate conditions that are associated with climate change projections, and in some cases these conditions have already risen to the levels predicted in some of the global climate projections.

These patterns of increasing vulnerability are occurring in cities that lack some key institutional capacities for dealing with these changes and disturbances. Many cities lack strong institutions for making and enforcing urban plans, and where land use plans are developed they tend not to consider longer-term climate risks. At the same time, there are critical gaps in knowledge and information related to climate and climate change, particular as it relates to urban infrastructure. Where there are efforts to develop the city to be prepared for climate change, cities are focusing heavily on engineered and infrastructure-based approaches to specific impacts, without paying closer attention to institutional mechanisms.

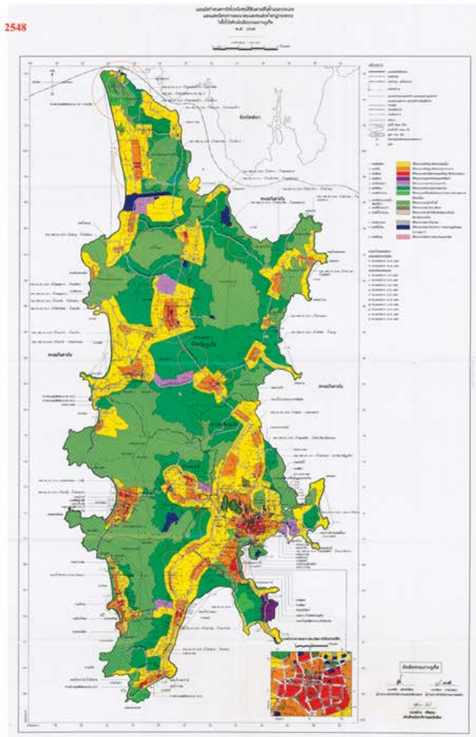
While the findings outlined below are drawn from experience in M-BRACE cities, experience that program partners have had with other programs (including the Rockefeller Foundation's Asian Cities Climate Change Resilience Network [ACCCRN]), as well as research conducted by other partners, suggests that many of these vulnerabilities are exhibited by many cities across the Mekong region and the developing world.

3.1 Processes of urbanization are creating new vulnerabilities

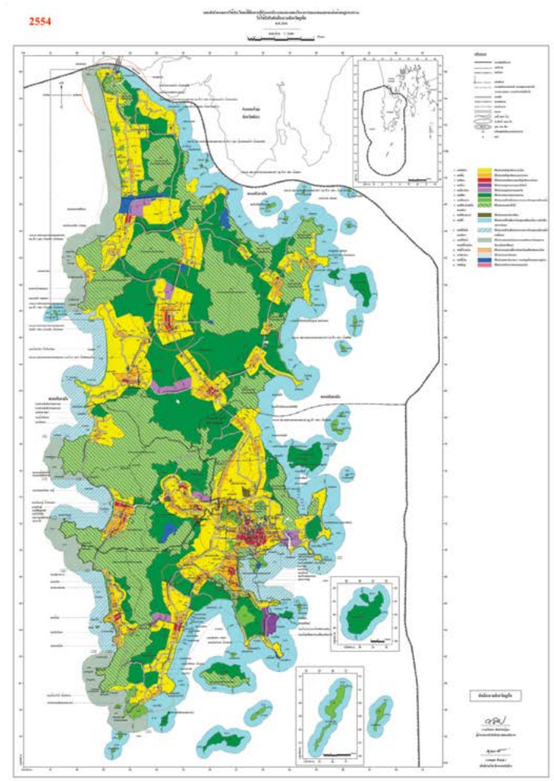
Even without considering future climate change, uncoordinated and poorly planned urbanization is making each of the M-BRACE cities more vulnerable. Over the past two decades, the four cities in the program have been growing rapidly, in terms of both population and urbanized area, and all have plans for continued expansion. This growth is causing cities to develop and build critical infrastructure in less safe and more hazardous areas. At the same time, this growth is putting additional stress on the available natural resources, particularly water, upon which cities are dependent.

FIGURE 3
VISIBLE SIGNS OF GROWTH IN PHUKET AND UDON THANI

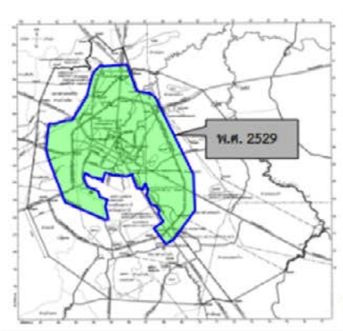
PHUKET LAND USE IN 2005



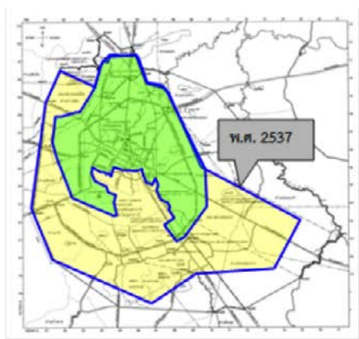
PHUKET LAND USE IN 2011



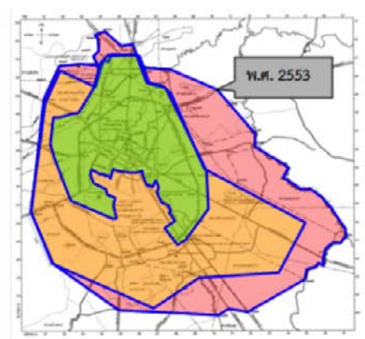
ภาพ 2.4-1 แสดงการเปรียบเทียบความเปลี่ยนแปลงผังเมืองรวมเกาะภูเก็ต พ.ศ.2548 และผังเมืองรวมจังหวัดภูเก็ต พ.ศ.2554
ที่มา : สำนักงานโยธาธิการและผังเมืองจังหวัดภูเก็ต, 2555.



Udon Thani Central Business District in 1986



1994, City development within the southern ring road



2010, City development within the new eastern ring

Urban Expansion

In Phuket and Udon Thani, the extent of the urbanized area has extended well outside city municipal boundaries, as defined by the administrative designation thesaborn nakhorn. Across the island, the built-up land area more than doubled between 2000 and 2007, growing from covering 9.8 to 20.2% of the island, and with the recent rapid increase in tourism, it can be expected that this figure has further increased. Satellite images show Phuket's rapid urbanization expansion. In Udon Thani, official statistics suggest that urbanization increased by 29.4% between 2003 and 2012. Notably, much of this growth has taken place outside of official municipal boundaries, with many residents relocating to suburban areas where land and commodity prices are cheaper (see satellite images).

In Vietnam, cities expand by annexing rural communes or districts to fall within their administrative boundaries. This has occurred for instance in Hue, which has grown by incorporating three communes over the last several years. Cities like Lao Cai and Hue are incentivized to expand in such a manner for several reasons. All cities strive to move up the ladder on Vietnam's urbanization classification hierarchy (City Class 1-6.), as this equates to a higher level of political autonomy and financial resources. This incentivizes outward expansion of urban boundaries by incorporating formerly rural communes.2 There is also a strong fiscal incentive for these processes: as areas become urban, the government is able to purchase (through voluntary or involuntary processes) land from farmers at the rate for rural land based on Vietnam's land price framework, and sell to private buyers at the price for urban land. This is one of the few sources of revenues for provincial governments that is not subject to appropriation and transfer by the central government.

Population growth has occurred in a similarly rapid fashion. Official census figures suggest significant demographic growth of Thai and Vietnamese cities over the past decade—Phuket Province's total registered population for instance increased from 221,835 to 351,909 people, or by 58.6%, from 1997 to 2011. However, even these types of statistics showing significant growth vastly underestimate actual residency, as they exclude urban residents who live in suburbs just outside municipal boundaries, unregistered international and domestic migrants, and tourists. The issue of registered residents is particularly apparent in the case of Phuket. In addition to the registered residents in the island, the number of unregistered Thai workers living in Phuket was estimated at 177,000 in 2012. Estimates of Myanmar and other migrants vary enormously from state estimates of 100,000, to estimates by NGOs of more than 300,000. The range in these estimates suggests that the true figures of migrant workers are difficult to pin down. Meanwhile, the annual number of tourists increased from 2,660,420 in 2009 to 8,891,039 people in 2012. Considering that the island boasts over 167,000 hotel rooms, for any given day in Phuket the number of people on the island, comprising registered residents, non-registered Thai workers, migrant laborers and tourists could well exceed 1.5 million, and may potentially be as high as 2 million in the peak tourist season. Further, the peak tourist season, when the population is at its highest, corresponds with the dry season on the island when the shortage of water is most acute.

There are echoes of this situation in Udon, which has considerable expanses of agricultural and forested areas; a significant portion of the district's nearly 400,000 residents live in the urban area, but there are only about 138,000 official residents counted in the municipality. Infrastructure and resource management is being planned based on official figures, resulting in insufficient projections of budget, water and energy needs.

Cities are Expanding into Hazardous Areas

As urban areas grow, they are expanding into spaces that are naturally hazardous and, where floods, and in some cases landslides, and other climatic disasters are already regular occurrences and can have significant impacts. Key infrastructure, businesses and homes built in

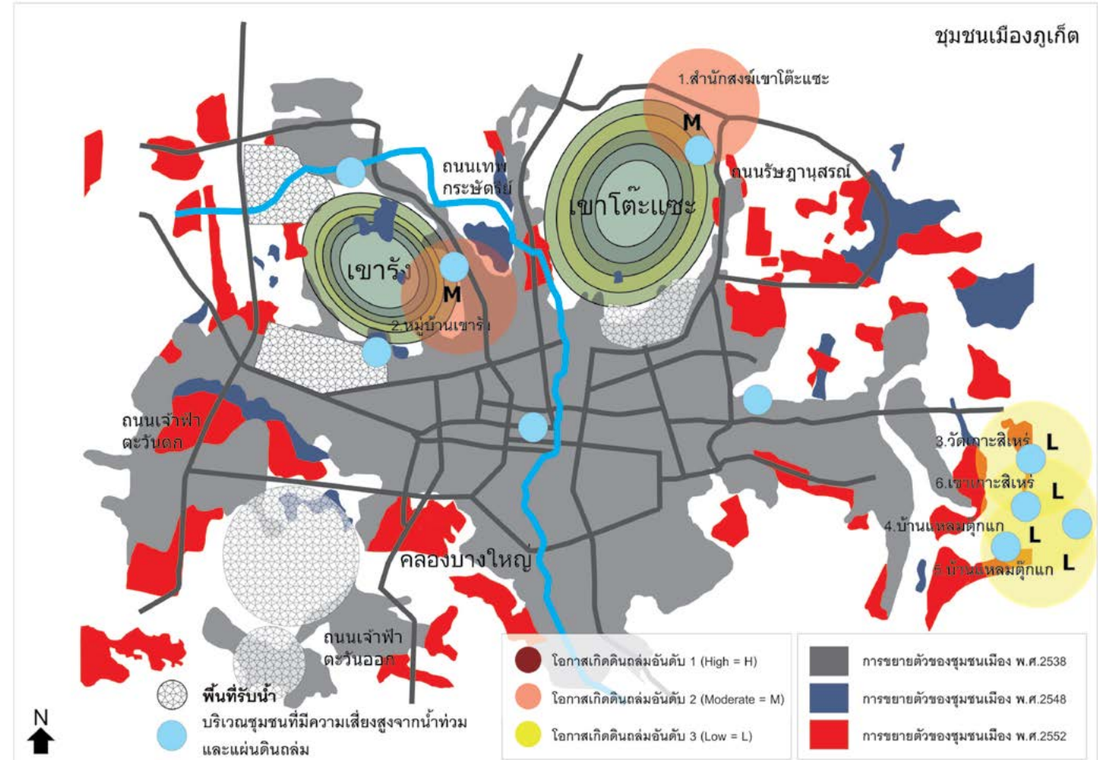
HUE
Tho Nguyen, ISET-Vietnam, 2013

these areas are at risk. At the same time, there is growing evidence that sometimes infrastructure built in these zones can change, exacerbate or otherwise alter some of these climate impacts.

This problem is evident in each of the M-BRACE cities. Udon Thani concentrates its urban area in the center of its saucepan-like topography. This means that residential complexes and public facilities like government agencies, hospitals and fresh markets are located in flood-sensitive areas. A ring road that was built around the outskirts to accommodate the urban growth has also cut off water movement into some key drainage zones, which has created or worsened flooding problems in some locations. Recent floods have shown that some areas in and near new urban expansion are now experiencing inundation for longer durations than other areas, and there is a growing recognition that urban expansion into flood-prone areas intensifies floods in these areas and that some of the infrastructure can also indirectly worsen floods in other, nearby areas.

In Phuket, loss of forested land and development on island slopes has contributed to downstream vulnerability. Luxury residential complexes and vacation resorts are being built on lands that are already prone to erosion. Further development increases the risk of landslides that can affect both hillside properties and properties located below, and reduction in the island's capacity to absorb rainfall can lead to longer and more extreme flood events. Encroachment on watersheds and drainage channels also lowers the ability for floodwaters to exit the municipality, and recent years have seen several floods affecting small- and medium-sized businesses throughout Phuket municipality.

FIGURE 4
FLOOD AND LAND SLIDE SENSITIVITY MAP FROM PHUKET

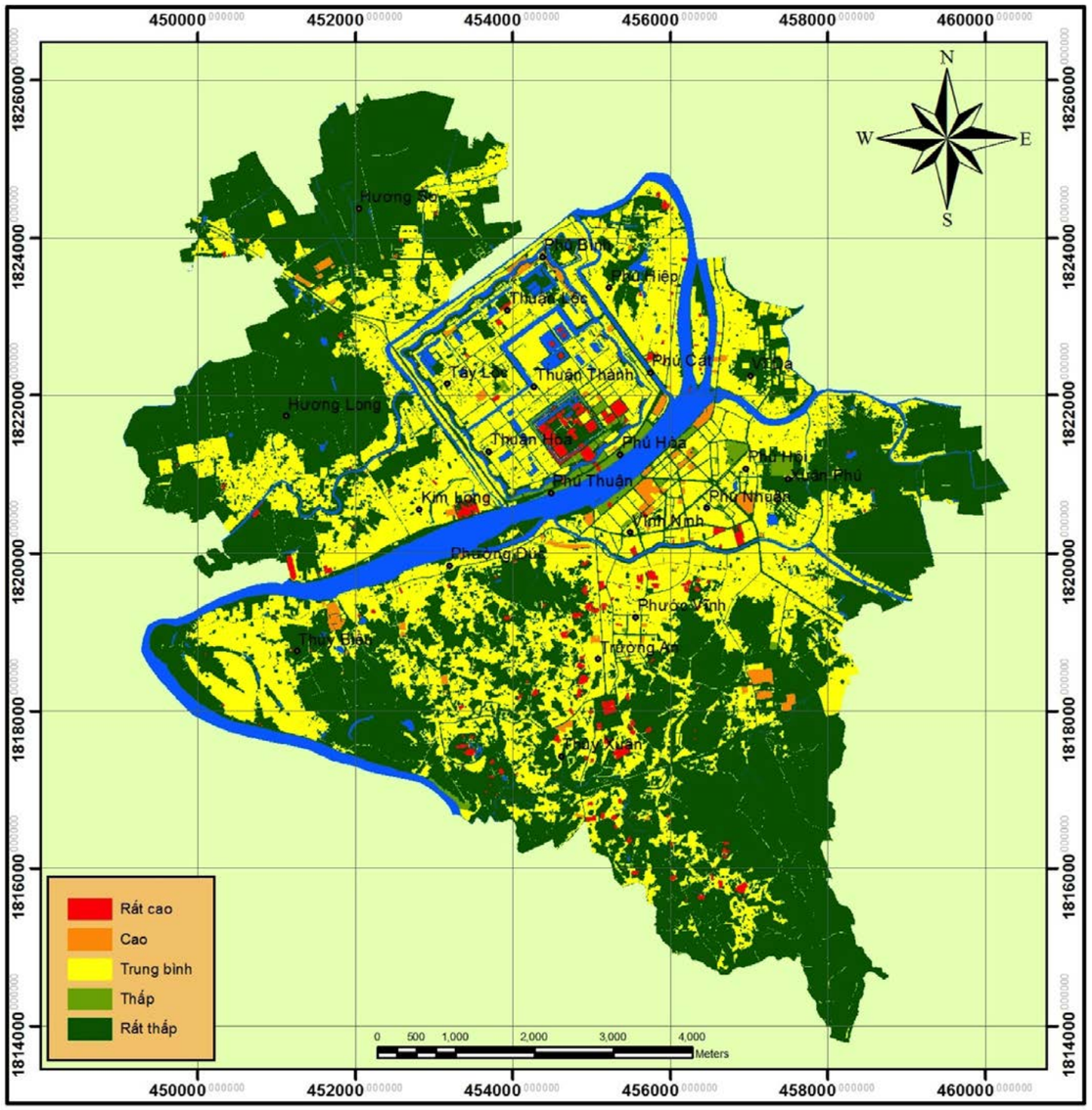


ภาพ 4.1-10 แสดงบริเวณชุมชนที่มีความเสี่ยงสูงจากน้ำท่วมและแผ่นดินถล่ม ในเขตเมืองภูเก็ต

Overview of flood and landslide risks in Phuket Municipality. Flood ways are denoted by shaded areas and communities at risk for floods are represented by light blue circles.

The yellow, orange, and dark red circles denote areas at risk from land slides along a scale from low risk to high risk. The grey, dark blue, and red show the growth of the city between 1995, 2005, and 2009 (respectively).

FIGURE 5
FLOOD MAPS FROM HUE VA SUMMARY



Hue City has expanded to the east of the city in low-lying areas that were previously the city's main drainage areas. Urban expansion includes activities such as road construction, land-raising and infilling; it often operates under the assumption that new land should be higher than the lands nearby, but this has resulted in drainage challenges as water is now draining in different directions and into older parts of the city. The Imperial City in Hue, the ancient seat of Vietnamese kings and a key part of the country's culture and history, is one area that is at risk from greater flooding as urban infilling continues.

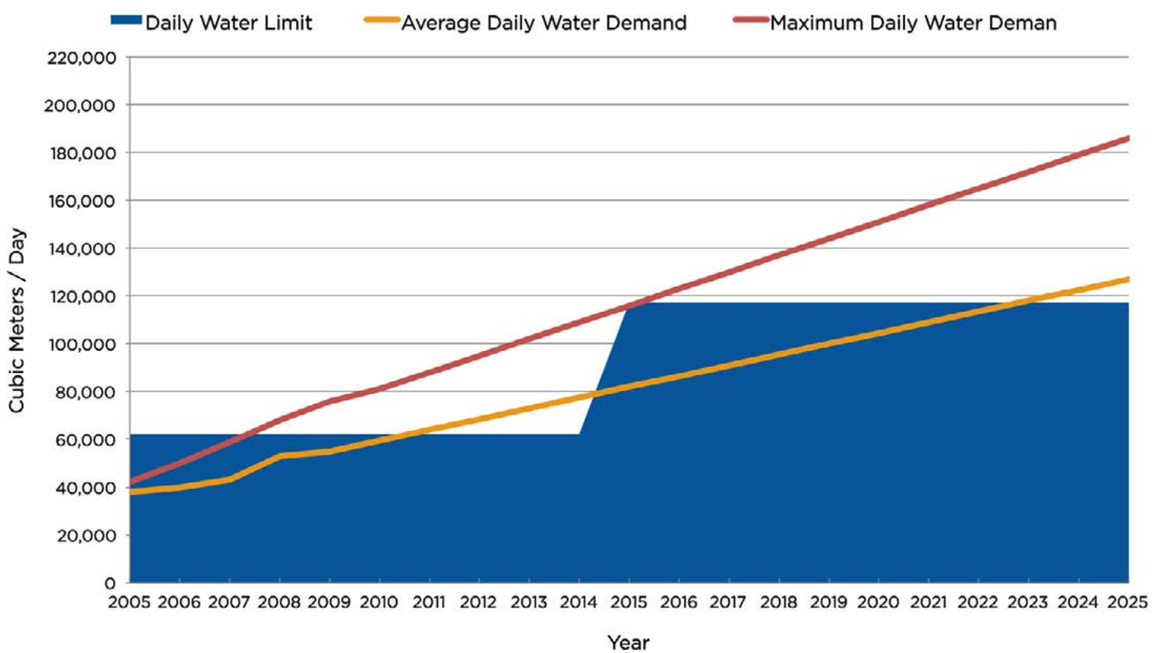
In Lao Cai, settlements have been established along the banks of the Red River, contributing to new flood risks. The Red River, Nam Thi River and other water streams are lined by new small and medium businesses. But all of these areas have experienced recent floods. Infilling of a lake in Kim Tan to make way for a new resettlement area has created a new flood zone. Meanwhile, ongoing road construction of the TN 7 route has redirected floodwaters towards neighboring Xuan Tang ward. The Hanoi-Lao Cai-China Highway cuts across several major streams and is blocking the floodway in Cam Duong Commune. Mining works have created small pockets of severe inundation by increasing soil movement downwards from the hill and inhibiting water flow during storms.

Across all of the M-BRACE cities, despite the problems arising from urban growth, rapid expansion is typically encouraged under provincial urban master plans. The urban master plan for Thua Thien Hue Province envisions further expansion into the southeast and eastern floodplains of the cities, with much of the planned development including residential zones as opposed to industry. Yet, this area's location on the coast, with fewer protections, such as lagoons and mangroves, makes it not only susceptible to flooding, but at a much greater risk from typhoons and other storms. In Lao Cai, new construction is planned along the river where flooding problems already exist, with plans to protect this region by extending the existing river dike.

Across all of the M-BRACE cities, rapid expansion is encouraged under national and provincial development plans.

EROSION IN TA PHOI, LAO CAI
Source: http://vov.vn, 2012

FIGURE 6
PHUKET IRRIGATION CAPACITY VERSUS DEMAND



Across the M-BRACE cities, urban expansion has also begun to strain available natural resources, particularly water, upon which these cities rely.

Natural Resource Pressures

Across the M-BRACE cities, urban expansion has also begun to strain available natural resources, particularly water, upon which these cities rely. In Phuket, city officials have struggled to maintain a balance between water supply and demand. Investments have been made in the water supply system, such as in new reservoirs, but current projections based on piped domestic water use and demand, which include expected usage and plans for developing new water sources project that demand from registered water users will outpace demand within five years. As alarming as this is, these projections are also known to be incomplete, not fully accounting for the huge increases in tourists and the high demand for water from the tourism industry, or for the growing demand from the non-registered foreign and domestic migrant laborers residing on the island.

At the same time, anecdotal evidence from interviews and consultations in Phuket highlights the widespread perception that water availability is a growing problem. Phuket residents suffer from frequent water shortages with private trucks selling water in the dry season. It is widely reported that people are accessing groundwater, and that while there is a registration process to monitor access, much of the access to water is informal and not registered. Users accessing groundwater include large businesses and hotels, which are protecting themselves from the shortages by drilling deep wells. It is reported that doing so requires going deeper than ever before—sometimes to a depth of 100 meters—suggesting that the water table of the island is being depleted.

Ambitions to increase the number of tourists visiting Phuket are an additional concern, which will add people and require additional workers, thereby increasing demand. The seasonality of these pressures is also a concern. The peak season for tourism occurs during the dryer part of the year when the island's natural water resources are at their most constrained. If the climate projections of decreased water availability in the periods of greatest demand are realized, the island could faces serious water insecurity with grave economic consequences.

In Lao Cai, plans project that the city's population will double or even triple by 2020, with new industrial estates planned. The Red River and Nam Thi River originating in China traditionally served as the city's primary freshwater source. However, pollution in the Red River has become so severe that the city has abandoned use of it for water supply, and stakeholders have observed an unstable flow from Nam Thi River due to upstream dams. For this reason, the water supply company plans to shift the city's main dependence to streams from watersheds around Lao Cai. But apatite and gold mining activities have reduced the quality of this water source, and there is concern that changing rainfall in future decades will further threaten it. Projections for increases in population, along with plans for new industrial plants, indicate that water demand will soon surpass supply.

Finally, in Udon, where the city depends on water resources from the Huay Luang Reservoir, plans for water supply are based on an assumed 5% increase in demand each year, without projecting actual needs based on urbanization, population growth and industrial growth trends. In addition, current planning is largely based on the rainfall being able to replenish reserves in reservoirs in intervals throughout the year. These assumptions were challenged recently in Udon, when a 2012 drought forced the city to prioritize certain water uses over others (namely urban and industrial uses over agricultural uses). During times of water scarcity, decisions on water restrictions, prioritization and distribution resemble decisions in times of flood that are made by provincial agencies to deal with a specific crisis of that time. Further, while there is limited information on the projected water consumption for planned developments of a new industrial estate and a potash mine, comparisons with other similar projects suggest that these developments will consume water at a level that will challenge the province's ability to meet all the demands. These developments are worrying as, unless they are managed very carefully, they could contaminate ground and surface water.

In sum, before considering climate change impacts, it should be realized that urban growth and expansion processes are resulting in a range of new vulnerabilities, including a greater likelihood of climatic and natural disasters as urban areas expand into hazardous zones and build infrastructure that disrupts natural barriers to managing disasters and generates potentially significant shortages of natural resources, particularly water.

As well as creating a lot of economic benefits, urban growth creates new vulnerabilities, including a greater likelihood of climatic and natural disasters as urban areas expand into hazardous zones, and generates potentially significant shortages of natural resources, particularly water.

HUAY LUONG RESERVOIR
Richard Friend, ISET-International, 2013

WOMAN IN LAO CAI
Richard Friend, ISET-International, 2014

3.2 Changing Patterns of Vulnerability

In addition to creating new vulnerabilities, across all four cities, urbanization processes are also changing the nature of who is vulnerable and the ways in which they are vulnerable. In Vietnamese cities, for example, the changes in land use and holdings, and associated shifts in formerly rural livelihoods, create both opportunities as well as vulnerabilities. Expansion of industry and mining has created new demands for limited land resources. Lao Cai Province has expropriated land from farmers for apatite mining and for construction of a new road, providing compensation and resettlement. However, because tracts of land granted to displaced households are smaller than those expropriated, for many displaced families farming is no longer viable as a primary source of income. In certain cases, the new lands given to farmers have higher exposure to natural hazards – many farmers displaced for highway construction were resettled into an area developed on a former lake, where flooding is now a major problem. For farming households resettlement to make way for mines and roads, is in principle only temporary, and households can recoup their land once mining has finished; yet many are concerned about the future quality of the land after mining activities are completed.

While there is growth of other job opportunities in mining and industry, at the lower end of the income scale, households have limited financial ability to change livelihood strategies or diversify their incomes. These residents receive compensation in form of a one-time payment of VND10 million (US$500) per household, a sum that is insufficient to meet basic needs or enable effective transitions. In addition, within resettlement areas, many households still have no water or electricity. Under the city's current development plans, the expropriation of farmland will need to continue. Through M-BRACE, stakeholders in Lao Cai identified this activity as a key element creating risks for those who have been resettled and increasing demands on urban service providers; it therefore requires particular attention.

A similar story can be seen in Hue, where rural-urban transitions result in compensation for former farmer households as the city acquires rural land for urban development. In Hue, the compensation for the land is considered to be closer to actual land value than in Lao Cai, yet there are many documented cases in which farmers, having lost their key productive asset, eventually end up impoverished.

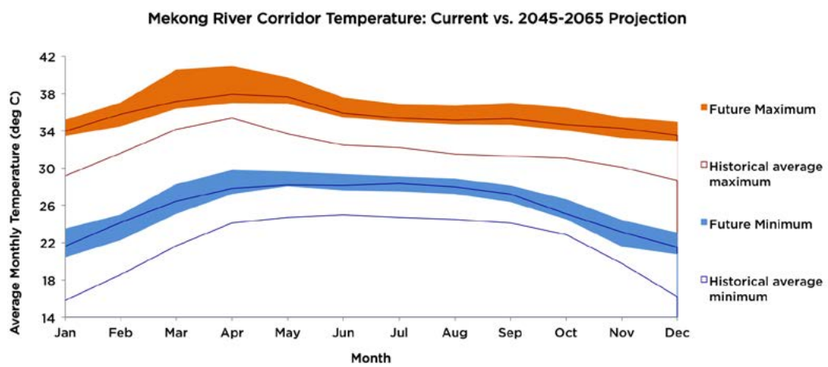
In addition to changing the patterns and nature of vulnerability, urbanization also makes it more difficult to identify and define vulnerable groups. Official poverty lines in both countries are often based on rural indicators, or urban indicators that do not capture the extent of urban poverty, or the specific needs of people living in urban areas. Other factors, such as the geographic characteristics of a residential area, are also known to be insufficient indicators of climate vulnerability. As such, official statistics or otherwise, are not able to provide the insight needed to understand and assess urban poverty and urban climate vulnerability.

The case of migrant workers in Thailand highlights some of these challenges. As noted above, the population of Myanmar migrant workers in Phuket may be as high as 300,000, nearly equal the size of the municipality's official population. There is an additional significant, but unknown, number of migrant workers from other countries and from other provinces within Thailand. Yet, these groups are not registered or accounted for in any specific way. National budget allocations, which are based on official population figures, thus are too small and unrealistic for addressing the needs of migrant workers. Informal settlements, often built on marginal public land, such as mangrove forests and along sewage-filled canals, lack basic facilities and services – exposing residents to vector-borne diseases and other risk factors. Further, because the communities are informal, there is often minimal communication with and from the government, meaning that critical information about storms or disasters rarely reaches them. At the same time, their wages can be well above the poverty line, but because they have to pay for all services, from drinking water to food to medical care and education, most families are living in conditions that reflect significant poverty and limited room for maneuver in times of crisis.

3.3 Cities are Seeing Changes Associated with Climate Change

In addition to the aforesaid new and changing vulnerabilities relating to urbanization, there are additional impacts from climate change that threaten cities. Across all four M-BRACE cities, observed climate trends and anecdotal evidence suggest that each of the cities is already witnessing the kinds of fluxes that are associated with future climate change. Regional climate change projections suggest that the dry season will be longer and dryer, raising the risk of seasonal water scarcity. The shifts in

FIGURE 7
CLIMATE PROJECTIONS FOR UDON



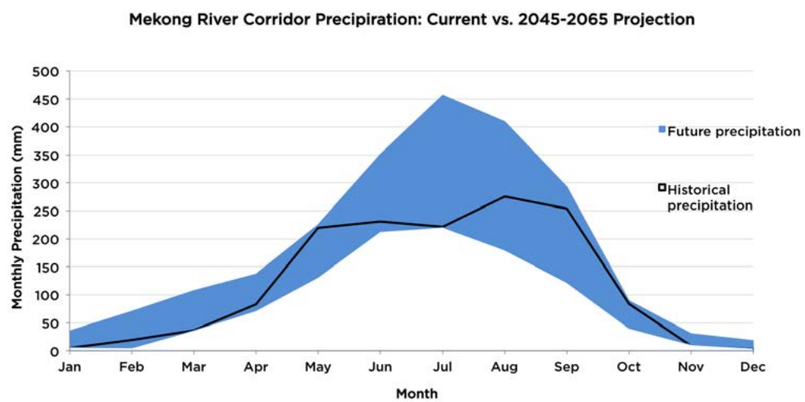
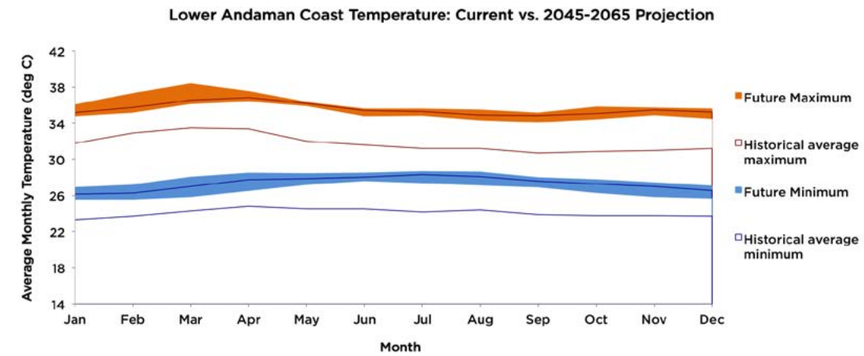
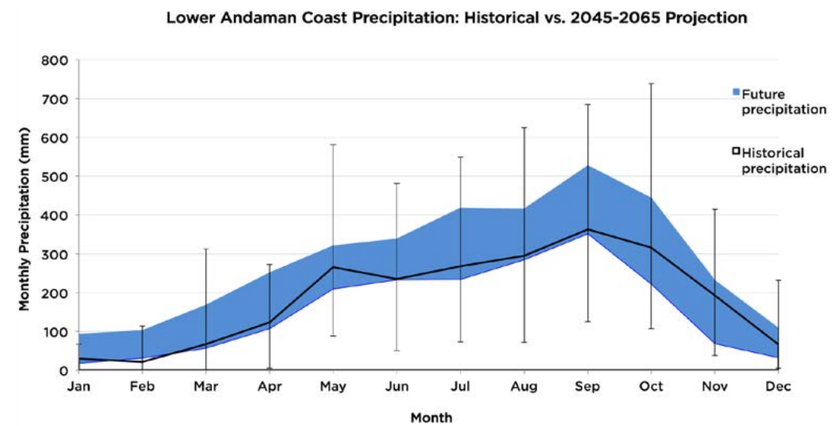


FIGURE 8
CLIMATE PROJECTIONS FOR PHUKET





seasonality will also influence the rainy season, predicted to be arriving later, shorter in duration, but with higher levels of precipitation. Historically the most dangerous time for hazards is from May to October during the rainy season, but this is also shifting. Hazards of different kinds are now occurring throughout the year with such risks clearly associated with changing patterns of land use.

In Hue, historical records suggest that dry seasons are become dryer and rainy seasons wetter in line with climate projections. From 2001 to 2011, July precipitation decreased by 23% while average annual precipitation increased by 22% in comparison with averages from 1961 to 1990.5 The province has experienced more rain events with increasing intensity over the last century. The observed increase in average annual rainfall increase is at a level higher than that suggested under Institute of Meteorology, Hydrology and Environment (IMHEN) projections based on the B2 scenario.

From historical records, Lao Cai has experienced less total precipitation, but a higher frequency of intense, heavy rainfall events. In the last 15 years there has been an observed trend of increasing average annual temperature, with prolonged and severe heat spells, including an early heat wave at the end of February 2010.

In 2012, Phuket City experienced significantly strong rainfall of over 170 mm in a few hours, resulting in severe flooding in the city, where the drainage system has a design capacity of 120 mm over the same time period. Climate change projections suggest that extreme events that can overwhelm systems designed for smaller events are going to become more frequent and less predictable. Yet, while the 2012 flood event suggests this kind of shift, data limitations due to the small number of weather stations (only two on the island), make it difficult to determine to what extent other flood events are the result of significant increases in rainfall or other factors related to development. In addition to changing rain patterns, temperatures are rising in Phuket, with the average temperature in Phuket increasing almost 1.5° Celsius over the last ten years.

Udon Thani is experiencing similar variation in rainfall. In 2011, the city experienced a dryer than normal dry season. The following year, owing to concerns about water scarcity, there was an effort to store more water in the main reservoir. But when the next rainy season was unusually wet, water had to be released during that period leading to flooding

in Udon. The dry season in 2012 was again unusually dry, leading to water shortages, and preventing the cultivation of the irrigated dry season rice crop.

Climate projections developed under M-BRACE recognize that there is significant uncertainty associated with future climate projections, but there are some clear patterns. In both Phuket and Udon, temperatures are expected to rise 2° to 4° Celsius. This trend is expected throughout the year and will be reflected in both higher high temperatures and higher low temperatures. At the same time, rainfall is expected to become increasingly unpredictable. Ranges for rainfall projections leave room for the probability of very wet rainy seasons, very dry seasons, very dry wet seasons and wet dry seasons. The uncertainty around rainfall leaves cities in a challenging place where water shortages as well as flooding are both significant concerns in the future.

3.4 Climate Change Knowledge and Information Gaps

All cities are struggling with building and improving the institutional mechanisms to deal with this increasing variability. This is perhaps the greatest challenge for managing a water system such as Udon's. With the combination of growing demand and competition, along with less reliable rainfall patterns, it is increasingly difficult to both manage peak water storage in the reservoir, and to reconcile competing interests for water in the dry season.

The capacity to build resilience to climate change depends on having credible public information to support preparation for hazards, and credible assessments of existing and future challenges, vulnerabilities and potential solutions to inform planning. This is a challenge in urban contexts in Thailand and Vietnam, where there are fundamental gaps in data, information and knowledge.

Systems for collecting and disseminating disaster information allow government, households and businesses to prepare in advance for natural hazards. The efficacy of these systems varies among the M-BRACE cities, but no city has yet implemented a fully robust early warning system. The Provincial Center for Hydrometeorology Monitoring in Hue is well equipped technically with real-time satellite transmissions system, weather forecast radar for early warning and regular training for staff. However, there are still some challenges related to coordinating among different agencies, sharing flood forecast information and issuing disaster warnings.

In Phuket, the current lack of flood warning information has posed multiple challenges for residents and visitors. Residents of Phuket City received no advanced warning of the 2012 flood that occurred at night. In the morning as people began clearing out water from their homes and businesses, they experienced another round of flooding, again with no advanced warning. Lao Cai likewise has gaps in the effectiveness of its early flood warning systems—residents complained that recent flash floods had taken them completely by surprise.

Similarly, the data needed to inform spatial and infrastructure planning and resource management are in many cases incomplete, unavailable or inaccessible. Credible baseline information on resources like water, energy and land are limited. In Phuket, there is no comprehensive information on water supply and demand on the island. While the formal water sector is well monitored, processes for buying water, developing and managing private reservoirs, and groundwater extraction are not monitored or tracked. The dispersed nature of these actions means there is no easy way to collect data, and it is thus challenging to comprehensively survey water balance. As such, there is no way to assess either water availability or demand, and therefore it is impossible to understand how changes, such as development and climate change, are impacting water resources, whether in terms of availability, demand or quality.

In Lao Cai each department keeps its own socio-economic data, planning and zoning information resulting in inconsistency among different sources. City planning information from the city-level urban management agency is not freely provided and difficult to access, even for government officials in Lao Cai. Though there is concern about water quality problems as a result of mining activities (for example with residents complaining about the quality of their drinking water, or that their private fishponds have turned black), there are no data to assess the nature and degree of contamination. The city does not conduct its own water quality monitoring. Through M-BRACE, local government partners have begun to seek out sources of information on water quality, but it is not clear whether this information exists and if so where it is archived.

Further, there are even indications that sensitive information related to land use, urban plans or large-scale development projects is not shared with relevant agencies or the public. Plans for a potash mine upstream from Udon Thani, expected to require heavy water extraction and which may threaten water sources with pollution, were not disclosed to municipal authorities until already approved by the province.

Efforts to assess future climate change impacts (for instance, by analyzing historical trends or downscaling climate projections) are hindered by a lack of full historical meteorological data.

RING ROAD CANAL IN UDON THANI
Richard Friend, ISET-International, 2013

This is particularly the case in Phuket and Lao Cai. Data from Phuket's two meteorological stations are not sufficient to develop an analysis of more general rainfall trends on an island where precipitation is highly localized. In Lao Cai, data housed in multiple agencies are discontinuous and inconsistent, with whole years of data missing or multiple, conflicting datasets for the same period.

With the exception of Hue, none of the M-BRACE cities had previously conducted assessments of disaster or climate risks that could inform urban planning. Across the cities, assessments are undertaken only in the aftermath of disasters, tracking damage costs for the primary purpose of determining compensation amounts. Further, these risk assessments are conducted based on administrative boundaries, with limited consideration of risks stemming from surrounding areas.

Finally, while planning for climate change can be enhanced by quality projections, in those cases where projections are available, planners have not fully embraced uncertainty associated with them. Thua Thien Province, where Hue is located, has a variety of recent studies on natural disaster risk assessment for different sectors and areas. This includes a hydrological model that can run climate change projections, developed through a Japan International Cooperation Agency (JICA) funded project for Integrated Flood Management Planning of Huong River Basin. The province has used this tool to model projections under the B2 scenario for IMHEN. The city is applying these outputs in development of its urban spatial Master Plan, led by the Korea International Cooperation Agency (KOICA), a large undertaking that will guide development in the city for several decades. Yet, this presents a major risk: while the B2 scenario is commonly used in Vietnam and is favored by the government for investment decisions, it is considered an extremely conservative projection of future climate change. In Hue, the review by the M-BRACE Vulnerability Assessment team suggested that recent historical rainfall may have already surpassed the modest precipitation rate of increases projected under this scenario. This experience indicates the value of applying a range of climate scenarios.

3.5 Reliance on Engineered and Infrastructure Solutions

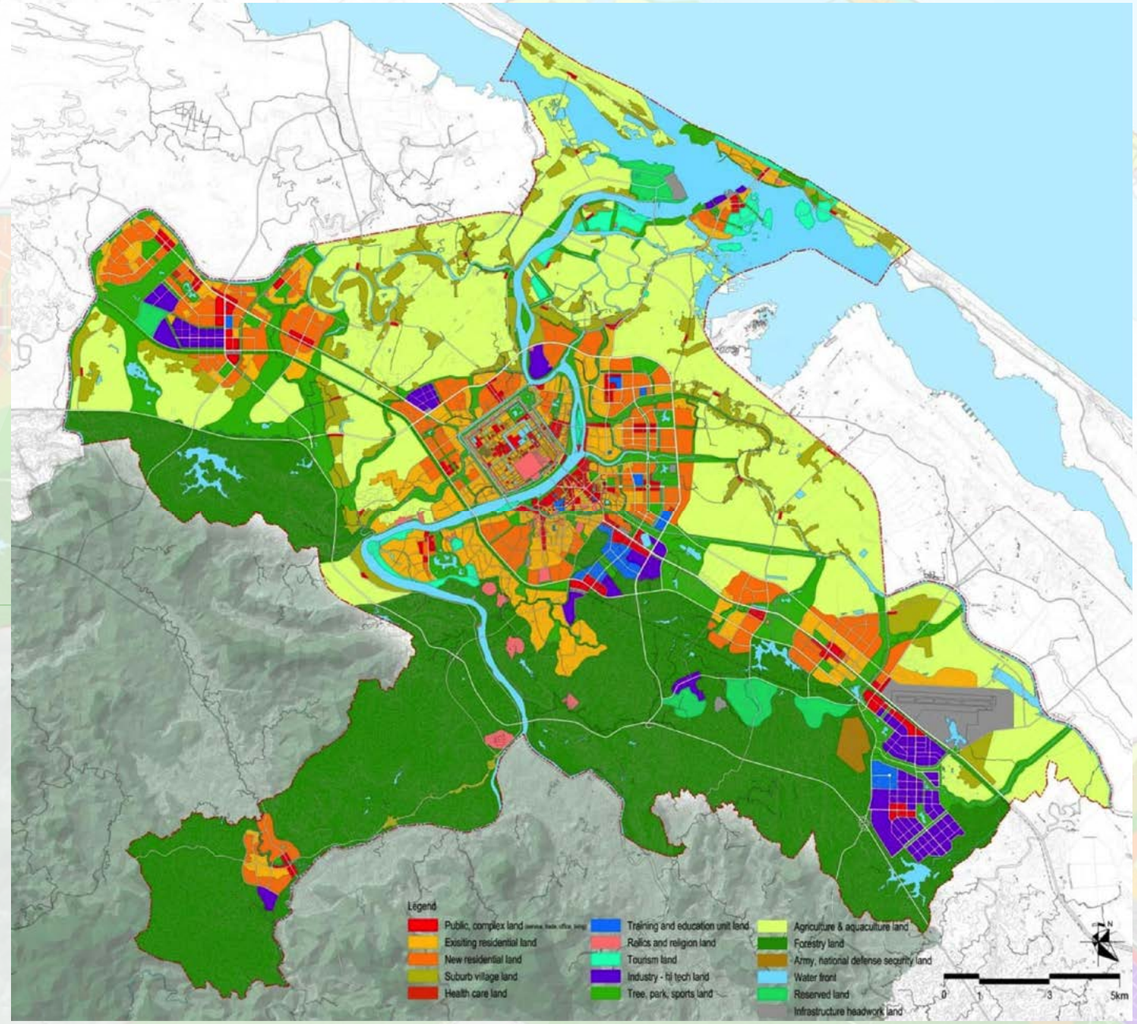
Urbanization and city growth depend on infrastructure to maintain water, energy, communications and transport systems, and thus to deliver critical services. The experience from the M-BRACE Vulnerability Assessments suggests some critical infrastructure in the cities is already struggling to deal with the kinds of pressures that are associated with future climate change, highlighting the importance addressing future climate risks in the design, construction and maintenance of future infrastructure. The kinds of infrastructure problems or failures experienced so far have not been catastrophic, but as urban areas grow, there are more people and more important assets that rely upon the continued functioning of infrastructure and are likewise at risk if infrastructure fails.

In both Phuket and Udon, drainage and road systems already cannot cope with existing floods. In both cities, critical infrastructure is poorly maintained so that in some cases it is barely functional. In Udon Thani a review of the piped water distribution system found widespread issues with pipes that are too small, clogged or broken.

The current drainage system in Hue is likewise inadequate due to both design and maintenance issues. A one-in-two year flood causes 70% of the city's roads to be inundated under 0.1-0.5 m of floodwater. In Lao Cai, the river dike system was designed to withstand a one-in-twenty-five year flood; however, more serious floods of one-in-one hundred and one-in-fifty years have already occurred in the recent past.

Moreover, the institutional mechanisms needed for regular maintenance and operations of these kinds of infrastructure are not yet in place. In both Lao Cai and Hue, there is no system for regular infrastructure maintenance. Intervention is taken only after facilities are found severely damaged or there is a failure. Maintenance budgets are small. As a result, much of Lao Cai's flood prevention infrastructure is already so poorly maintained that it does not

FIGURE 9
URBAN MASTER PLAN FROM HUE



LAO CAI
Tho Nguyen, ISET-Vietnam, 2014

As climate extremes make the possibility of failure more likely, cities will need to build and develop according to the principles of 'safe failure' such that even in instances of failing infrastructure people and key services in the city are safe.

provide the service for which it was designed. Drainage systems in Van Hoa and Kim Tan wards of Lao Cai are considered to be in critical condition. Forty percent of the total 20 km of river and stream dikes in the city boundaries is already compromised or vulnerable to breakage to during a flood.

In Hue, upstream flood management systems have struggled to balance between water storage needs and flood protection during the rainy season. This has led to large, sudden releases, as was the case in 2011. Decision-making on this issue is complicated by a number of factors, and is an example of the inconsistencies referenced above in trying to coordinate and link the activities of different agencies and organizations working on similar issues. Dams are privately owned and managed. Hydropower regulations are overseen by the Ministry of Industry and Commerce, whereas flood and irrigation system regulations are formulated by the Ministry of Agriculture and Rural Development.

All four M-BRACE cities have ambitions to expand their area and all are experiencing a boom in construction. Yet, current planning processes do not incorporate climate information, and national building codes and infrastructure standards (where they are applied) are based on historical events that may no longer provide an adequate guide to future risks.

Udon Thani is positioning itself as a gateway to the Mekong Region leading to further investments in infrastructure. It is experiencing one of the highest rates of increase in land values in Thailand as private investment is drawn to the city and surrounding area. As the city grows there are planning discussions around building a second ring road to accommodate the growing volume of traffic. However, the existing ring road is already considered to have created a barrier blocking the drainage of floodwaters outside the city, and there are concerns that an additional ring road will merely add another drainage barrier, further exposing the city to flood risks. This would require putting in place additional infrastructure to deal with these drainage challenges.

Further, current development is not taking advantage of existing natural features that can support and sustain the city. As the city grows, newly developed areas are connecting to the piped water system fed by Huay Luang Reservoir. At the same time, these new developments are infilling or releasing wastewater into the many small, local waterbodies that historically provided household and irrigation water for local communities. However, current research is exploring the possibility of rehabilitating these many resources and using them to support the water system in Udon, which would lessen the reliance on Huay Luang and strengthen the resilience of the city system.

In Vietnam, urban planners base infrastructure and planning decisions on historical flood return rates. However, with climate and land use change, these historical references are increasingly unreliable predictors of future conditions. Further, the historical data that flood return rates are based on are often limited and even without changes represent considerable uncertainty. This is particularly challenging where these probabilities dominate planning practices. Lao Cai is responding to current drainage problems by constructing a new drainage system and expanding the Red River dike. Neither design considers climate change projections; thus there is a risk of designing for floods that are smaller than those likely to occur in the future.

In contrast, the Master Plan of Thua Thien Hue Province does consider impact of urban flooding from climate change; as noted above, it incorporates outputs of the JICA-produced hydrological model under the B2 scenario. This leaves little room for failure with figures that may well be too conservative. Likewise, a number of plans and reports in Hue assume that three dams located upstream from the city will operate perfectly, reducing flood risk under current climate conditions. Yet, there have already been cases in which these dams have failed, and existing dam management problems will only intensify if historical trends of wetter rainy seasons and dryer dry seasons continue, as suggested by climate projections.

All of these factors point to a critical area of urban vulnerability and the value of resilience thinking in addressing future climate change. Engineered solutions are an important element of the broad arsenal of climate change adaptation strategies. But they need to be designed with future climate risks in mind, and budgets allocated to allow for regular maintenance. All infrastructure systems run a risk of failing, and with urbanization and

climate change the consequences of such risks are intensified – the assets dependent on and protected by infrastructure are much greater, and the potential of climate-related events triggering failure is much higher. A critical policy and planning consideration is thus how to ensure that any such failures are manageable and not contribute to catastrophic impacts. The concept of safe failure is of central importance for urban infrastructure resilience.

However, if cities continue to rely on infrastructure that has already failed, while developing under the assumptions that said infrastructure will not fail, these cities may be exposing themselves to the possibility of both small and catastrophic disasters that could be avoided. These are partly challenges related to design of infrastructure, but also to the institutional mechanisms for their maintenance and operation.

One of the most significant areas that will need to change to address this growing uncertainty will be the construction of new urban areas and infrastructure. With the possibilities of climate extremes more likely, it may be increasingly challenging to find areas to build on that are safe or to build infrastructure that is large and strong enough for storms. As climate extremes make the possibility of failure more likely, cities will need to build and develop according to the principles of 'safe failure' such that even in instances of failing infrastructure people and key services in the city are safe.

3.6 Institutional Arrangements for Disaster Risk Reduction are Stronger than for UCCR

Urban climate change resilience (UCCR) presents a new way of working for all of the M-BRACE cities, and cities are still developing their own understandings and skills to build resilience. Across the four cities, there is currently a greater awareness of and institutional arrangements for disaster risk reduction, rather than climate change. In many ways this puts the cities in a strong position to deal with climate change. But it also presents some challenges; for example, there appears to be a tendency to think of climate change solely in terms of disastersthat is specific impacts related to specific events—rather than more fundamental, long-term changes and the uncertainties, risks and opportunities they present.

Across Vietnam, disaster risk reduction is reasonably well established and functional. Vietnam has experienced devastating climate-related disasters throughout its history, and coastal cities, including Hue and Lao Cai, regularly experience severe storms and flooding. In Hue and Lao Cai, there are well-established systems and capacity to respond to and recover from disasters. Each year these cities develop flood and storm control action plans, identifying most vulnerable areas and responding to extreme events. In Hue in particular, there are specific plans for safe shelters, emergency supplies and household evacuation plans. Committees for flood and storm control have full-time staff at the provincial level and a roving command board to help manage and respond to disaster emergencies. In Lao Cai, the province is able to effectively coordinate and mobilize support from a variety of agencies, including mining and transportation companies, for flash flood response. These commands are able to mobilize residents, the military and other agencies (including mining companies working in Lao Cai) before and during a disaster. Rescue and provision of aid are thus considered by local stakeholders to be generally effective.

In contrast Thailand's experience of major disasters is rather limited and confined to specific areas. Nationally, institutions are seemingly less prepared than in Vietnam. At the city level, the Indian Ocean Tsunami of 2004 shaped Phuket's approach to disasters, but Udon's main experience of disasters is on a much lower scale, with two main flooding events in the last ten years. Institutional systems for disaster response in Udon Thani and Phuket have just recently emerged, with the implementation of disaster prevention and mitigation legislation in 2007.

In self-assessments, provincial disaster prevention and mitigation departments are still learning how

NATIONAL POLICY CONTEXTS FOR URBAN CLIMATE RESILIENCE– VIETNAM AND THAILAND

Vietnam has a well-established system for disaster response that spans the national to local level. Under the Ministry of Agriculture and Rural Development (MARD), each level of government in Vietnam has a Committee for Flood and Storm Committee and Search and Rescue (CFSC) responsible for disaster response and recovery. CFSCs are active at provincial and district levels, with an annual plan and budget. They are responsible for implementing disaster risk reduction measures such as early warning systems, training and awareness-raising on disasters and evacuation planning. Following disasters, CFSCs undertake post-disaster assessments to inform allocation of recovery budgets, sourced from local contributions, provincial and central budgets, and funds of international NGOs.

More recently, Vietnam has demonstrated a central-level policy commitment to addressing climate change. The central government has approved and is currently implementing the National Target Program to Respond to Climate Change (NTP-RCC) and National Strategy on Climate Change. The NTP-RCC was initiated in 2008 and required each ministry and province to develop an Action Plan to Respond to Climate Change, to be approved by the Ministry of Natural Resources and Environment (MoNRE). By mid-2013, some but not all provinces had completed their NTP-RCC action plans. These national policies also require integration of climate change into all new development strategies and policies. Guidance for integrating climate change into development plans has been developed by IMHEN.

To inform development of climate change policy and plans across Vietnam, IMHEN has released a series of government-sanctioned climate change projections. The projections provide average values for temperature, precipitation and sea level rise for approved scenarios, downscaled to a regional scale. In initial phases of the NTP-RCC, the central government mandated that all planners use the B2 scenario in developing their NTP-RCC plans, although policy has since changed and permits application of more extreme scenarios at local discretion. Field experience however shows that many local authorities are unaware of this or prefer to apply the government-favored B2 scenario to expedite national-level approval.

Climate change has not yet emerged as a serious policy priority in Thailand, and disaster risk reduction has just recently been introduced. The Disaster Prevention and Mitigation Legislation (2007) was introduced for establishing a Department of Disaster Prevention and Mitigation in each province. This new department is intended to provide an emergency unit for disaster response, and capacity building for municipalities.

At the central level, the Office of Natural Resources and Environmental Policy and Planning is the key agency in developing the National Climate Change Adaptation Strategy and providing guidance in climate change adaptation to agencies, civil society organizations and the private sector. The First Draft of the Strategy is still in the public consultation process. However, a number of agencies at the ministerial level and departments are already developing their own climate change strategies.

to most effectively respond to disasters. In both Thai cities, emergency flood responses during recent floods were perceived as inefficient and ad hoc. Neither city has an early warning system, or any mechanism for identifying or providing priority support to vulnerable groups. As a result of this gap, city residents often rely on themselves and their networks to cope during disasters. Volunteers, NGOs and foundations provide support to victims during and immediately after disasters. Disaster aid from the local governments arrives much later, and decisions about its deployment are not transparent. Yet, despite the important role many different groups are playing in disaster response, key decisions on emergency responses to hazards like flood and drought are not developed collaboratively with multiple stakeholders, but rather determined at the provincial level.

The definition of disasters in Thailand covers fires as well as natural disasters. Much of the planning around disasters addresses training to deal with hazards, but there is less attention to broader planning and how infrastructure can be developed in ways that might reduce risk. The 2011 floods in the Central Plains and around Bangkok have precipitated a new national investment initiative that is largely based around flood protection infrastructure, but so far there has been little involvement from local administrations in how such efforts could be designed.

Even in Vietnam, disaster risk reduction approaches are stronger at coping with impacts and recovery than with disaster preparedness or long-term planning. Action plans at the local level focus primarily on relocation, evacuation and cross-sector collaboration for early warning and rescue. Budgets for longer-term recovery are ad hoc, identified post-disaster and come from many sources, including transfers from the central government as well as voluntary contributions from individuals and businesses. The government conducts emergency drills, but stakeholders in Hue noted that they have low participation and are overly formalistic and structured. At the community level, stakeholders described instances of both very active and passive local responses. In Lao Cai, people reported waiting for instructions from the government rather than preparing in advance themselves.

Climate change resilience is a new concept in all cities, although adaptation planning has been initiated in Thua Thien Province. City stakeholders, including local government officials, are still developing their understanding of the concepts and science of climate change and how it might exacerbate existing vulnerabilities. The mandates of provincial disaster prevention and mitigation departments likewise do not cover climate change, and plans in relevant sectors such as water supply do not refer to climate risks, even where anecdotal evidence suggests that these are important concerns for local people. While stakeholders in Lao Cai are aware of the broad issue of climate change, the province has not yet developed its own plans under the countries National Target Program to Respond to Climate Change (NTP-RCC). There are no official climate VAs available for the city or province.

Hue is the only M-BRACE city that had already initiated climate adaptation planning. The province to which Hue City belongs received approval of its NTP-RCC Action Plan in 2013. The People's Committee engaged a consultant from Cadastre Land Consultancy and Service Company to develop the plan, which considers the provincial profile and environment, historical climate, climate change projections and potential impacts from climate change on a variety of sectors. It applies regional-level projections of the B2 scenario developed by Vietnam's IMHEN. On this basis, the plan prioritizes a set of 12 projects, including climate change awareness-raising, mangrove planting, reforestation of upstream arboreal forests, environment and natural resources monitoring, database development, upgrading or construction of embankments, dikes and flood barriers, and providing equipment and facilities for disaster response[1].

1 A full review of the Thua Thien Hue Action Plan to Respond to Climate Change was not conducted under the M-BRACE-supported Vulnerability Assessment, as the plan was not approved and released publically until the vulnerability assessment had already been completed.

MAPPING IN UDON
Richard Friend, ISET-International, 2013

The greatest challenge for each of the cities will be to support institutional mechanisms that allow for dealing with climatic variability and greater uncertainty. The nature of this challenge is clearly demonstrated by the case of Udon Thani. Rainfall patterns that are the basis for operating reservoir storage are so different from one year to the next that it is increasingly difficult for local institutions to determine when in the rainy season they should be aiming to reach maximum storage. If they store too early in the rainy season they run the risk of having to deal with heavy rainfall towards its end and having to release water suddenly in order to prevent dam failure. Yet even if they do manage to store enough water in the rainy season, they still face the institutional challenges of allocating limited water to a growing number of demands in the dry season. Dealing with these kinds of challenges will place enormous pressure on local institutions.

3.7 Planning System and Governance Challenges

At the heart of dealing with urbanization and climate change are governance challenges related to how problems and solutions are framed and actions undertaken. Addressing the challenges and changing vulnerability associated with urbanization and climate change requires solutions that build institutional capacity and governance mechanisms capable of dealing with the inherent uncertainty and risk that characterize climate change. These areas present some of the greatest challenges for the M-BRACE cities.

In Thailand, a national, shared vision for urbanization has not yet emerged. While national development strategies are based on Thailand expanding its economy through regional trade and further

growth of industry, manufacturing and services that will entail expansion of urban areas outside of Bangkok, there has been less consideration of what such urbanization might look like. This is even more apparent at the local level. Urban plans are often, as a result, a set of core communications and transport infrastructure investment plans and land use maps that are not linked to a city vision. In many cases, there are few spaces for longer-term thinking, such as about transport options beyond construction of roads, or of designing urban centers in ways that might protect public green space while also contributing to flood protection. The growth of urban areas across multiple administrative boundaries has exacerbated this issue—each administrative unit has its own economic imperatives for encouraging urbanization, but few institutional incentives to collaborate on a shared urban vision. In their current form, planning systems do not support coordination between municipalities and other local administrative units.

In Vietnam there is a clear and effective planning hierarchy and process. Yet the challenge is to accommodate the local-level context and climate-related uncertainties. Local Socioeconomic Development Plans offer broad visions and plans for urbanization, but as yet limited consideration of long-term visions of what such urbanization might look like.

Ensuring effective institutional coordination, collaboration and broad stakeholder participation is a critical challenge for addressing both urbanization and climate change. Overlapping jurisdictions and interests is a clear barrier. In Thailand, for example, the authority to approve infrastructure and industrial site construction is granted by three different laws to the National Industry Ministry, the Pollution Control Department and local administrative units; there is no structure for determining which of these government units has authority over what aspects of planning, construction and regulatory processes. Similarly, in Vietnam, there is often weak coordination between local agencies responsible for urban planning (Department of Construction), irrigation and urban flood management (Department for Agriculture and Rural Development) and transportation infrastructure (Department of Transportation).

Finally, many local and national governments are also failing to enforce the laws and plans that have been developed to guide development and address climate change. Land use planning in particular is weak and poorly enforced, leaving considerable room for maneuver in the planning system. In Thailand, plans bear little resemblance to development that is actually occurring on the ground. When land use plans are revised, they are updated to take into account changes that have occurred in violation of the previous plan. In Vietnam, the more rigorous planning system is nevertheless malleable. In Lao Cai, stakeholders noted frequent violations of land use planning. This has included land use purpose changes from commercial to residential or the conversion of lakes to schools and residential uses. Short-term benefits and speculative development play an important role in this process. Addressing these gaps in land use policy and planning will be critical in addressing future climate risks.

3.8 Intervention Projects in M-BRACE

As M-BRACE prepares to move beyond the vulnerability assessment phase, it will be working with all four cities to implement intervention projects and to identify policy changes that can promote resilience. Based on the findings of these VAs, the next steps of M-BRACE will focus heavily on institutional and agent-based approaches to building resilience, including by building the capacity of stakeholders, generating new knowledge and information, promoting more public access to information and advocating for approaches that allow for and enable flexibility in responding to a changing future.

TABLE 2
SUMMARIES OF CITY INTERVENTION PROJECTS IN M-BRACE

Country	City	City Intervention Summary
THAILAND	UDON THANI	The three intervention projects in Udon Thani all share the main objective to build capacity for climate change resilience, especially water management, using different approaches. This includes building awareness about uncontrolled urban development and creating a local youth network to begin to think about solutions for water-related disasters . A second project focuses on building the capacity of Udon to develop visions and plan for the future, including by building the capacity of city leaders to incorporate climate change and urban development information, to use tools to integrate planning and to collaborate with multiple stakeholders. The final project in Udon works at the community level to help community leaders and stakeholders collaborate with each other in order to understand and address the changes and impacts they are witnessing at the city level.
	PHUKET	Project interventions in Phuket aim to engage a wide range of citizens and stakeholders in better understanding and communicating about the important challenges the island faces. In Patong Municipality, M-BRACE is supporting the establishment of a community-based network for monitoring to protect upper catchment ecosystems that will involve a diverse group of people in looking at the challenges of water and flood management. The project will focus on building the capacity of the network in environmental management and climate change, promoting local ownership and collecting data. Another project under development will engage youth in telling stories by video; this will provide a platform to share some of the key challenges with the next generation in Phuket and with a wide range of people across the island. The final intervention will focus on developing a database of climate and weather forecasts so that stakeholders on the island have better access to information that can support planning and forecasting.
VIETNAM	LAO CAI	In Lao Cai, projects focus on two priority areas for intervention. The first relates to concerns highlighted in the vulnerability assessment about water scarcity under climate change conditions. The City Working Group is working to assess current total water supply for the city, current gaps in needs and delivery, and making projections for future demand and shortfall under conditions of increased urbanization and climate change. Second, the team has prioritized capacity building activities for members of relevant provincial and ward departments, including provincial leaders, city leaders and government staff, as well as commune-level residents, on issues including city planning and integration of climate change into socio-economic development planning.
	HUE	Intervention projects in Hue collectively address the risks associated with urban expansion into flood-vulnerable areas. The first project is a study to assess the risks under a series of scenarios outlining different climate change effects, urban development and reservoir management scenarios. These efforts will be integrated into a shared decision model that is being developed in partnership with the US Army Corps of Engineers. A final intervention project, being conducted in partnership with the Provincial Department of Transportation and the Provincial Center for Flood and Storm Control, applies mobile phone telecommunications technology to develop a real-time, participatory flood monitoring system, providing information for residents on flood levels as they are occurring and data to inform the flood model.

CLIMATE CHANGE AND CLIMATE THRESHOLDS

The M-BRACE approach to vulnerability assessments has included new approaches to understanding climate change. In particular, M-BRACE has applied the concept of climate thresholds—or levels at which the impacts of climate change have widespread and dramatic effects. Within this concept, climate change will not be felt as a series of long-term, cumulative small-scale impacts that collectively threaten a city, but rather that climate change will push conditions past the capacity of certain systems, such as food, water or disaster mitigation, so that they are no longer able to provide—at least for a certain period of time—the key services that cities and individuals rely on. These failures, then, could be catastrophic, having widespread impacts on the health, safety and livelihoods of people throughout the city.

In the four M-BRACE cities, there is already evidence that urban development is pushing the cities to the edge of some of these thresholds, and that climate change, in the form of unexpected or particularly extreme climate events could push the cities into crisis. In Udon Thani, for example, a recent drought resulted in a dry season where nearly all of the water stored in the province's primary reservoir was insufficient to meet demand, meaning that agricultural production had to be curtailed in order to maintain supply for urban domestic use. With ongoing city development that will include projects that require significant water resources, such as major industrial estates, it is easy to see how reductions in rainfall as projected under climate change scenarios could lead to hard decisions about allocation of water resources.

Across the other cities, evidence suggests that even slight changes in future climate could push cities beyond thresholds. In Hue, changes in land use and the growth of the urban area has resulted in more widespread and longer flooding, and even a slightly heavier than normal storm period may have widespread effects. In Lao Cai, increased mining and deforestation, as well as the movement of people into flood-prone areas, means that even storms that would have previously not have had a major impact may now result in major flash floods. Rapid urban growth in Phuket, without the additional investment in storm management infrastructure has already resulted in situations where rainfall exceeded storm capacity, leading to flooding.

All of this points to a need to understand the implications of climate change as well as urbanization in a city, and in particular to be able to understand where and how urbanization may exacerbate the impacts of climate change, or push the city towards a situation where those impacts could have particularly devastating impacts. Cities are already struggling to cope with many climate-related shocks. Climate change projections—with dramatic increases in temperature and ranges of precipitation for some areas—suggest that these shocks may well intensify the pushing of cities beyond thresholds.

RIVER BANK GARDENS IN LAO CAI
Richard Friend, ISET-International, 2013

4. CONCLUSION

HUE
Tho Nguyen, ISET-Vietnam, 2013

This summary of the Vulnerability Assessments conducted under M-BRACE points to cities that are in the midst of significant change. The process of urbanization is changing the size, face and shape of cities, thereby changing and creating new economic and social development opportunities. At the same time, urbanization also creates new sets of vulnerabilities and risks that are likely to be exacerbated by climate change. Historical and anecdotal evidence indicates that the cities are already experiencing changes and variability that are in line with climate change projections. However, addressing these challenges has not yet been taken up in local policy and planning.

Urbanization centers around land use change. In each of the cities, the pace and pressure of land use change places considerable strains on existing planning processes. Land use planning is rarely informed by long term visions of urban futures or assessments of climate related risks. Urban growth places a much greater demand on other key resources as well, such as water and energy. While many cities have developed around a local water source (groundwater or surface water), urban expansion is already taxing and depleting these local sources, forcing cities to find and develop new water supplies. Similarly, cities consume large amounts of energy in comparison to rural areas, and their growth will require additional energy sources. Already in Thailand and Vietnam, the requirements of different sectors are creating competition for energy resources among different sectors.

The M-BRACE Vulnerability Assessments point to critical areas that need to be addressed, specifically around data, information and knowledge, as well as institutional planning processes.

One of the most basic challenges for urban resilience programs are large gaps in knowledge and information. Given that these knowledge and information gaps cover such critical areas as urban growth and management, a core function of resilience projects can be to develop basic information gathering and monitoring systems that can help a city identify resilience-building priorities. As cities fill key knowledge and information gaps, they should look for ways to both provide public access to information and building public awareness of climate change and its potential effects. Improved data and information that are widely available is the basis for enabling city governments as well as private sector and civil society actors to incorporate and plan for climate change in their own work and activities. Individual actions combined with citywide efforts to address these challenges will lead to more resilient cities.

The growing uncertainty around climate change that cities are already experiencing also points to a need to take a different approach to climate change. For many cities climate change is going to have a wide range of impacts, beyond just increasing flood levels. It will be important to understand the potential impacts of climate change throughout the city. Further, the growing likelihood of extreme events increases the possibility for failure at different scales. While there has been significant investment in climate models to help cities understand the impacts of climate change, the uncertainty around future climate conditions suggests a need to plan and prepare for a wide range of future climate conditions. This requires a shift towards scenarios and thresholds in thinking about climate change.

These findings suggest new ways of working that resilience programs, such as M-BRACE, are well positioned to promote. Finally, and perhaps most importantly, the results of the VAs suggest that, by and large, building resilience will rely on approaches that strengthen institutions and build the capacity of agents, and will rely much less on technical, engineered and/or infrastructural solutions. For example, in a city that is dealing with regular flooding, while building a floodwall or floodway may protect part of the city against a certain level of flood, building the capacity to have effective and responsive land use planning will enable the city to meet and respond to a variety of future conditions. Working in this way will require building better institutions, for example improving planning processes, while also building the technical skills of agencies and individuals to engage in this kind of work.

Resilience efforts in a city should be designed and developed through a city-wide, inclusive process of shared learning and dialogue that can be the basis for identifying specific actions. Through these open, multi-stakeholder arenas, the city will be able to better understand the implications of changing conditions, the knowledge and information available throughout the city, and the needs of different groups as they relate to climate change and development. These shared learning processes can also serve as the basis for developing mechanisms and building an environment in which stakeholders are willing and able to see the benefits of sharing information.

Implementing effective resilience-building programs will require working at multiple scales and across communities. Building multi-stakeholder networks that connect government, private sector, and civil society actors will enable more collaborative approaches that draw on the respective skills of different organizations. This will also enable skills and knowledge in the context of how to respond to some of these challenges to be distributed more broadly.

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