Urban Vulnerability: Bridging Systems and People-Centred Approaches in Dawei, Tanintharyi Region, Myanmar

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Abstract:

"We face the challenge like a forest. There is the wind and the storm, if there is only one tree, it is easy to collapse. How about the forest?"
-(HH19.S2.M)

This research discusses urban vulnerability to environmental change in Dawei, Myanmar through the analysis of the exposure and sensitivity of urban systems. The scope of this research attempts to encompass the complexity of multi-scalar relationships between the exposure and sensitivity of urban systems and wider supporting ecological systems to climatic and non-climatic shocks and stresses. Moreover, this research aims to bridge systems and people-centred approaches by considering the existing sensitivity of vulnerable populations living in Dawei through the use of two case studies. Specifically, an urban livelihoods approach was used to consider the entitlements, priorities, and capacities of households to cope with shocks and stress given existing challenges. The analysis of findings have been presented according to nested scales, beginning with the macro-level in the consideration of the exposure of urban socio-ecological systems; the meso-level through the analysis of the differential exposure and sensitivity of two communities living in Dawei in light of access to urban infrastructure and services; and lastly, the micro-level through the analysis of household sensitivity through the application of a livelihoods approach.

Dedication

I would like to dedicate this work to my Sayar, Oo Saw Win, who has been an incredible mentor, teacher, and collaborator throughout this learning experience. Thank you for sharing your insight, guidance, wisdom, and kindness. Ah pwey neh lo deh. Kyay zu tin ba deh.

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List of Abbreviations

ADB Asian Development Bank

BSPP Burmese Socialist Programme Party

CHES Coupled Human Environment System

ECF Economic Corridors Forum

GMS Greater Mekong Subregion

ITD Ital-Thai Development Corporation

NLD National League for Democracy

SEZ Special Economic Zone

SLORC State Law and Order Restoration Council

1.0. Introduction

The growing concentration of people and economic activity in rapidly urbanizing areas in low and middle-income countries is creating new patterns of vulnerability to expected climate change impacts (IPCC, 2014; Douglas et al., 2008; UNISDR, 2009, 2011). The global shift in urban demographics informs the growing exposure of urban areas to climate change, whereby roughly 50 percent of the world's population currently lives in cities, with projections to increase to 70 percent by 2050 (UNDESA, 2010). The rapid urbanization of the world's population creates a host of vulnerabilities to climate change as the concentration of people, physical infrastructure and economic activity heightens exposure to certain shocks and stress (Wamsler et al., 2013).

Climate change impacts are expected to interact with and compound the existing social, economic, and environmental stresses that urbanizing areas in the Global South already face (Gasper et al., 2011; Wilbanks et al. 2007; Bulkely & Tuts, 2013). Existing vulnerabilities range from environmental stresses such as resource scarcities in terms of water and food, to socio-economic aspects of poverty. Moreover, climate change places an even greater burden on the existing resource and financial constraints of governments to address the needs of growing urban populations in terms of planning, infrastructure development, and the provisioning of basic services (Laukkonen et al., 2009). The institutional and financial resource constraints of local governments to provide for infrastructure and deliver basic services to growing urban populations in low and middle-income countries is compounded by capacity gaps to plan for, mitigate against, and adapt to climate change (IPCC, 2014). As such, vulnerability research requires an appreciation of how climate change compounds the existing development needs of urbanizing areas in light of contextual sources of poverty, institutional capacity, and financial resource constraints.

Importantly, poverty is one of the most significant contributors to the existing vulnerability of urbanizing areas in the Global South. The world's poor are increasingly living in urban areas, often without access to basic services and housing needs (Friend & Moench, 2013). Climate change is expected to exasperate the existing vulnerability of the urban poor by placing added stress on resources and system services, while increasing the frequency of climate hazards (Satthethwaite et al., 2007). Further, the urban poor are often situated in slums and hazard-prone areas that are extremely exposed to climatic disturbances (Satterthwaite et al., 2007). Given the precariousness of the livelihoods and settlement patterns of the urban poor, they are seen as the most vulnerable to climate change impacts, while having the least capacity to cope and adapt (Laukkonen et al., 2009). The urban poor are thus central to analyses of vulnerability, in which addressing issues of poverty

and exposure to climate shocks and stress simultaneously is a growing area of concern in development research and policy.

Last, urbanizing areas represent complex systems in which ecological and social processes coalesce to form intricate and multi-scalar dependencies that inform sources of exposure and sensitivity. The complexity and scope of relationships that weave across urban socio-ecological systems adds to the challenge of assessing vulnerability in light of the interaction of climatic and non-climatic shocks and stresses in rapidly urbanizing areas in the Global South. As such, attempts to understand sources of vulnerability in urbanizing areas in low and middle income countries require an in-depth understanding of how climate change interacts with complex socio-ecological systems as well as existing sources of exposure and sensitivity.

1.1 Urban Vulnerability in the Greater Mekong Sub-Region

Asia is exemplary of how rapid urbanization renders significant populations vulnerable to climate change. In the past 40 years, Asia has experienced a profound shift from a largely rural society to one that is increasingly urban (Table 1) (Pellegrini, 2015). Currently, half of the world's urban population resides in Asia, while projections estimate that by 2050, Asian cities will have grown by 1.25 billion people, equivalent to roughly 60 percent of Asia's total population (UNDESA, 2014). Much of this growth will occur in secondary cities with less than a population of 500,000 (Brown et al., 2012; United Nations, 2012).

Table 1: Urbanization in Southeast Asia

	Urban population ('000) (% of total in brackets)			Rural population ('000)			Urban annual growth rate (%)		
	1990	2010	2025	1990	2010	2025	1990-95	2005-10	2020-25
Cambodia	1,482	2,801	3,975	8,050	11,337	12,711	5.32	1.79	2.49
	(15.5)	(19.8)	(23.8)						
Lao PDR	647	2,054	3,563	3,545	4,147	3,866	5.06	5.30	2.95
	(15.4)	(33.1)	(48)						
Myanmar	9,664	15,388	21,777	29,604	32,575	31,417	2.23	2.45	2.12
	(24.6)	(32.1)	(40.9)						
Thailand	16,793	23,315	29,704	40,279	43,486	43,108	1.46	1.62	1.63
	(29.4)	(31.1)	(40.8)						
Vietnam	13,591	26,700	39,837	53,510	61,149	59,499	3.78	3.26	2.30
	(20.3)	(30.4)	(40.1)						

Source: UNDESA 2012

Larger urban centres often overshadow secondary cities in the consideration of vulnerability; however, there exists a real need to focus vulnerability research on smaller cities. This is especially

true for Asia, where cities often lack basic services, have higher rates of poverty, and lack institutional and financial capacities to prepare for and adapt to shocks and stresses (Middleton & Krawanchid, 2014; Tacoli, 2003; Satterthwaite, 2006). Further, rapid urbanization in Asia poses severe challenges to the way in which cities develop, as many developing secondary and tertiary cities struggle to deliver basic infrastructure needs and services to growing populations (Brown et al., 2012; UNDP, 2013).

Climate change exacerbates the vulnerabilities inherent to Asia's rapidly urbanizing population. According to the Intergovernmental Panel for Climate Change Fifth Assessment Report, "Asia has a large—and rapidly expanding— proportion of the global urban exposure and vulnerability related to climate change hazards" (2014, p. 1346). The growing urban exposure and vulnerability of Asia to climate change is in part due to high rates of population growth coupled with the migration of people to coastal urban areas (Nicholls & Cazenave, 2010). Accordingly, more than 18 percent of Asia's urban population resides in low-lying coastal areas that are highly exposed to sea level rise and climate change-related extreme weather events (McGranahan et al. 2007). Asia also has the largest urban population facing water shortages today, with increased projections of water shortages due to climate change by 2050 (Brown et al., 2012; McDonald et al., 2011; Bates et al., 2013). Additional sources of vulnerability to climate change in Asian cities stem from the saline intrusion of aquifers, and the increasing intensity of weather patterns, with the latter potentially leading to the escalating severity of cyclones, storm surges, flooding, as well as increases in vector-borne and diarrheal diseases (Pelligrini, 2015).

1.2 Urban Vulnerability in Myanmar

Myanmar is especially vulnerable to climatic and non-climatic shocks and stresses, having extremely high levels of exposure coupled with high rates of multi-dimensional poverty and low levels of human development (Eastham et al., 2008). Myanmar is classified as a least developed country by the World Bank, ranking 150 out of 189 countries by the Human Development Index, while standards of living lag behind other East Asia countries (World Bank, 2015; UNDP, 2013; MIMU, 2015). Myanmar has a total population of 51.4 million people, 25.6 percent of which live below the national poverty line (World Bank, 2015; CIA, 2014). Notwithstanding, a large proportion of households are clustered near the poverty line, and are highly vulnerable to falling into poverty in the event of a shock or crisis (Dutta, 2015). Studies suggest that health shocks are the most common shocks experienced by households, in which the illness or death of an income earner can have

devastating impacts in terms of lost income and health care expenses (Dutta, 2015). Infant and maternal mortality, child malnutrition, and non-communicable and infectious diseases remain persistent problems, which combined with malnutrition and Myanmar's weak public health environment, expose large populations to illness, disability, and premature death (Dutta, 2015).

Inadequate government expenditure on healthcare has resulted in the financial burden of illness being borne to households insofar as out of pocket payment accounts for 79 percent of total health expenditure (WHO, 2014). Weaknesses in Myanmar's public health system have led to the heavy involvement of the private sector in health care provisioning, which is illustrated by the high number of private clinics in Dawei (WHO, 2014).[1] Moreover, low levels of government spending on social assistance places the burden of coping and adapting to shocks and stresses on households insofar as government expenditures on social assistance represent only 0.02 percent of GDP, falling far below neighbouring countries and the regional average of 1.2 percent for East Asia and the Pacific (Dutta, 2015). Underlying vulnerabilities related to health underscore the sensitivity of Myanmar's population given the weak social security system and the limited financial resources available to low income households to buffer shocks and cope with stress.

Myanmar's underlying vulnerabilities of poverty and low levels of human development are exacerbated in the urban context, in which exposure to shocks and stresses is heightened. Urbanization in Myanmar is growing steadily, at a rate of 2.5 percent from 2010-2015, and currently one third of Myanmar's population now lives in urban areas (CIA, 2014). Additionally, the population density of Myanmar's urban areas increased from 6,200 people per square kilometre in 2000 to 7,500 in 2010, which ranks second behind Indonesia in terms of the greatest increase in urban population density amongst Asian countries (World Bank, 2015b). Myanmar's largest urban centres include Yangon— 4.6 million; Mandalay— 1 million; and Mawlamyine— 500 thousand (ADB, 2013). In 2009, there were 31 urban areas in Myanmar with populations of more than 100,000, the large proportion of which are concentrated in low-lying regions and coastal areas (ADB, 2013; UNDP, 2013). Despite steady rates of urbanization, the majority of people in Myanmar struggle with access to basic services, in which urban areas have inadequate water supply, drainage, sanitation, and wastewater facilities to service existing and growing populations (ADB, 2013). Moreover, the rapid growth of informal settlements in major urban centres as a result of rural-urban

[1] Dawei's healthcare environment illustrates the discrepancies between government provided and privatized healthcare, in which there is one General Township Hospital, one Maternal and Child Welfare Association, five Indigenous clinics, and forty-five private clinics (Naing, 2008).

migration and increasing land and rental costs compounds challenges posed to the development of urban infrastructure and services (ADB, 2013; Forbes, 2016).

High levels of exposure to climatic shocks and stress compound Myanmar's urban development challenges. Myanmar's overall climate vulnerability factor is classified as acute, with high levels of exposure to extreme drought; cyclones; intense rainfall; flooding; storm surges, and sea level rise (Institute for Sustainable Futures, 2011; NAPA, 2012). Myanmar was the second hardest-hit country by climate-related extreme weather events from 1991-2010 (Harmeling, 2011). Over the past 25 years, Myanmar has experienced 32 disaster events, which has affected more than 4 million people and has cause more than USD 4.7 billion in damages (Dutta, 2014). Given Myanmar's high level of exposure to climatic shocks and stress, high levels of poverty and low levels of human development, growing urban population and gaps in service and infrastructure provisioning, there is an apparent need for research to focus on issues surrounding urban vulnerability.

1.3 Research Questions

The IPCC recognizes that "more research is needed on impacts, vulnerability, and adaptation in urban settlements, especially cities with populations of less than 500,000" (2014, p. 1331). Two knowledge gaps are of particular interest to this research: (a) there remains a general lack of attention to urban adaptation and to the potential impacts of climate change at the urban spatial scale (IPCC, 2014; Hunt & Watkiss, 2011); and (b) there has been inadequate attention placed on understanding and addressing urban vulnerability, particularly in low and middle-income countries (Lahsen et al., 2010; Moser & Satterthwaite, 2008; Romero-Lankao & Qin, 2011).

This research contributes to the existing gaps in the literature surrounding urban vulnerability to climate change through a case study in Dawei, Myanmar. Two main bodies of thought are used to understand urban vulnerability (a systems perspective, drawing on the work of Turner et al. 2003 and a people-centered livelihoods approach, drawing on DFID's sustainable livelihoods framework). Key research questions include: (a) Which groups are vulnerable?; (b) How do select vulnerable groups frame sources of vulnerability in their lives?; (c) How do issues of urban system access and quality compound the existing stresses faced by select vulnerable groups?; and (d) How do select vulnerable groups cope with and respond to these stresses?

2.0 Vulnerability: Theoretical and Conceptual Approaches

The literature surrounding vulnerability to climate change has grown significantly over the past decade, corresponding with the shift in climate change discourse and policy to place greater attention on adaptation. The IPCC defines vulnerability as "the degree to which geophysical, biological and socio-economic systems are susceptible to, and unable to cope with adverse impacts of climate change" (2007, p. 27). Although there remain differences across understandings of vulnerability, definitions typically share three key elements, namely exposure, sensitivity, and coping and adaptive capacity (Table 2) (Miller & Bowen, 2013; Bruno Soares et al., 2011; Carter et al., 2007). The following section reviews the key components of vulnerability and how they speak to one another in discussions of vulnerability to climate change.

Exposure is often considered the external component of vulnerability, referring to the preconditions and positionality of physical assets, infrastructure, and populations in relation to climate related stimuli and impacts (Costa & Kropp, 2013; IPCC, 2014). Exposure is fundamental to the vulnerability of socio-ecological systems as it represents the degree or magnitude that a system will be potentially affected by an external impact, stress, disturbance, or perturbation. Conversely, sensitivity is considered the internal component of vulnerability, which is defined as the extent to which populations or assets are subject to change as a result of being exposed to a given hazard (Krellenberg et al., 2014; Kulicke et al., 2012). Put differently, it is the precondition to suffer harm when an impact occurs based on the characteristics of socio-ecological systems, which can vary from the frailty of infrastructure to the limited access of certain populations to essential services (Krellenberg et al., 2014; Kuhlicke et al., 2012). Taken together, exposure and sensitivity interact with and compound one another, determining the degree of an impact on a unit of analysis.

Coping and adaptive capacity are also key components of vulnerability, referring to the ability of a system to cope with and adapt to the adverse impacts of climate change. Coping capacity is the ability to manage and handle stress and disturbance, whereas adaptive capacity is the ability to adjust attributes or behaviour to manage and cope with existing or expected stress and disturbance (IPCC, 2012; Brooks, 2003). Both coping and adaptive capacity shape how systems and populations respond to and manage the adverse impacts of climate change, and are thus central to resilience (O'Brien et al., 2008). Resilience has grown to become central within discussions surrounding vulnerability to climate change. In its most simplistic interpretation, resilience is inversely related to vulnerability, in which the more resilient a system is; the less vulnerable it is to climate impacts (Bruno Soares et al., 2011). Resilience is generally understood as the ability of systems to cope with

an external stress or disturbance, and respond or adjust in ways that retain its basic purpose, character, and structure (IPCC, 2014).

Table 2: Selected Definitions of Vulnerability

"The degree to which a system or part of a system may react adversely to the occurrence of a hazardous event" (Timmerman, 1981, p. 21).
"Vulnerability refers to exposure to contingencies and stress, and difficulty in coping with them. Vulnerability has thus two sides: an external side of risks, shocks, and stress to which an individual or household is subject: and an internal side which is defenselessness, meaning a lack of means to cope without damaging loss" (Chambers, 1989, p. 1).
"the set of characteristics of a group or individual in terms of their capacity to anticipate, cope with, resist and recover from the impact of natural hazard. It involves a combination of factors that determine the degree to which someone's life and livelihood are put at risk by a discrete and identifiable event in nature or in society" (Blaikie et al., 1994, p. 9).
"Vulnerability is conceived as both a biophysical risk as well as a social response, but within a specific areal or geographic domain. This can be geographic space, where vulnerable people and places are located, or social space who in those places is most vulnerable" (Cutter, 1996, p. 533).
"Vulnerability is a state of defenselessness which renders a community powerless to withstand the debilitating effects of events commonly perceived as disaster or natural hazard" (Mustafa, 1998, p. 290)
"the ability or inability of individuals and social grouping to respond to in the sense and cope with, recover from, or adapt to any external stress placed on their livelihoods and well being" (Kelly and Adger, 2000, p. 328).
"degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity " (IPCC, 2001, p. 995).
"Vulnerability is the degree to which a system, subsystem, or system component is likely to experience harm due to exposure to a hazard, either a perturbation or stress/stressor" (Turner et al., 2003, p. 8074).
"the vulnerability of any system (at any scale) is reflective of (or a function of) the exposure and sensitivity of that system to hazardous conditions and the ability or capacity of resilience of the system to cope, adapt or recover from the effects of those conditions" (Smit and Wandel, 2006, p. 286).
"function of physical exposure to hazards, sensitivity to the stresses they impose, capacity to adapt to these stresses, susceptibility, fragility, and lack of resilience in socio-economic and physical infrastructures" (McBean and Ajibade, 2009, p. 180)

The consideration of exposure, sensitivity, coping and adaptive capacity in the conceptualization of vulnerability varies according to the different conceptual and theoretical approaches found within the literature. Despite the abundance of perspectives, there are three main

conceptual approaches to understand vulnerability to climate change, including: (a) biophysical approaches that are based in the natural hazards school; (b) social constructivist approaches that emphasize the contextual character of vulnerability; and, (c) integrated approaches, which aim to address the linkages between biophysical and social components within social-ecological systems (Bruno Soares et al., 2012; Romero-Lankao & Qin, 2011; McLaughlin & Dietz, 2007; Eakin & Luers, 2006).

The biophysical approach to vulnerability is largely based in the natural hazards tradition, which conceptualizes vulnerability according to biophysical sources of exposure and its potential impact relative to the sensitivity of the system under analysis (Bruno Soares et al., 2012; Romero-Lankao & Qin, 2011). This approach is characterized by a technical assessment framework that seeks to understand the nature of a hazard based on its magnitude, duration, frequency, and relative impact on a given system (Bruno Soares et al., 2012; Romero-Lankao & Qin, 2011). Biophysical approaches are described as being impact-oriented, in which vulnerability is conceptualized as an 'outcome' or an 'end-point' based on the exposure and sensitivity of a system to a biophysical hazard (Bruno Soares et al., 2012; Romero-Lankao & Qin, 2011). The risk-hazard framework is characteristic of biophysical approaches to vulnerability, which assesses the impact of an external hazard relative to the exposure and the sensitivity (dose-response) of the given unit under analysis (Turner et al., 2003). Elements of exposure and sensitivity are central to biophysical approaches as studies tend to consider the distribution of biophysical hazards and their relative impact on systems and populations (Bruno Soares et al., 2012; Romero-Lankao & Qin, 2011). Although biophysical approaches provide for an understanding of the external sources of vulnerability and its impacts, they fail to consider how and why populations and systems are differentially vulnerable, while lacking an understanding of the social, economic, and political factors that contribute to vulnerability (Romero-Lankao & Qin, 2011; Bruno Soares et al., 2012; Ford 2002; Cardona, 2004). The limitations of biophysical approaches in terms of its top down assessment framework and narrow understanding of biophysical hazards and impacts has led to the development of social constructivist approaches that emphasize how vulnerability is shaped by contextual factors.

Social approaches to vulnerability focus on the inherent and contextual aspects that render systems, areas, and populations vulnerable to climate change (Romero-Lankao & Qin, 2011; Bruno Soares et al., 2012; Ford et al., 2010). Social approaches are largely based on political economy, political ecology, and livelihood frameworks, which emphasize the social, economic, and political determinants that contribute to vulnerability (Romero-Lankao & Qin, 2011). According to this

approach, vulnerability is socially constructed, that is, how social, economic, and political processes influence the differential distribution of vulnerability across social groups (Romero-Lankao & Qin, 2011; Bruno-Soares et al., 2012; Liverman 1990; Adger 1999; Brooks, 2003). Elements of exposure, sensitivity, coping and adaptive capacity, and resilience are central aspects to considerations of social vulnerability, in which social systems are the fundamental unit of analysis (Bruno Soares et al., 2012).

Within social approaches, there are various theoretical frameworks that structure the way in which researchers approach and analyze how vulnerability is socially constructed. Political economy and political ecology approaches tend to focus on how vulnerability is differentially distributed within and across sectors, areas, and populations based on social, economic, and political considerations of access to and control over resources (McLaughlin & Dietz, 2008). Here, issues of poverty, class, social and economic marginalization, and the distribution of entitlements are key to understanding the social and contextual sources of vulnerability (McLaughlin & Dietz, 2008). Kelly and Adger (1999) for instance, consider how access to and control over resources constrain or support adaptation for social groups in coastal communities in Vietnam. Livelihood approaches represent another perspective to understanding the socially constructed nature of vulnerability, in which the assets and capabilities available to individuals, households, and communities are at the centre of analysis (IPCC, 2014; Romero-Lankao & Qin, 2011). Pelling (2003) for instance, uses a livelihoods approach to consider how access to different types of capital determines differential levels of vulnerability to environmental hazards in urban areas. Moser and Satterthwaite (2008) similarly use an asset-based framework to measure the adaptive capacity of households and communities in urban areas in low and middle-income countries.

Despite the variance in theoretical frameworks to analyze social vulnerability to climate hazards, these approaches seek to understand the causal and differential expression of vulnerability within and across systems and social groups (Romero-Lankao & Qin, 2011; Bruno Soares, 2011). Studies surrounding differential vulnerability vary widely, ranging from analyses of poverty and class (Adger, 1999; Jabeen, 2014), gender (Cannon, 2002; Ajibade et al., 2013; Kher et al., 2015), age, religion, and ethnicity (Bruno Soares et al., 2012 Chambers, 2006, Susman et al., 1983; Blaikie et al., 1994). Given that social approaches consider the underlying social, economic, and political context as ultimately responsible for shaping vulnerability within a system, the causal dynamics and structures that lead to vulnerability are central within frameworks (Preston et al., 2011; Hilhorst and Bankoff, 2004). The Pressure and Release (PAR) model developed by Blaikie et al., (1994),

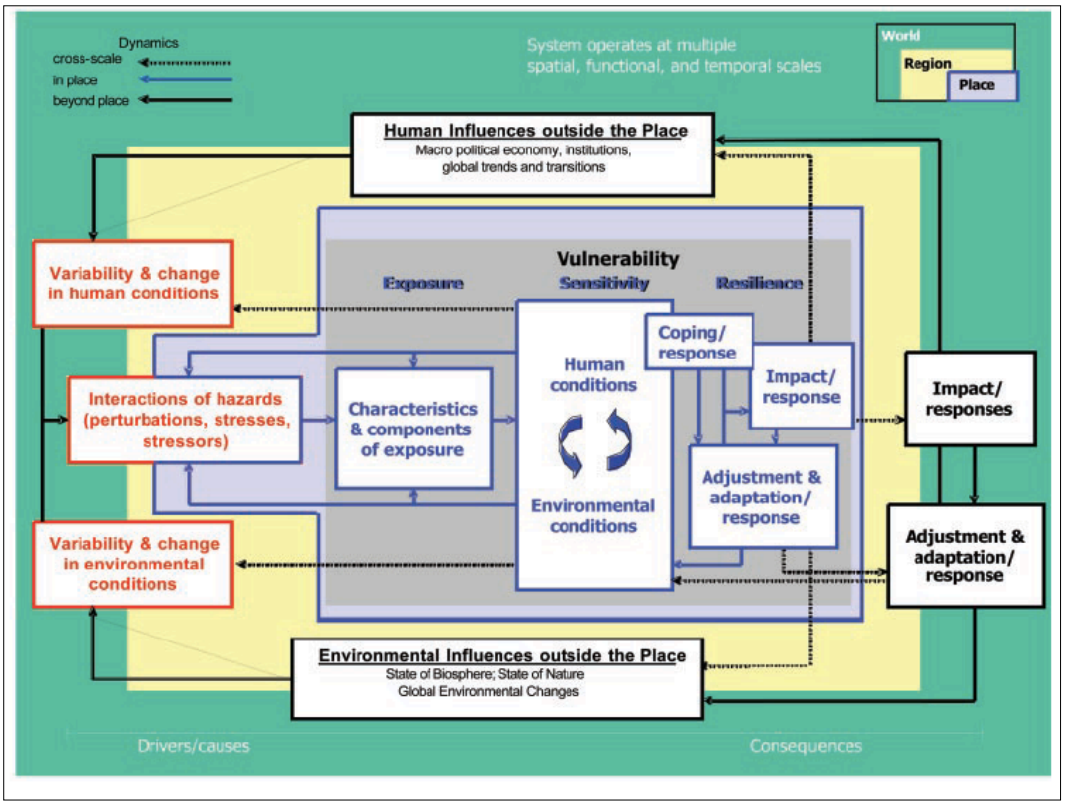
exemplifies how social approaches seek to understand the multiple and overlapping dynamics that render populations differentially vulnerable based on the confluence of root causes, dynamic pressures and unsafe conditions (Bruno Soares et al., 2012; Blaikie et al., 1994; Bruno Soares et al., 2012). Although social constructivist approaches provide for a strong understanding of the contextual and causal sources of vulnerability, they are criticized as lacking a complete understanding of biophysical hazards and impacts (Bruno Soares et al., 2012; Cardona, 2004).

2.1 Socio-Ecological Systems

As a result of the respective limitations of biophysical and social approaches, integrated frameworks that merge concerns between biophysical hazards and social, political, and economic factors have become the current paradigm in vulnerability research (Bruno Soares et al., 2012; Fussel & Klein, 2006; Eakin & Luers, 2006; Ford, 2002). This research draws from integrated approaches in applying the Sustainability Systems vulnerability framework by Turner et al., (2003) to consider the nested scales that inform the exposure and sensitivity of socio-ecological systems in Dawei. Integrated approaches draw from theories of complex systems and ecological resilience in framing the multi-scalar processes and dependencies that form between humans and the environment (Bruno Soares et al., 2012). The dualism between biophysical and social approaches is broken down insofar as the complex interactions between social and environmental components is modelled according to the coupled human-environment system (CHES) or social-ecological system (SES) (Folke, 2006; Bruno Soares, 2011; Liu et al., 2007).

The Sustainability Systems vulnerability framework considers exposure, sensitivity, and resilience according to multiple interacting stresses and scales affecting the coupled human-environment system (CHES), in which social and environmental systems interact through complex and dynamic feedback loops and linkages. The framework considers exposure as the extent to which components such as individuals, households, infrastructure, and ecosystems are subject to disturbances and stressors (Turner et al., 2003). Exposure interacts with the sensitivity of human and environmental conditions, framed according to social and biophysical capitals and endowments, while resilience is modelled as a matter of responses in terms of impacts, coping, and adaptation.

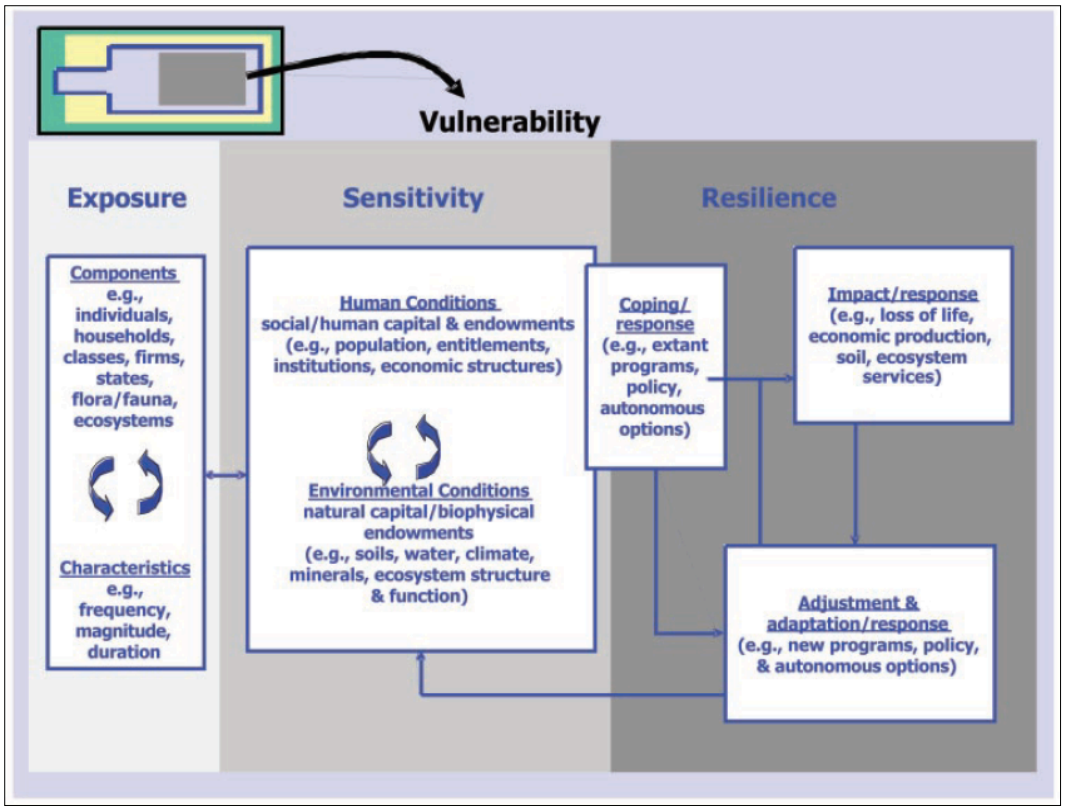
Figure 1: Sustainability Science Conceptual Framework



Source: Turner et al., 2003

The rationale for applying this framework to this research context is to understand the interactions between social and ecological processes at local, regional, and global scales. The consideration of nested scales, cascading impacts, and the interaction of hazards at multiple levels aligns with an urban systems perspective insofar as the failure of one system component, (electricity generating plants, drinking water supply, wastewater treatment facilities, sources of food, modes of transport) can have cascading impacts on other system components (Friend & Moench, 2013). The framework is also grounded by principles that attempt to balance systems thinking with people-centred approaches by placing importance on the role of local stakeholders in defining issues related to vulnerability that are of local concern through the use of participatory methods while extending analysis to the various scales in which these hazards originate and interact. Moreover, the framework places importance on understanding how institutional structures, processes, and entitlements distribute exposure, sensitivity and coping and adaptive capacities unevenly between social groups.

Figure 2: In-Place Model of Vulnerability



Source: Turner et al., 2003

The consideration of vulnerability in Dawei is framed according to elements of exposure, sensitivity, and resilience as illustrated in Figure 2. The analysis of the various climatic and non-climatic stresses present in Dawei is framed according to the exposure of Dawei's urban systems, wider supporting ecological systems, and the specific shocks and stresses affecting select populations. Sensitivity is considered according to the human and environmental conditions of urban systems and populations in Dawei, respective of urban infrastructure and services, as well as livelihoods. To emphasize resilience, the coping, impact, and adaptive responses taken by institutional structures, groups, and households is considered in light of exposure and sensitivity.

2.2 Sustainable Livelihoods

Sustainable livelihood approaches are often used to complement vulnerability frameworks by extending a people-centred approach to understand vulnerability at the household level. Sustainable livelihood approaches originally emerged from the seminal work of Amartya Sen in the 1980s, and the work of Chambers and Conway in the early 1990s (Ashley & Carney, 1999; Wisner et al., 2004). Sen's capability approach strongly influenced the development of thinking around livelihoods given

the importance of capabilities in pursuing livelihood opportunities, meeting basic needs, and coping with shocks and stress (Chambers & Conway, 1991). According to Sen, livelihoods provide the means to support people's livelihood objectives, while capabilities provide the means to pursue livelihood opportunities (Chambers & Conway, 1991). Sustainable livelihood approaches have since gained prominence in international development by framing questions of poverty according to people's lived experiences and the constraints that people face in pursuit of their livelihood goals (Ashley & Carney, 1999).

Livelihood approaches have been widely applied in vulnerability research through the sustainable livelihoods framework, which considers the capacities and assets of individuals and households to pursue livelihood objectives or cope with shocks and stress (Ashley & Carney, 1999). The vulnerability context provides the basis for understanding the environment in which people live, in which shocks, stresses, and seasonality are explicitly considered in relation to the asset profiles of households. Shocks can destroy and damage assets directly, while also forcing people to abandon their homes and dispose of assets as part of coping strategies (Ashley & Carney, 1999). Trends and stresses are more predictable and tend to be more benign, often affecting the rates of return to livelihood strategies in the form of seasonal shifts in prices and employment opportunities (Scoones, 1998).

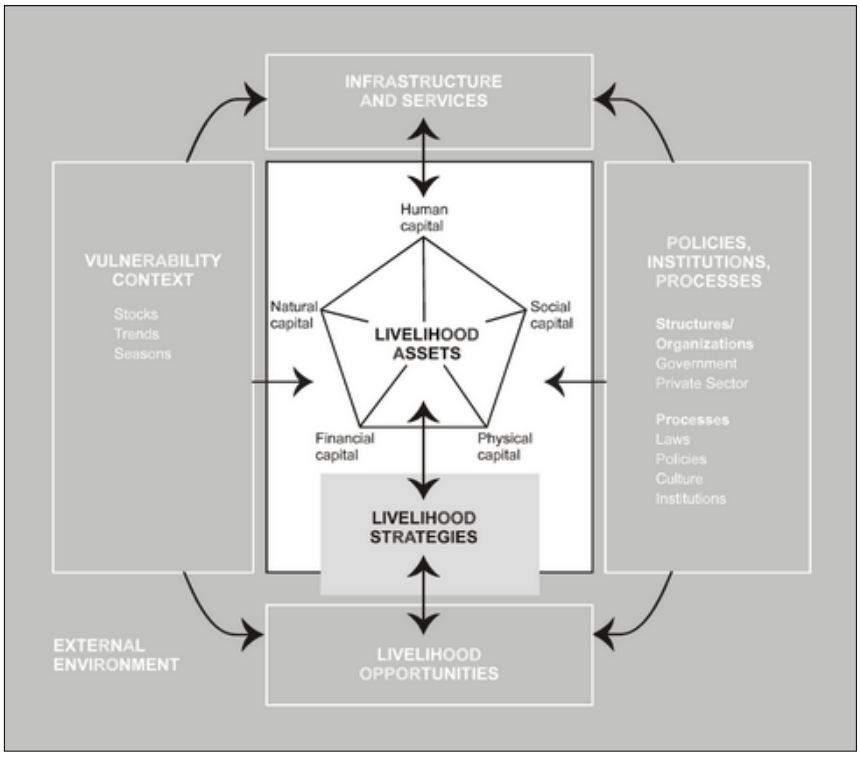
The framework considers livelihoods as the activities and resources in which people draw on to earn a living, in which the capacities and constraints of households are largely dependent on the combination of human, social, physical, financial, and natural capital. The stock of capitals available to households are termed as endowments, which range from education and health, financial earnings and savings, access to water and land, to the social networks in which people draw to cope during periods of stress or crises. Entitlement on the other hand, refers to the command of a household over a set of resources based on the ability to access different capitals and services through financial resources, formal and informal relationships, and legal rights (Farrington, Rasmut, & Walker, 2015).

Although the range of capitals in which a household is endowed shapes people's entitlements, financial and social capital are especially important in the context of urban areas (Miekle, 2002). Due to the highly monetized character of cities, financial capital is essential for determining access to goods, food, shelter, and water (Meikle, 2002). However, given the limited financial resources available to the urban poor, social capital is critical to accessing resources and coping with shocks and stress (Farrington, Rasamut, & Walker, 2002). Social capital refers to the networks of relationships and mutual support which people draw on to access resources within and

external to a community (Farrington, Rasamut, & Walker, 2002; James & Paton, 2015). Networks can either be vertical (patron/client) or horizontal (shared interests, familial, kinship); and formal through membership to organizations, or informal based on relationships of trust and reciprocity (Ashley & Carney, 1999).

Importantly, people's entitlements are fundamentally shaped by institutional structures that determine access to resources and infrastructure, deliver services, or the options of available livelihood strategies (Ashley & Carney, 1999). Institutional structures refer to the organizations that implement policies, deliver services, and perform functions that affect livelihoods, whereas processes refer to the way in which structures and individuals operate and interact (Ashley & Carney, 1999).

Figure 3: Urban Sustainable Livelihoods Framework



Source: Lloyd-Jones, 2002

The sustainable livelihoods framework provides an analytical tool to understand how contexts, structures, processes, and capitals shape the vulnerability, security, and well being of individuals and households. The application of livelihood frameworks to assess vulnerability varies in academic research and development practice, ranging from approaches that assess the capacities of communities to withstand climatic and non-climatic stress (Ried & Vogel, 2006), to more focused applications that assess the vulnerability of specific livelihoods (Miller, 2014), or those that seek to

determine the differential exposure of households based on livelihoods and assets (Fisher & Chhatre, 2015). More recent adaptations of livelihood frameworks in vulnerability research have emerged to include additional concepts and theories such as ecosystem services, social learning, and adaptive management (Reed et al., 2013). Most relevant to this research are adaptations of livelihood approaches to consider the unique social and environmental context of urban areas in framing vulnerability. The development of livelihood frameworks to consider urban contexts is especially warranted given the fundamental role of institutional structures and processes in shaping infrastructure and service access.

In light of the strengths of livelihoods frameworks in bridging household analysis with contextual factors and institutional structures, this research applies an urban livelihoods framework adapted by Tony Lloyd Jones to assess household vulnerability in Dawei (Figure 3). The rationale is grounded in the objective of applying a people-centred approach to understand vulnerability in the context of peoples' livelihoods, in which research is focused on the pressures and priorities that people themselves identify. The framework is also helpful for identifying key pressure points and the multiple stressors that affect peoples' livelihoods. The urban sustainable livelihoods framework is applied in the analysis of household vulnerability, which is discussed in chapter 5 in light urban system exposure, and in chapter 6, in the discussion of livelihoods.

2.3 Bridging Systems and People Centred Frameworks

This research attempts to bridge systems- and people-centred approaches to assess urban vulnerability in Dawei by applying the Sustainability Systems vulnerability framework with the Sustainable Livelihoods framework. The Sustainability Systems framework seeks to understand the multi-scalar relationships between human and environmental conditions that influence the exposure, sensitivity, and resilience of specific place-based systems. This framework is centered on understanding the processes and conditions operating at multiple scales that affect the vulnerability of specific places, and therefore the framework places much of the emphasis on understanding the broader context. The sustainable livelihoods framework on the other hand represents a more people-centred approach to understanding the vulnerability of specific groups, focusing on the priorities that people themselves identify and the livelihood strategies that they adopt in the pursuit of their priorities. In this way, the Sustainable livelihood framework is more focused on the interaction of household level vulnerabilities with institutional structures and processes, rather than understanding the exposure of urban socio-ecological systems.

Between the two frameworks, there are a number of similarities that bridge differences in attention to scale. Both frameworks recognize the political, socio-economic, and institutional structures and processes that shape the differential exposure and sensitivity of certain groups. Despite the varying emphasis on multiple and interacting scales, both frameworks are ultimately focused on understanding place-specific vulnerability, while valuing the role of local stakeholders in framing discussion. In bridging the two frameworks, the Sustainable Livelihoods framework aligns closely with the 'in-place' vulnerability model of the Sustainable Systems framework, whereby the vulnerability context of the Sustainable Livelihoods framework is captured in the exposure of 'in-place' vulnerability. The livelihood assets within the Sustainable Livelihoods framework is captured in the in-place sensitivity of the Sustainability Systems framework, drawing parallels between the former's focus on the five capitals and the latter's attention to the entitlements and endowments that shape peoples' differential sensitivity. Last, the livelihood strategies adopted by individuals and households is captured in the resilience column of the Sustainability Systems framework, in which the impacts of specific shocks or stresses, and peoples' coping and adaptation responses grasp the ways in which people respond to impacts.

In light of the similarities and differences between the Sustainability Systems and Sustainable Livelihoods framework, a number of opportunities are present for collaboration. The differential focus on systems and people-centred approaches opens the door to bridge a macro-level understanding of interacting systems, processes, and scales with a micro-level understanding of the specific vulnerability of certain groups within the socio-ecological system under analysis. Therefore, the Sustainability Systems framework allows for a 'big picture' understanding of the vulnerability context, which includes elements of exposure, sensitivity, and resilience, while the sustainability livelihoods framework develops an in-depth understanding of the stresses, shocks, and priorities that specific households identify.

3.0 Research Design

This chapter outlines the political economy, research scope and context, design and methodology, guiding questions, and contribution of this research to the understanding of urban vulnerability to climate change in Myanmar. The first section begins by outlining the political and economic history of Myanmar, followed by the scope and research context, which includes background information on Dawei's socio-ecological systems. The third section outlines the research design and methodology used for data collection and analysis, followed by the research questions used to assess vulnerability in Dawei. The chapter concludes with a short explanation of the contribution of this research to the wider understanding of urban vulnerability in academic literature and development practice.

3.1 Political Economy

Myanmar's history is rife with political turmoil, having been subject to over 100 years of British occupation, shortly followed by almost 50 years of oppressive military rule. After declaring independence from the British in 1948, Myanmar entered a short period of parliamentary democracy. However, post-independent Myanmar was plagued by communist and ethnic insurgencies, prompting the military to seize power in 1962 under the Burmese Socialist Programme Party (BSPP) (Keling et al., 2010). Under isolationist policy and state socialism, the political and economic situation of the country deteriorated, leading to mass unemployment, inflation, and economic stagnation (Jones, 2014). Mass democratization protests erupted in 1988 that were met with violent state opposition (Jones, 2013). In the aftermath of uprisings, the BSPP resigned to the State Law and Order Restoration Council (SLORC), which favoured pro-market reforms that led to the alliance between the state and an oligarchic 'crony capitalist' elite (Jones, 2014). Although elections held in 1990 led to the victory of the National League for Democracy (NLD), the military government

Map 1: Myanmar

Source: MIMU, 2015

refused to transfer power, instead pursuing its own "road to democracy" (Jones, 2014). The election of the NLD in the parliamentary elections in November 2015 marks a new era of political reform in Myanmar (Kempel & Nyien, 2014; UNDP, 2015). Optimism surrounding Myanmar's democratic transition however, is flanked by scepticism surrounding the oligarchic structures that pervade relations between the military, capital, and positions of power (Jones, 2014). Despite considerable barriers to reform, there is hope that as the country continues to open its borders in trade and diplomacy, good governance and economic growth can address development gaps stemming from Myanmar's political and economic history.

3.2 Research Scope and Context

This research centres on the city of Dawei; however, to understand vulnerability at the urban spatial scale, it is important to recognize the linkages that exist between Dawei City and its surrounding area. Therefore, the administrative Dawei District in Myanmar's Tanintharyi Region has been selected as the scale for analysis. The Dawei District is comprised of four townships: Dawei, Launglon, Thayetchaung, and Yeybu as the impact of economic integration with Thailand and other Mekong countries cannot be confined to just Dawei City or even the township. The Dawei District is located in the northernmost part of the Tanintharyi Region, which borders Mon State to the North, Thailand's Kanchanaburi province to the East, the Myiek District to the South, and the Andaman Sea to the West. The Dawei District comprises a total area of 13,750 square kilometres and is flanked by the Tanintharyi Coastline to the West and the Tanintharyi Yoma Mountain Range to the East (UNDP, 2014).

Map 2: Dawei City

Source: MIMU, 2015

Map 3: Dawei District

Source: MIMU, 2015

The Dawei District has a total population of 493,576 people (Ministry of Immigration and Population, 2015, p.18). At the township level, Dawei accounts for the largest population in the district with 125,605 people, followed by Launglon (118,317), Thayetchung (105,662), and Yebyu (100,768) (Ministry of Immigration and Population, 2015, p.18). The Dawei Township is the most urbanized in the Dawei District, with 63.8 percent of its population living in urban areas, which largely reflects the urban population living in Dawei city (Ministry of Immigration and Population, 2015, p.18). The Dawei District is comprised of many ethnic groups and minorities, including Dawein, Karen, Mon, Shan, and Rakhine (UNDP, 2014). The majority of the population in the Dawei District are ethnic minorities, Dawein and Karen.

Table 3: Population Statistics for Tanintharyi Region and the Dawei District

	Population	**Urban Population**	**Rural Population**	**Urban Population (%)**
Tanintharyi	**1,408,401**	**338,419**	**1,069,982**	**24**
Dawei	**493,576**	**107,956**	**385,620**	**21.9**
Dawei	125,605	80,117	45,488	63.8
Lounglon	118,317	5,334	112,983	4.5
Thayetchaung	105,662	11,305	94,357	10.7
Yebyu	100,768	4,744	96,024	4.7

Source: Ministry of Immigration and Population, 2015

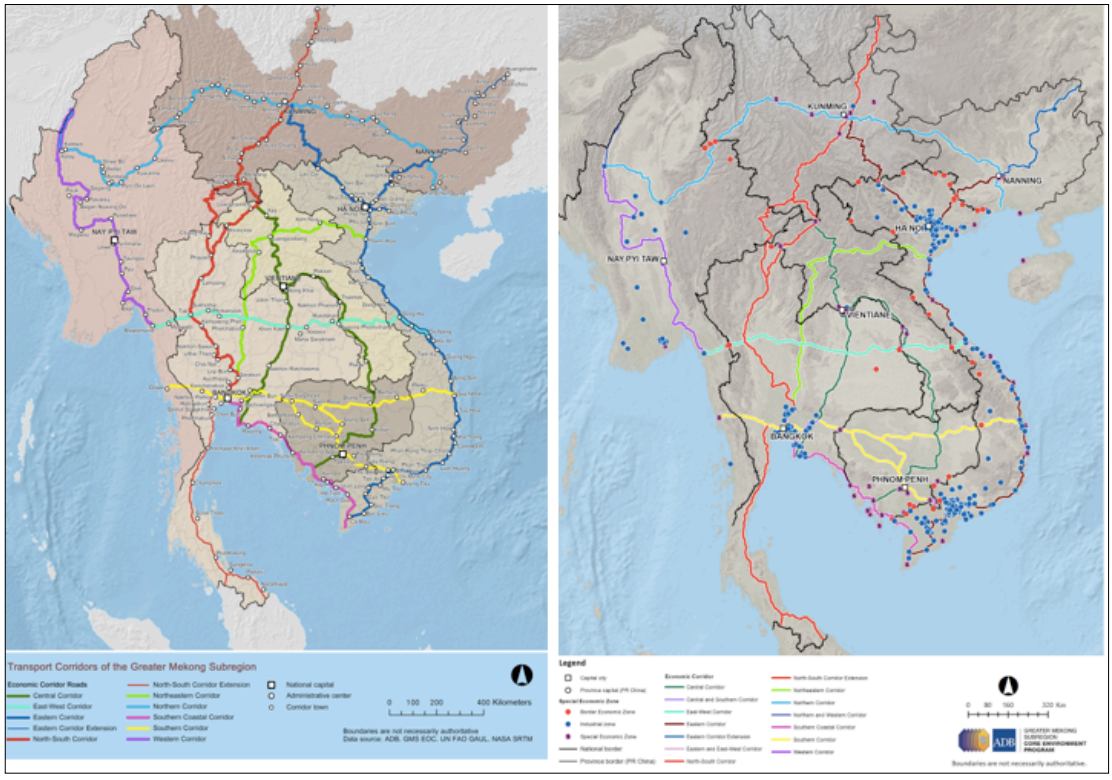
When considering population statistics for Dawei city, data retrieved from the Immigration and National Registration Department suggests that Dawei has a total population of 141,274 people. However, the discrepancy between population statistics from the Immigration and National Registration Department for Dawei city (141,274), and the Tanintharyi Regional Population Census for the Dawei Township (125,605) suggests that government data should be taken as one source of information among others. According to the Immigration and National Registration Department, Dawei city comprises of 15 wards and spreads over an area of 10 square miles, with a total population density of 14085. The wards within the city with the highest population are Hteinthit, Sinseik, and Kyetsarpyien, and the wards with the highest population density are Thinbawseik, Daungoo, and Peintaw.

The economy of the Dawei District is largely driven by agriculture, forestry, mining, fisheries, and to a limited yet growing extent, tourism (UNDP, 2014). Seasonal employment and underemployment has led to the large out-migration of native workers to neighbouring countries such as Thailand, Malaysia, and Singapore (Loewen, 2012). For context, the Tanintharyi Region has one of the highest records in the country for household members living abroad (203,232) ranking fourth after Mon State (426,586); Kayin State (322,761); and Shan State (235,869) (Ministry of

Immigration and Population, 2015, p.37). The Dawei District accounts for more than half of the total population living abroad from the Tanintharyi Region, which is largely fuelled by lack of employment opportunities. Accordingly, most people living in Dawei between the ages of 15 and 45 are working as migrant workers, with the majority living in neighbouring Thailand (Dawei Project Watch, 2012).

Important to understanding the research context is the planned Dawei deep-sea port and special economic zone (SEZ). The Dawei SEZ will be the largest of its kind in the region being over 200 square kilometres in size, and requiring more than USD $50 billion in investment (Mahithirook, Wiriyapong, & Tansubhapol, 2012). The project plans to become a major gateway to Southeast Asia as the development of a 138km road corridor to Thailand's Kanchanaburi province effectively links key economic hubs of Bangkok, Phnom Penh, and Ho Chi Minh to the Indian Ocean (Dawei Bursts into Life with Japanese Aid, 2015).

Map 4: Transport Corridors in the GMS **Map 5: GMS Special Economic Zones**



Source: GMS Environmental Resource Centre

The Dawei SEZ is therefore important to regional integration efforts in the Greater Mekong Sub-region (GMS), which was formed in 1992 by the Asian Development Bank (ADB) under an initiative to support integration through improved transport and economic development in the

Mekong region (Pongsudhirak, 2015). Regional connectivity has been a central pillar of the GMS programme, and since its establishment, it has funnelled over USD $15 billion in transforming regional transport corridors into full fledged nodes of economic activity through investments in transport infrastructure, the facilitation of cross-border trade, and the development of Special Economic Zones (SEZs), especially in border areas (Private funds for GMS urged, 2014; GMS Economic Corridors Forum Meets in Vietnam's Capital City, 2014).

The Dawei SEZ is therefore representative of how regional flows of investment surrounding transport connectivity and industrial development have drastic social, political, economic, and environmental implications in shaping vulnerability. The growth of industry alongside the influx of labour and capital, and greater regional connectivity to Thailand will ultimately change Dawei's positioning in the region as a key economic centre linked to the GMS. This process of regional connectivity and urbanization is already taking place in Dawei as the city grows with the prospect of the SEZ. As Dawei continues to urbanize, there is a need to consider how to bridge existing gaps between the provisioning of urban infrastructure and services in light of growing demand, while considering existing and potential vulnerability of urban socio-ecological systems to climatic and non-climatic shocks and stresses.

3.3 Research Design and Methodology

The research design comprises of three sequential phases of data collection, which includes the collection of primary and secondary data spanning household, community, urban, and district levels. The research design aims to foster a sequential and iterative process to learning, beginning with an understanding of the wider social, economic, political, and ecological context then moving into a detailed understanding of household level vulnerability (Appendix A). This sequential process to data collection draws from Bunce, Rosendo, and Brown (2010) and DFID (2000). Primary data collection draws from multiple sources of information and methodologies in order to triangulate information and develop a comprehensive understanding of the exposure and sensitivity of urban systems and populations to climatic and non-climatic shocks and stresses in Dawei.

Key informant and household level interviews involved the use of an oral translator, which translated between interview questions and responses. Key informants were selected beforehand based in secondary research and knowledge of governmental departments and organizations present in Dawei. Households were selected through snowball sampling, in which initial participants were asked to refer other participants to be included in subsequent interviews. Interviews were audio

recorded and later transcribed manually into text and imported into NVivo. Data analysis involved the coding and analysis of information and data using Nvivo. Coding rubrics were developed to organize data according to themes raised in each data set (Appendix B). Data was then analyzed according to major themes related to subject matter, which was then applied to the conceptual frameworks used to organize information according to the exposure, sensitivity, and coping and adaptive capacity.

The first phase involved a situational analysis of the social, economic, political, and ecological context of the Dawei District through the collection and review of secondary data from government documents, grey literature, and newspaper articles. The second phase involved a series of scoping interviews (n=18) and focus groups (n=2) with a range of key informants from local government, non-governmental organizations, civil society organizations, university, and local religious institutions. Semi-structured interviews probed into social and environmental change, urbanization, past and potential shocks or stresses, access to and quality of key urban systems, including drinking water, sanitation, drainage, electricity, and transportation, and potentially 'vulnerable' or 'more sensitive' populations (Appendix C). Participatory mapping exercises were used in the scoping phase to visualize and spatially represent vulnerability in Dawei, which was especially helpful for mapping out flood prone areas, target communities, and key urban systems (Appendix D). In addition, transect walks were used to select target sub-populations that were identified as 'vulnerable' or 'more sensitive' in key informant interviews.

During the initial scoping phase, two groups were identified as 'vulnerable' or 'sensitive' to climatic and non-climatic shocks and stress. Methods involved focus group discussions, key informant interviews, and participatory mapping exercises to identify sample sub-populations. Key informants explicitly identified Kyetsarpyin quarter as vulnerable for reasons associated with (a) water access; (b) poverty; and (c) flooding. Although participants did not explicitly identify Karapyien quarter as vulnerable, their responses elicited information about the characteristics of vulnerable groups living in Dawei. Respondents described vulnerable groups as (a) poorer; (b) working as daily labourers; and (c) living in the urban periphery. Through inductive reasoning, the second target group was identified as vulnerable based on information from field observation and informal discussion with households. This information was then cross-referenced with the mapping exercises completed by key informants. Karapyien quarter shared many characteristics associated with the vulnerability of the first group, including (a) water access; (b) poverty; and (c) flooding.

The third phase consisted of household semi-structured interviews (n=41) that were framed according to a livelihoods and urban systems approach in order to understand vulnerability at the household scale for the sample sub-populations. Household level interviews probed into understanding people's livelihood strategies and outcomes, as well as their challenges and priorities (Appendix E). Questions sought to gain a sense of a households' everyday challenges to gauge their existing sensitivity and the constraints limiting their coping capacity to deal with shocks and stresses. Questions then probed into challenges stemming from urban system access and quality with particular attention placed on water, drainage, sanitation, and electricity. Throughout the interview, questions probed into impacts and coping or adaptation strategies to understand the strategies people employ to cope with and respond to the shocks and stresses that inform household vulnerability.

3.4 Research Questions

1. Which groups are vulnerable in Dawei?
2. How do select vulnerable groups frame sources of vulnerability in their lives?
3. How do issues stemming from urban systems compound the existing stresses faced by select vulnerable groups?
4. How do select vulnerable groups cope with and respond to these stresses?

The entry point for discussion began with understanding the challenges and priorities of vulnerable groups. The first question seeks to identify vulnerable groups living in Dawei. The second question aims to understand the sensitivity and coping capacity of households as well as the constraints that households face in achieving wellbeing. Questions probed into the everyday challenges faced by households in order to gain a sense of their struggles, their existing sensitivity, and the challenges that limit their coping capacity to deal with shocks and stress. The third question aims to understand the sensitivity of households in light of their access to and the quality of urban systems (ie. water access; sanitation; waste disposal; sewage; electricity; drainage). Questions probed into potential challenges that stem from urban system access and quality to understand how stresses stemming from access to and quality of urban systems may augment the vulnerability/existing stresses faced by households. The fourth question aims to understand the coping and adaptive capacity of households, while emphasizing the agency of individuals and groups to address and overcome sources of vulnerability. Throughout the interview, questions probed into potential impacts from stresses or shocks experienced as well as the strategies used by households to cope and/or adapt to potential challenges, shocks and/or stresses. Although this research is interested in understanding urban vulnerability in Dawei, it ultimately aims to

emphasize human agency and the capacities of households to cope, respond, and adapt to sources of climatic and non-climatic stress.

3.5 Research Contribution

This research bridges systems and people-centred approaches in the analysis of the drivers and sources of vulnerability in Dawei to environmental change. This research aims to not only understand the underlying drivers that expose urban systems and populations to shocks and stress, but also contextual sources of vulnerability in the analysis of differential access to infrastructure and services. The research also aims to shed light on how systems and people-centered approaches can be used to develop a multi-scalar understanding of urban vulnerability at the macro, meso, and micro level.

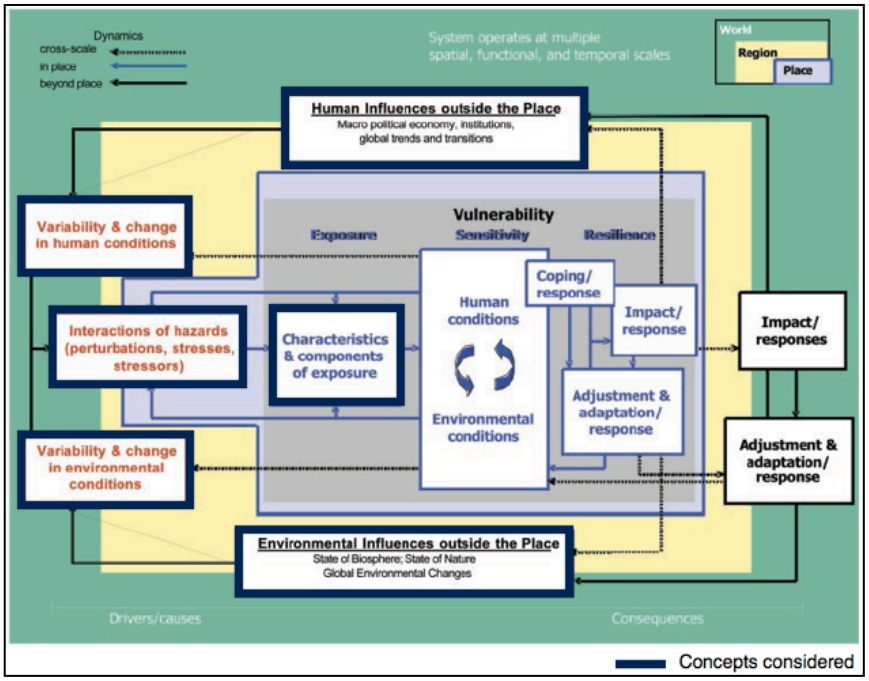
In addition to contributing to the academic literature surrounding urban vulnerability to environmental change, this research also fills a critical gap in understanding the practical implications of urban vulnerability in Myanmar. Given Myanmar's isolated history under military rule for almost fifty years, there is very little research on understanding vulnerability to climate and environmental change. In light of gaps in understanding, this research aims to contribute to the understanding of the multiple and intersecting drivers of climatic and non-climatic stresses that inform the vulnerability of urban areas in Myanmar. As such, this research aims to not only inform the literature on urban vulnerability in Myanmar, but also to inform adaptation planning in development practice in urbanizing areas in low and middle-income countries in the Mekong Region.

In addition to contributing to gaps in knowledge, this research also aims to support stakeholder engagement in discussions surrounding vulnerability and resilience. This research is affiliated with the Urban Climate Resilience in Southeast Asia (UCRSEA) partnership, with field support from Mercy Corps, an international relief agency, and the Renewable Energy Association Myanmar (REAM). Mercy Corps funded the dissemination of research findings through the organization of multi-stakeholder workshops that were held in May 2016. Research findings were shared with community members, civil society groups, and government representatives through project briefing reports and workshops for the verification of findings and the continuation of the research dialogue. A report outlining the findings of this research was made available to UCRSEA partners and city stakeholders in July 2016 to disseminate findings surrounding urban vulnerability in Dawei, and inform future UCRSEA project activities.

4.0 Urban Vulnerability and Socio-Ecological Systems

This chapter discusses vulnerability through a systems perspective that considers the various climatic and non-climatic stresses affecting drinking water and flooding in Dawei. Although this research is focused on understanding urban vulnerability, it is important to recognize the linkages between Dawei city and the wider supporting socio-ecological systems within the Dawei District. Moreover, in asking questions around vulnerability, this research applies the Sustainability Science framework to consider vulnerability according to conceptual elements of exposure, sensitivity, and resilience (Figure 4). This chapter employs a multi-scalar approach to the analysis of the exposure of urban systems in Dawei city and the wider socio-ecological systems in the Dawei District to sources of stress. This chapter begins with a discussion of the various climatic and non-climatic drivers and sources of stress in Dawei, followed by an analysis of the exposure of drinking water and flooding to climatic and non-climatic stress.

Figure 4: Conceptual Elements Considered in Chapter 4

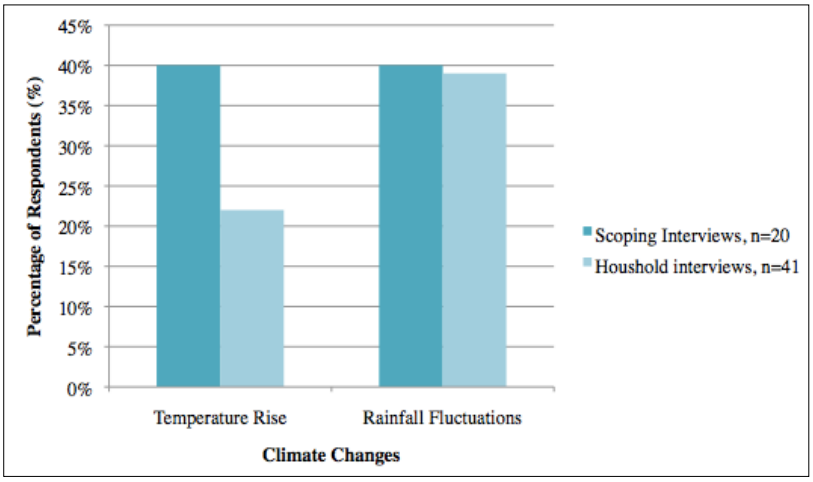


4.1 Climatic Stress

Climate change is a global phenomenon, yet has far-reaching implications for driving environmental change in specific places. The following section discusses climatic stresses of temperature rise, changing rainfall patterns, and sea level rise affecting the exposure of Dawei's socio-ecological systems.

Trends from climate data from 1960-2000 suggest that Myanmar has experienced a significant upwards trend in average and high temperatures; while other data sources suggests that temperatures have increased by an average of ~0.08°C per decade from 1951-2007 (Ministry of Agriculture and Irrigation, 2010; Wassmann et al., 2009). Future projections suggest that average temperatures will increase between 1-4°C by the end of the century (World Bank, 2012). Downscaled findings from scoping and household interviews suggest that temperature rise is apparent in Dawei, framed in terms of rising temperatures and the disappearance of the cold season (Figure 5). As one key informant explained, "the temperature is rising, not only in Dawei, but across the country, it's hotter every summer… we had three seasons, not like a winter season, not like snow, but a lot of fog and cold, but now people don't have to wear warm clothes, so it's totally changed, so now we only have two seasons, summer and rainy season" (K.I.6).

Figure 5: Climatic Changes noted by Respondents (%), n=61

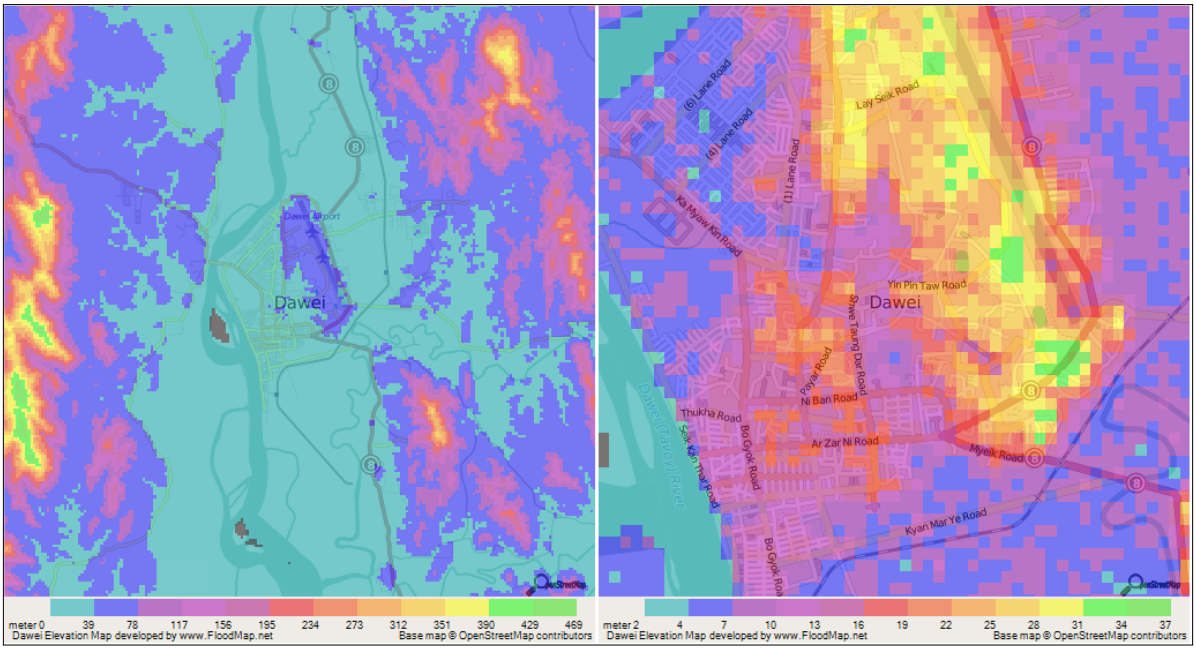


Additionally, rainfall patterns are becoming more erratic and unpredictable. Meteorological data suggests that there has been a significant decrease in the monsoon duration by an approximate average of 0.5 days per year from 1955-2008 (Ministry of Agriculture & Irrigation, 2010). Moreover, rainfall is becoming more concentrated with regular reports of record-breaking rainfall (Department of Meteorology & Hydrology, 2010); corresponding with projections suggesting that rainfall will increase by approximately 10 percent and concentrated in fewer rainfall days (World Bank, 2012). Downscaled findings suggest that Dawei has experienced an upward trend in annual rainfall over a 39-year period (Naing, 2008). Perceptions from interviews suggest that rainfall is becoming erratic, shifting between periods of heavy rain and drought. One key informant described rainfall as shifting between "irregular rain, heavy rain, and no rain… the weather is very hot and drought… I notice just

three years [the] change, irregular raining, weather is hotter than previous and the environment is dry" (KI.8). Households described changes in rainfall as "irregular" (HH.S1), and noted that rainfall was becoming "heavier" (HH.S1; HH.S2).

In addition to changes in temperature and rainfall, sea level rise is a slow-onset stress that augments current tidal fluctuations in water levels on the Dawei River estuary, which presents issues of greater coastal erosion, heightened flood risk, and the saline intrusion of coastal aquifers.

Map 6: Elevation of Dawei City, 5 Meter Map



Source: Burle, 2014

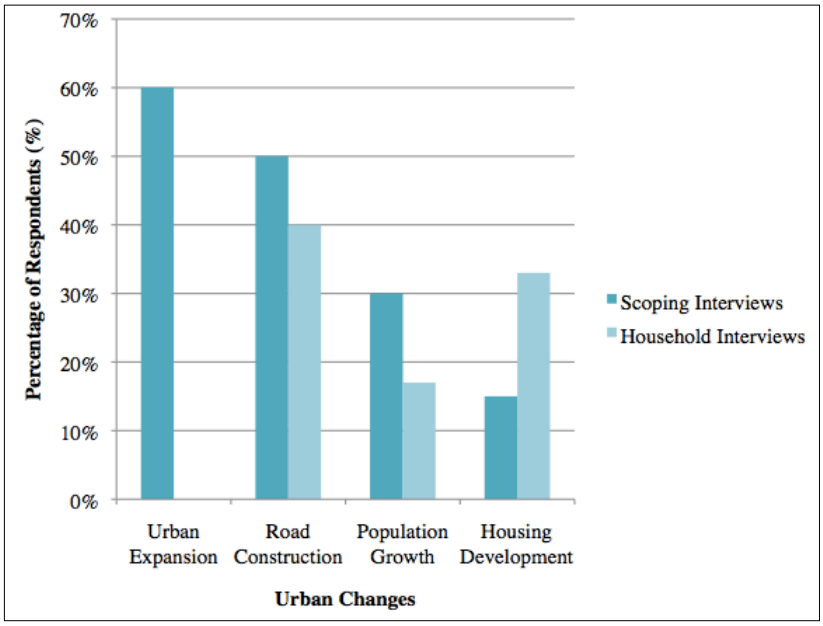
4.2 Non-Climatic Stress

To provide a holistic overview of the various drivers of vulnerability in Dawei, it is important to consider climatic and non-climatic stresses together. This section discusses non-climatic stresses of urbanization, and land use change in light of drivers of regional integration and investment.

Findings suggest that foreign investment surrounding the Dawei SEZ is driving population growth and urbanization in Dawei. Respondents characterized urban changes according to urban expansion, population growth, road construction, and housing development (Figure 6). Population growth was attributed to the influx of migrant labour to work for the Dawei SEZ and associated infrastructure projects. As one key informant explained, "the city is growing, especially since last year, the SEZ is driving the growth of the city" (FG.2). Population growth and urbanization

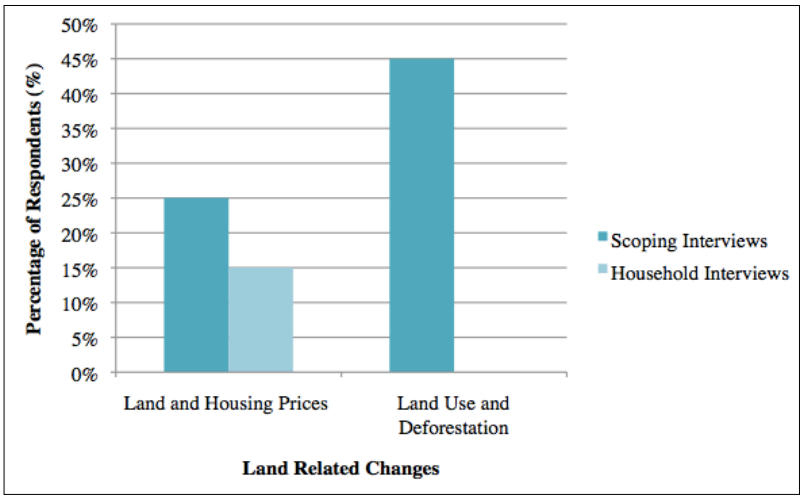
exacerbates existing pressure on Dawei's urban systems and the capacity of the municipal office to develop infrastructure and supply essential services.

Figure 6: Urban Changes noted by Respondents (%), n=61



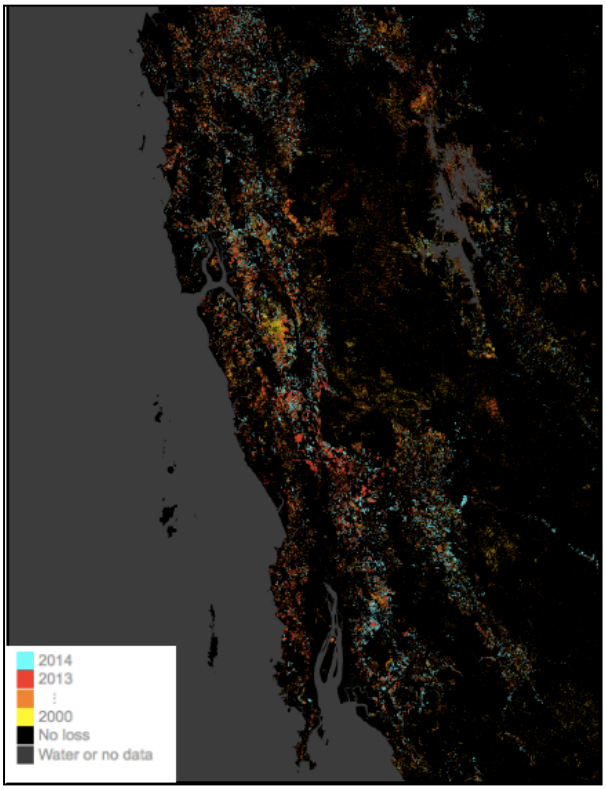
Additionally, the SEZ is driving the rise of land and housing prices in Dawei and surrounding areas (Figure 7). As one respondent explained, "when the deep-sea port intervened there, the before and after situation is, how to say, the house rent fees, so high" (KI.2). Increasing land and housing prices in Dawei as a result of land speculation surrounding the Dawei SEZ illustrates how regional investment flows can affect housing markets in urban areas.

Figure 7: Changes in Land Use and Values noted by Respondents (%), n=61



Moreover, land speculation surrounding the Dawei SEZ is driving forest loss in the Dawei District insofar as rubber plantations are being used by large businesses and local elites to claim land. Respondents attributed drivers of deforestation to the Dawei SEZ, explaining, "because of the money for the infrastructure projects in Dawei, our country is like a land rush, so many people are trying to grab the land" (KI.11). Another respondent explained, "the private sector grabs the land, [and] they talk about plantations, so they get the land, but they do not do the plantation. So the land prices rise. Just investment and shows some plants" (KI.10). Secondary research aligns with findings suggesting that the Dawei SEZ and the road link to Thailand is driving land speculation and deforestation (Woods, 2015). Moreover, GIS data suggests that forest loss in Dawei has predominantly taken place after 2010, which corresponds with more recent developments in the Dawei SEZ project (Map 7) (Hansen et al., 2013).

Map 7: Forest Loss in the Dawei District



Source: Hansen et al., 2013

Mining operations in tin, tungsten, coal, iron, and lead is another non-climatic stress present in the Dawei District, with the most notable and contentious mining projects being the Heinda tin and tungsten mine, and the Ban Chaung coal mine. Key informants (40%) raised concerns over the pollution of water resources from the release of wastewater from mining industries. As one respondent explained, "water resources… [there is] more and more damage from extracting natural

resources, logging, mining. Watershed area. If you go along the road to the border, only two to three rivers are maintained as original, so almost every river area is damaged, already polluted" (KI.11). Many mining projects in Dawei are operated by enterprises from China and Thailand, illustrating how the influx of investment surrounding extractive industries is driving stresses affecting the health of Dawei's watershed.

4.3 System Exposure

The consideration of climatic and non-climatic stresses in Dawei provides context for assessing the exposure of Dawei's socio-ecological systems. Table 4 outlines the various climatic and non-climatic stresses in Dawei and their implications for the exposure of water supply and flooding. In respect to water supply, rising temperatures and fluctuations in rainfall exacerbate seasonal variations in groundwater, while sea level rise exacerbates the existing exposure of coastal aquifers to saline intrusion. In respect to flooding, changing rainfall patterns in the form of more concentrated rainfall and sea level rise exacerbates flood exposure, especially in riverbank areas.

The assessment of the exposure of Dawei's socio-ecological systems is incomplete without the analysis of human-induced or non-climatic stresses. Accordingly, deforestation presents issues for the loss of surface and groundwater, as well as downstream flooding. Moreover, the pollution of surface water from mining projects highlights the exposure of Dawei's water supply to potential contamination, while raising issue to planning for prospective drinking water resource needs. Stresses stemming from land use change point to the need to consider integrated water resource management, and by extension the importance of institutional structures and processes in mitigating or exacerbating exposure.

Importantly, non-climatic stresses interact with and compound the exposure of urban systems to climate change. Urban expansion in flood prone areas exacerbates exposure to flooding, while urbanization and the growing demand for groundwater exacerbates climatic stresses exposing Dawei's groundwater to seasonal water scarcity and saline intrusion. The importance of considering exposure according to the interaction of climatic and non-climatic stress was explained by one respondent as:

> "I think to say climate change, it is difficult, but we can say it is interlinked, but normally what you can see, lost forest, urban expansion, the plantation area increases, the water volume decreases, the infrastructure projects are more and more, the watershed area. It's the main cause than climate change" (KI.11).

Table 4: System Exposure to Climatic and Non-Climatic Stress in Dawei

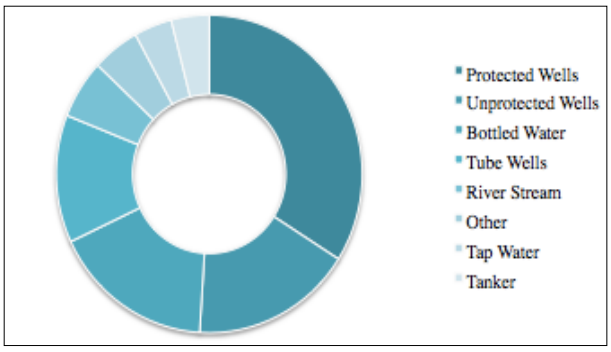
Variability and Change	Stress and System Exposure	Description of Hazard	Areas Impacted	Impacts
Temperature rise and rainfall fluctuations	Water Scarcity ▪ Drinking Water	Drought and water shortages occur every year in late summer for 2-3 months in March, April, and May.	Water shortages are severe in rural areas surrounding Dawei city, and islands in the Dawei River. Water scarcity in Dawei city is less serious due to alternative modes of access and variable water conditions.	Water levels are lower in shallow and tube wells in the dry season, causing difficulties to access water in rural and urban areas. Supply from tube wells cannot meet demand in the dry season in some areas, ex. the Dawei Hospital.
Rainfall fluctuations	Flooding • Drainage	Annual flooding occurs in the monsoon season during July and August. Flooding depends on rainfall duration and tidal flows of the Dawei River. Flooding can last between 1-10 days.	Flooding is prevalent in rural and peri-urban areas surrounding Dawei city, in lowland areas near the Dawei River, and along urban creeks and streams. Areas of high exposure are in the South of the city near Pauktaing Chaung Stream.	Flooding impacts include disrupted transportation within Dawei city and to surrounding areas; higher food costs; compromised drinking water; higher incidences of dengue; and the spill over of pit latrines and sewage into streams and drainage.
Sea level rise	Saline intrusion • Drinking Water	Salt-water intrusion of shallow wells is prevalent in riverbank areas. Saline intrusion is heightened by over extraction of groundwater and sea level rise.	Groundwater aquifers in rural and urban areas near the Dawei River experience salt-water intrusion.	Saltwater from the Dawei River estuary intrudes shallow wells resulting in poor water quality and the need for alternative water sources.
	Flooding • Drainage	Sea level rise presents a slow-onset stress for flood exposure in Dawei as flooding depends on the tidal range of the Dawei river and rainfall.	Areas located along riverbank areas surrounding the Dawei river are exposed to flooding as a result of sea level rise.	Sea level rise present a slow-onset stress that heightens flood exposure in riverbank and low elevation areas in Dawei.
Deforestation	Flooding: • Drainage	Deforestation in the Dawei District heightens the exposure of downstream areas to flooding as forest loss is resulting in the loss of upstream tributaries and reduced downstream storage capacity as a result of increased sedimentation.	Deforestation is occurring in rural hill areas in the Dawei District as the spread of rubber cultivation is resulting in forest loss. Deforestation is tied to land speculation in the Dawei District, and is occurring in peri-urban areas and along road corridors.	Rapid deforestation in rural areas heightens the exposure of downstream areas to prospective flooding in the future. Forest loss is resulting in higher sedimentation rates, resulting in shallower riverbeds and streams.
	Water Scarcity • Drinking Water	Deforestation is impacting the watershed area in Dawei, as forest loss is resulting in the disappearance of streams and creeks upstream and the loss of surface and ground water.	Deforestation is occurring throughout the Dawei District, especially along major roads and beside city as a result of land speculation surrounding the Dawei SEZ.	Deforestation is resulting in the loss of surface and ground water in rural areas, which is negatively impacting Dawei's watershed area. Respondents attributed deforestation to the loss of surface and groundwater.
Urbanization	Water Scarcity • Drinking Water	Dawei is experiencing population growth and increasing economic activity, where rising demand for drinking water places mounting pressure on finite ground water resources.	Underground water sources in Dawei city are under increasing pressure as a result of increasing demand from Dawei's growing population.	Population growth and increasing demand for drinking water places stress to groundwater resources, while compounding the exposure of Dawei's drinking water to issues of water scarcity and saline intrusion.
	Flooding • Drainage	Urban expansion in flood prone areas heightens flood exposure.	Urban development in flood prone areas through formal and informal settlement heightens flood risk.	Urban expansion through the growth of formal and informal settlements heightens flood exposure.
Mining	Water Pollution • Drinking Water	Mining projects are resulting in the pollution of streams, creeks, rivers, and soil in the Dawei District. The watershed area is negatively impacted from the release of wastewater from mining projects.	Rural areas and villages in the Dawei District are exposed to water pollution as a result of the release of wastewater in streams and creeks from mines. Polluted tributaries include: the Tanintharyi River, the Pauktaing Chang Stream.	The release of chemicals and wastewater from mining projects has resulted in the pollution of surface water, and soil, compromising drinking water in rural areas. The pollution of surface water by mining raises issue to planning for future water supply resources.

This statement exemplifies how the exposure of urban systems is shaped by multiple and interacting sources of stress, while emphasizing the importance of human induced drivers in shaping exposure. The following section discusses the interaction of climatic and non-climatic stresses affecting the exposure of drinking water and flooding in Dawei.

4.3.1 Water Supply

Drinking water in Dawei is primarily dependent on groundwater, whereby more than two thirds of the Dawei Township is reliant on various types of ground wells (Figure 8). Downscaled findings from primary data suggest that water supplied by the municipal office is limited, causing the majority of households to be reliant on individual shallow wells, and to a growing extent private suppliers that distribute water from tube wells via pipe or by vehicle.

Figure 8: Sources of Drinking Water, Dawei Township (2014)



Source: Ministry of Immigration and Population, 2015

Table 5: Mean Monthly Rainfall (mm) and Rainy Days of the Dawei Station for (1971-2010)

Month	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Rain-fall	6.89	13.97	28.72	88.14	519.94	1140.9	1202.2	1312.18	781.56	309.88	49.53	5.33	5463.29
Rainy Days	0.6	0.9	3.2	5.8	18.6	26.2	28.5	27.6	24.9	15.2	2.9	0.6	154.9

Source: Department of Meteorology, Dawei Station

Groundwater in Dawei is highly dependent on seasonal rainfall, with 90 percent of rain falling during the southwest monsoon (May-October), while the northwest monsoon (December to March) is cool and dry (Table 5) (Zaw, 2013; FAO, 2014). Seasonal rainfall patterns cause groundwater quality and quantity to fluctuate between the dry and wet season, leading to water scarcity in March, April, and May in Dawei and surrounding areas. As one respondent explained, "the well is dry in summer season in some quarters. My old house in downtown in summer season the water level is very low. And the colour is not clear. The wells are dry in some parts of the

summer" (KI.8). In other instances, the supply of groundwater is lower than demand. The Dawei Hospital for example can only supply 2000 gallons of water per day out of the 8000 required in the dry season, and is thus reliant on donations of water from the municipal office and civil society groups. The dependence of the Dawei Hospital on donations of water for up to 60 days during the dry season exemplifies the severity of the exposure of Dawei's water supply to climatic stress, while highlighting the need to develop an adaptive and sustainable supply of water to meet growing demand. Water scarcity is more pronounced in surrounding areas of Dawei, in which some villages are completely dependent on donations of water from civil society groups, government, and the private sector. As one respondent explained, "we donate water, 60 million kyat every year. That is only from CSO side not from government and private side, maybe more than 100 million kyat" (K1.10). Donations of water to affected areas highlight the existing exposure of Dawei to water stress in light of limited infrastructure and service provisioning, while pointing to how donations of water to cope with water scarcity fall short of implementing longer term adaptive strategies.

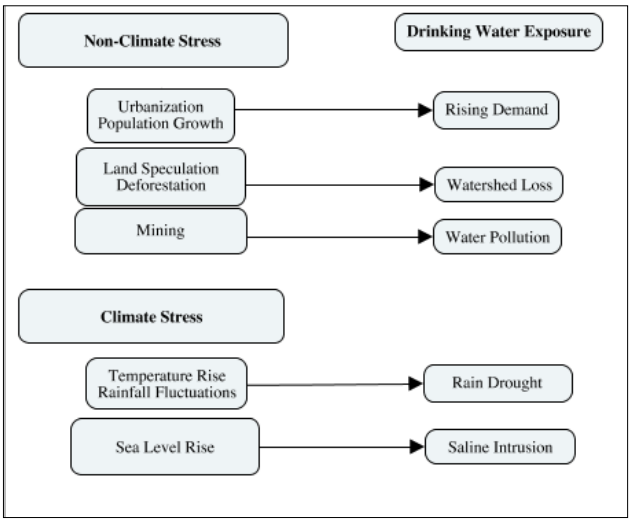
The dependence of groundwater on seasonal rainfall patterns exemplifies how climate change may exasperate the existing exposure of Dawei's water supply to seasonal water scarcity in the dry season. Key informants raised concerns over the increasing severity of water scarcity in light of the increased prevalence of rain drought and decreasing water levels in shallow wells. As one respondent explained, "so every year, there is more drought in the summer time, so there is less drinking water" (KI.6). Another respondent explained, "every year I watch for ten years, I measure, especially for my well and my friend's well, maybe around ten, and every year we lost nearly 1 foot of water level, every year it's going down" (KI.10). Current trends illustrate how shifting rainfall patterns, rising temperatures, and the increased prevalence of rain drought exasperate the existing exposure of Dawei's water supply to seasonal water scarcity.

Additionally, tidal flows of seawater expose groundwater in riverbank areas to salt water intrusion. As one respondent explained, "about 80m from the riverbank, in this 80m area, they cannot dig a well because of salty water" (KI.18). Sea level rise thus exacerbates the existing exposure of groundwater to saline intrusion. Moreover, saline intrusion interacts with other climatic and non-climatic stresses affecting rates of groundwater recharge such as rainfall fluctuations and urbanization. As one respondent explained, "the population is growing and the underwater table is becoming lower… when the population gets bigger and bigger it will become harder for people to get water" (KI.7). Urbanization and the growing demand for groundwater represents an evolving stress that compounds the exposure of Dawei's water supply to climate change. Given current trends in

urbanization, greater regional connectivity, and industrial development, non-climatic stresses will likely exasperate the exposure of groundwater to seasonal water scarcity in light of competing and growing demand.

Moreover, the functioning of urban socio-ecological systems are ultimately shaped by the wider supporting ecological systems in which urban areas depend. According to the Water Risk Index, "the water security of a city must be considered in the context of the management of the river basin or basins in which the city is located" (Asian Water Development Outlook, 2013, p.44). Land use changes in the Dawei District present issues for the management of Dawei's watershed area in light of current and prospective water supply needs. Key informants raised concerns over deforestation and its implications for the loss of surface and groundwater. As one respondent explained, "in Tanintharyi Region, after 2-3 years, because of deforestation, the water volume drops" (KI.12). Another respondent explained "when you deforest along the hill, a lot of small water resources are coming along the mountain… environmentally, you have to leave one third of the mountain, [but] they just clear all the trees, so… 10 or 20 many hills are wiped out, so… all the water resources are gone" (KI.12). Although the relationship between deforestation and groundwater is complex and contingent on multiple factors, further research is required to better understand the implications of forest loss on Dawei's groundwater and surface water resources.

Figure 9: Drinking Water Exposure to Climatic and Non-Climatic Stresses in Dawei



Last, key informants raised concern over the widespread pollution of surface water resources from the release of chemicals and wastewater from extractive and mining industries. As one

respondent explained, “we have mining, and mining companies, the impact of the mining company so they are suffering about some, so many soils polluted by the freshwater, river and creek. This comes into the city also” (KI.18). The widespread pollution of surface water resources in Dawei highlights how human induced drivers of stress undermine the ecosystem health of Dawei’s watershed area, while raising issue to the potential contamination of Dawei’s existing and prospective water supply.

Climatic and non-climatic drivers of stress in Dawei fundamentally stem from global and regional socio-political and economic relationships, yet have place-based implications for shaping vulnerability. Climate change represents a global, yet local phenomenon, while regional integration and investment flows of capital are driving non-climatic stresses of urbanization, forest loss, and the water pollution. Importantly drivers of stress interact insofar as temperature rise, rainfall fluctuations, and sea level rise are compounded by non-climatic stresses of urbanization and the growing demand for groundwater. Human induced drivers of stress emphasize the importance of institutional structures and processes in mitigating or exacerbating exposure through the form of land use planning and resource governance. Moreover, institutions play a fundamental role in responding to climatic change, which is illustrated through the donation of water from civil society groups and the municipal office to cope with water scarcity. Although representative of the impressive networks between institutional structures and civil society to cope with water scarcity, the severity of water shortages in Dawei highlights the need to build on the long-term adaptive capacities of the municipal office to develop infrastructure and services to meet growing demand for water.

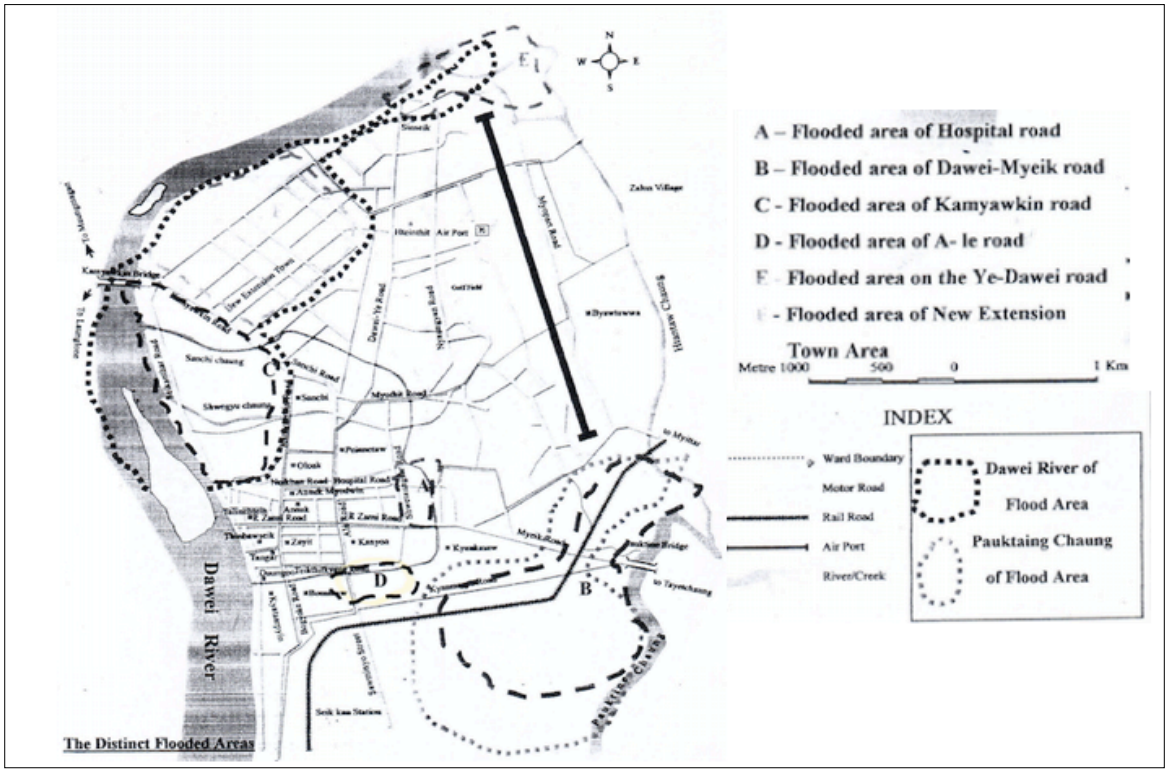
4.3.2. Flooding

Annual monsoon flooding occurs in Dawei during July and August when rainfall is heavy and coincides with high tide on the Dawei River. As one respondent explained, “when there is heavy rain, continuous rain, at the same time the tide is high... at that time they come together and there will be floods in the city” (KI.14). Flooding occurs in rural and peri-urban areas surrounding Dawei, particularly in the southwest, in lowland areas near the Dawei River, and along creeks and streams that flow throughout the city (Map 8). Tidal flooding tends to be of a short duration, lasting for a couple of hours during periods of high tide, whereas the duration of flooding in lowland creeks and streams is longer, lasting up to 10 days (Naing, 2008).

The dependence of flooding on rainfall and the tidal range of the Dawei River was explained by one respondent as, “it depends on how much rainfall and the tide” (KI.11). The dependence of

flooding on hydrological and meteorological factors suggests that sea level rise, and heavier and more concentrated rainfall may alter the severity or frequency of flooding. As one respondent explained, "the rainy period, previously it was normal, but now there is a longer rainy season. The water in the mountains comes to the valleys and sometimes it reaches the town and it floods" (KI.15).

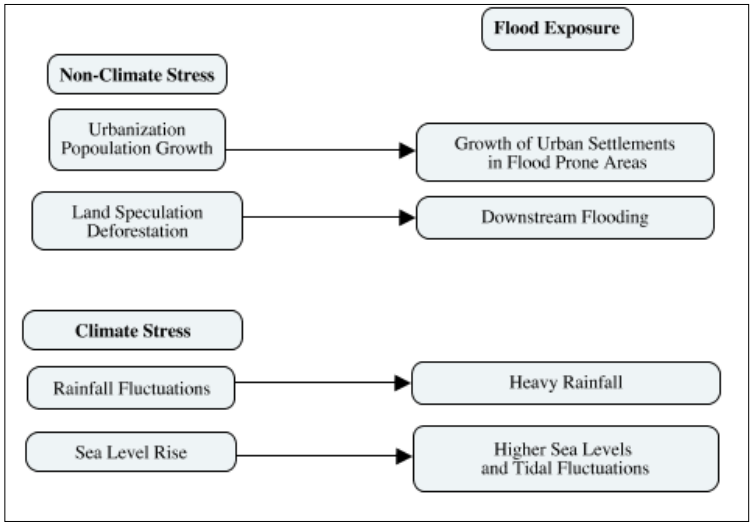
Map 8: Map of Flood Exposure in Dawei



Source: Naing, 2008

Additionally, flood exposure is heightened by urban expansion through the development of formal and informal settlements in flood prone areas. As one respondent explained in reference to the new extension quarter, "the area has no tributary... this is the old paddy field… they have a big flood in [the] rainy season" (KI.8). Urban expansion in flood prone areas illustrates how urban growth heightens flood exposure, while highlighting the need to consider flooding in institutional processes of urban planning.

Figure 10: Flood Exposure to Climate and Non-Climate Stresses in Dawei



Stresses affecting wider supporting ecological processes also shape flood exposure. Deforestation is widely cited in scientific research to augment the frequency and severity of flooding as the loss of forest cover increases surface water runoff and sedimentation, leading to heightened flood risk downstream (Bradshaw et al., 2007). As one respondent explained, "every year, there is a flood because the tributaries for the rivers and the streams are gone and the slope of the river is not very deep, because when the rain comes it always floods, every year" (KI.6). Another respondent explained, "there are a lot of plantations that are developing around Dawei and the road that is being constructed to Thailand will likely open up new areas for expanding the plantations. These will have implications for flood control and drainage" (KI.4). As regional influences of greater transport connectivity and investment continue in Dawei, land use change and forest loss will likely accelerate, exasperating flood exposure. Land use changes represent an evolving stress that illustrate how regional integration and the rise of land speculation surrounding the Dawei SEZ heightens flood exposure, while illustrating the need for institutional processes of watershed management to mitigate flood risk.

4.4 Conclusion

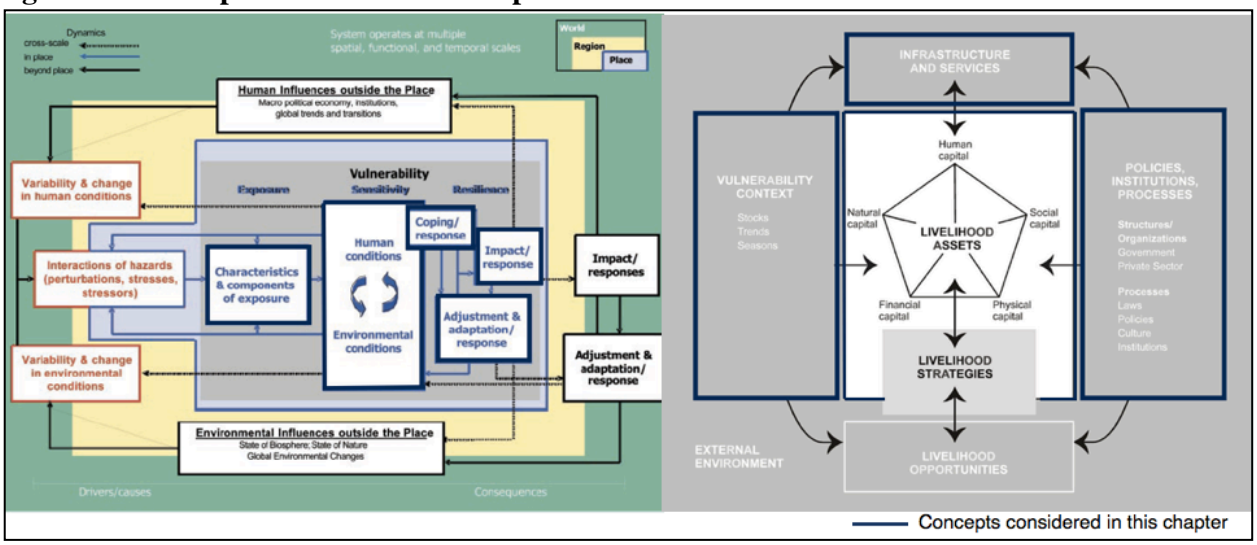
This chapter served to ground the vulnerability context by presenting findings surrounding the various climatic and non-climatic stresses present in the Dawei District. Key findings highlight how climate change and human-induced stresses interact to shape the exposure of groundwater and flooding, while illustrating how current trends will likely exasperate existing areas of vulnerability. The chapter highlighted how vulnerability is shaped by scalar socio-political, and economic

relationships insofar as climate change and regional integration drive stresses affecting exposure. Lastly, findings point to the fundamental role of institutional structures and processes in shaping vulnerability through gaps in governance that exacerbate human induced drivers of stress, or fail to address systemic issues such as urban planning and infrastructure provisioning which would mitigate exposure of water supply and flood risk to climatic stress. The next chapter builds on this macro-analysis by discussing sources of exposure and sensitivity to stress at the household level, using two case studies to ground the analysis of how vulnerability is manifest in Dawei in light of differential access to urban infrastructure and services and exposure to stresses affecting water access and flooding.

5.0 Household Vulnerability and Urban Systems

This chapter discusses urban vulnerability at the meso-level through the analysis of the differential exposure, sensitivity, and resilience of two communities living in Dawei (Figure 11). This chapter begins by introducing the selection of sample populations included in the analysis of household vulnerability, followed by a description of each case study. Thereafter, a comparative analysis of the urban infrastructure and services in each case study will follow in light of electricity access, sewage, waste disposal, drainage infrastructure, and water supply. The chapter concludes with the discussion of the differential sensitivity and resilience of each case study to exposure to climatic and non-climatic stresses affecting water supply and flooding.

Figure 11: Concepts Considered in Chapter 5

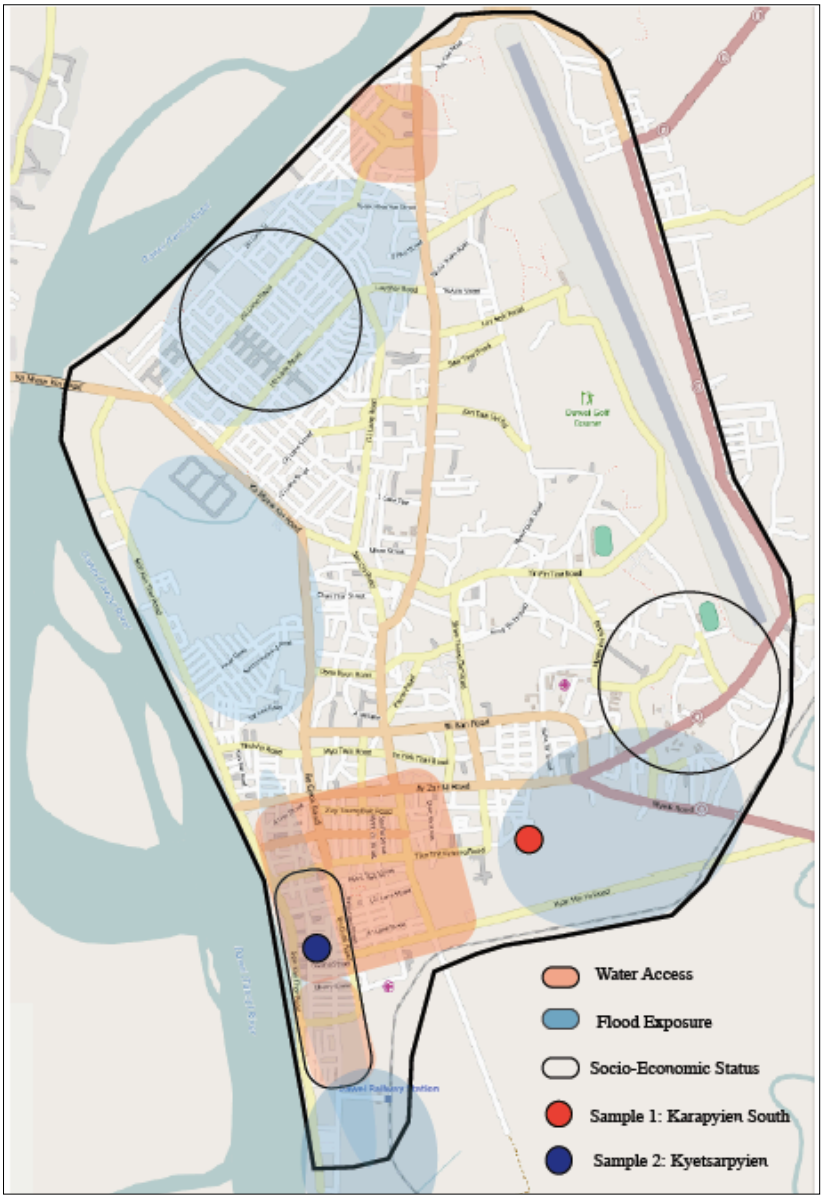


Source: Turner et al., 2003; Tony Lloyd Jones, 2003

5.1 Sample Populations

During the initial scoping phase, two groups were selected as sample sub-groups to understand how urban vulnerability is manifest at the community and household level. Key informant interviews and participatory mapping exercises were used to identify vulnerable communities in light of factors of exposure and sensitivity. Key informants attributed vulnerability to factors of socio-economic status and livelihoods, and groups living in the urban periphery. Field observation, transect walks, and informal discussion with households were used to triangulate findings to select two sample sub-groups to conduct household level interviews. The following section discusses findings surrounding the selection of sample communities, followed by a detailed description of each sample sub-population.

Map 9: Map of Dawei City and Location of Sample Populations



Key informants attributed vulnerability to groups of lower socio-economic status, daily waged labour, and groups living in the urban periphery. The majority of key informants attributed vulnerability to groups of lower socio-economic status, described as living "hand to mouth" (KI.12; KI.10; KI.6), and engaged in livelihood strategies based on "daily wages" (KI.12; KI.7; KI.14; KI.2; KI.11). Given that vulnerability is strongly linked to socio-economic status, there is a strong livelihoods component in understanding the sensitivity of vulnerable groups. Key informants described the livelihood strategies of poorer groups as working as "general workers" (KI.10),

"carriers or coolies" (KI.12), or as "hard labour" (KI.8; KI.12; FG.1) in construction, transportation, and plantation processing.

Interviews suggest that poorer groups in Dawei live in peri-urban areas and in satellite towns with limited access to infrastructure and services. As one respondent explained, "if you go around the town in the satellite town, you will see people are vulnerable and poor. If you just walk on the main road you will not feel poverty, but if you go to the small place, you will see poverty. A lot of poor people in the small alleys, no light, no security, no proper toilet" (KI.12). The spatial marginalization of poorer groups to the urban periphery highlights the limited access of lower income groups to urban infrastructure and services. Additionally, key informants highlighted the vulnerability of female-headed households to shocks and stress due to the double burden of labour, and earning less income than male counterparts. In light of the differential vulnerability of women, this research applies a gender-mainstreaming approach to understand the unique challenges faced by women in the analysis of household level vulnerability.

Participatory mapping exercises were used to aid in the selection of vulnerable groups, whereby key informants were asked to identify flood-prone areas, quarters with limited access to groundwater, and the location of lower socio-economic populations. Map 9 is an overlay of participatory mapping exercises in relation to factors of exposure and sensitivity (Appendix D). Findings indicate that areas with poor access to groundwater are located along riverbank areas; lower socio-economic groups live in the urban periphery; and flood exposure is highest in the Southeast of Dawei and riverbank areas.

The first group included in the analysis of household vulnerability is in Karapyien South ward, a peri-urban area located in the Southeast of Dawei. Although key informants did not explicitly identify this community as vulnerable, their responses elicited information about the characteristics of vulnerable groups, which was cross-referenced with mapping exercises and informal discussion with households. Through inductive reasoning, Karapyien South was selected based on factors of water access, geographic location in the urban periphery, poverty and livelihood strategies, and flood exposure.

Karapyien is a newly developing settlement located in the outskirts of Dawei. Households are located on the edge of an unpaved road that leads across a creek by use of a wooden footbridge into surrounding paddy fields. A monastery is located on the opposite end of the road. Land tenure is divided between households that own property in the 'upper area' (16%); squatter households that live along the main road towards the stream in the 'lower area' (53%); and households that rent

property in the paddy fields (31%). The population density of the community is low relative to land area with an average household size of 5.5 persons. The length of occupancy of households corresponds with land tenure, whereby squatting and renting households have been living in the quarter for less than 5 years, whereas households with home ownership have been living in the quarter for upwards of 10 years. The majority of households attributed high rental and housing costs to why they had settled in the area. As one household explained, "for living here, we do not have to pay rent… it is not our own, but it is more easier for us to live here because we can spend some money. We can use money for renting for other things, like livelihood and food" (HH3.S1.M). Interviews suggest that rising housing prices compound difficulties for households to afford accommodation in Dawei. As one household explained, "because the cost of renting a house is higher… I cannot afford to rent the house" (HH12.S1.M). Karapyien illustrates how rising housing costs in Dawei are resulting in the development of informal settlements in peri-urban areas.

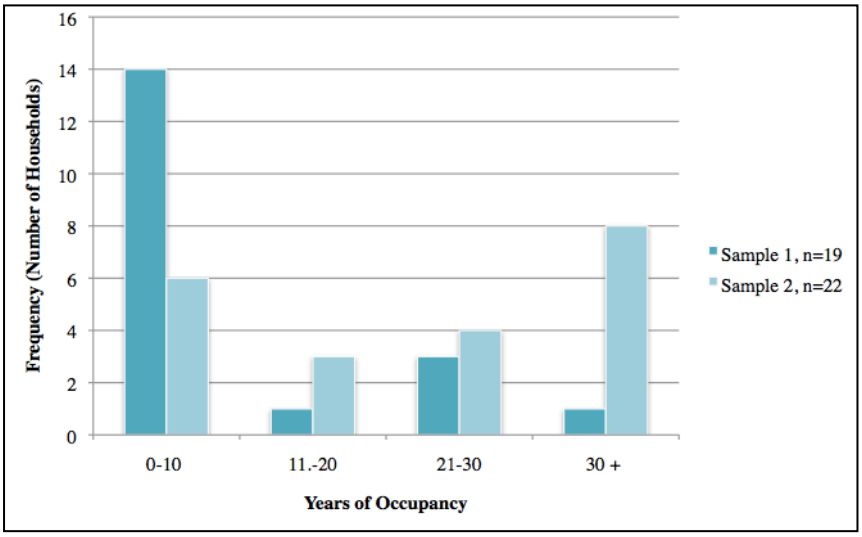
Table 6: Differences in Characteristics between Case Studies

	Karapyien, n= 19	**Kyetsarpyien , n= 22**
Location and Environment	South-east of Dawei, peri-urban environment, surrounded by paddy fields	South-West of Dawei, in proximity to the Dawei River, semi-urban
Population Density and household Size	Low Population Density Average 5.5 persons/hh	High Population Density, Average 9.6 persons/hh
Years of Occupancy	>10 years	<20 years
Land Tenure	Own- 16% Rent- 31% Squat- 53%	Own- 100%
Electricity	Access- 40%	Access- 90%
Sewage	Pit latrines- 47% No toilet- 35% Stream- 18%	Pit latrines- 80% No toilet- 10% Flush toilet- 10%
Household Water	Household water Neighbour- 89% Own well- 11%	Household water Piped- 68% Vehicle-32%
Drinking Water	Monastery- 74% Neighbour- 11% Own well 11% Bottled water- 1%	Vehicle- 82% Bottled water- 18% Rainwater- 27%

The second sample sub-population is in Kyetsarpyien ward, a semi-urban area located adjacent to the Dawei River. Kyetsarpyien was selected because key informants explicitly identified the area as vulnerable, which respondents framed according to livelihoods, income, and drinking

water access. As one respondent explained, "they need it [water] every summer when the rain is gone, they need to buy this water for everybody, not only for drinking, maybe cooking, they need everyday" (KI.10). Kyetsarpyien was selected in light of socio-economic status, livelihood strategies, and limited water access.

Figure 12: Comparison of Years of Occupancy between Case Studies, n= 41



Kyetsarpyien is known in Dawei as a slum area, and is characterized as semi-urban due to the high population density of the quarter with an average household size of 9.6 persons. The majority of households have been living in the area for upwards of 20 years, and own their homes, either through direct land title or by living with relatives with home ownership (Figure 12). The gradual development of the quarter was explained by one respondent as, "when I arrived here 27 years ago… Only napa palm. There was no housing behind my house. So 15 to 20 years ago there is no housing there, it is just napa palm tree. I think after making the retaining wall and road, there is more houses" (HH22.S2.F). The urbanization of Karapyien illustrates how peri-urban areas develop slowly through settlement, population growth, and the development of infrastructure and housing.

5.2 Urban Infrastructure and Services

This section discusses the differential access to and quality of urban infrastructure and services between Karapyien and Kyetsarpyien in light of electricity access, sewage, waste disposal, drainage infrastructure, and water supply. The purpose of this section is to compare the differential

entitlements between case studies to analyze how physical infrastructure and access to services shapes sensitivity to climatic and non-climatic stresses affecting water supply and flooding.

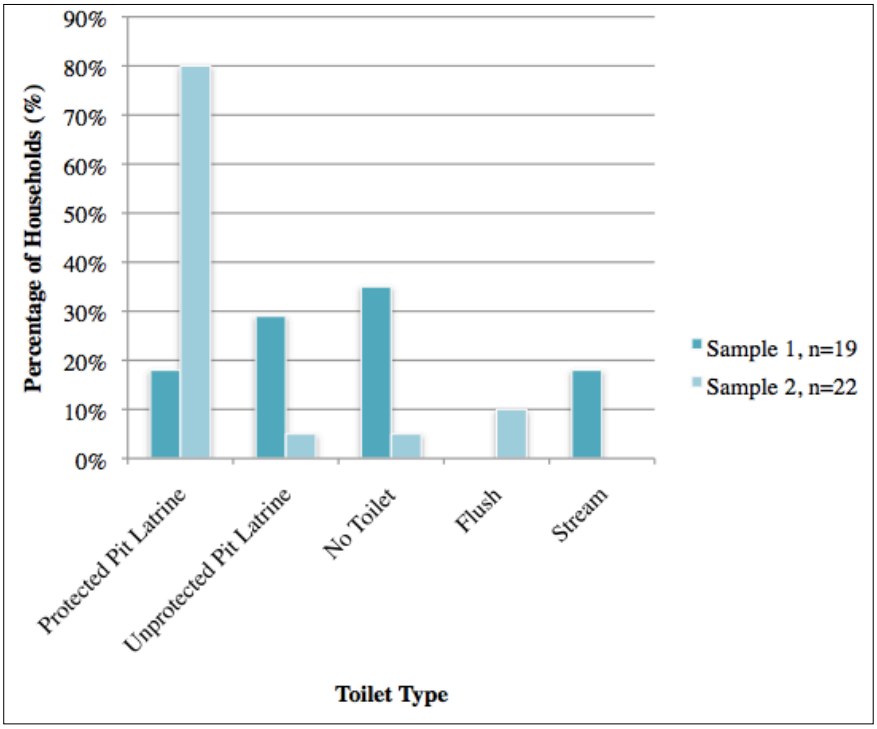
5.2.1 Electricity

The majority of households in Karapyien do not have electricity access (60%) due to high installation costs and unaffordable monthly fees. In addition to financial resource constraints, lack of home ownership disincentivizes households from investing in electricity installation. As one household explained, "because we don't own the land… that is why we don't get the electricity… to reach the electricity is an investment" (HH7.S1.F). Access to electricity is thus dependent on the combination of physical and financial capital. Comparatively in Kyetsarpyien, electricity access is more widespread (90%), in which households have received subsidies from the electricity company for installation. As one household explained, "the owner of the electricity company… came and investigate the situation of the poor guy who lives here and he provides the installation fee for free and even for electricity costs, it is only half" (HH15.S2.F). Although electricity is accessible, affordability remains a challenge as households struggle to pay monthly fees ($12-15 USD/month). Differences between Karapyien and Kyetsarpyien in electricity access is shaped by land tenure and subsidies; however the affordability of electricity access remains a challenge, pointing to the financial resource constraints of low income households to procure access.

5.2.2 Sewage

Sewage infrastructure in Karapyien is rudimentary as the majority of households use simple pit latrines made out of bamboo and soil (47%); while others share with neighbours and relatives (35%); and a minority of households connect their sewage directly to the creek (18%) (Figure 13). As one household explained, "it goes to the creek. It's a pipe that goes into the creek" (HH9.S1.F). The connectivity between sewage and stream water highlights the exposure of households to potential human health hazards as a result of limited infrastructure access. The limited availability of sewage in Karapyien is shaped by the financial resource constraints of households and lack of land tenure, as the development of infrastructure is ultimately the responsibility of households. As one household explained, "the owner of the house did not provide the toilet even though we have been living here for 4 years" (HH14.S1.M). The limited development of sewage infrastructure in Karapyien exemplifies how the development of urban infrastructure in peri-urban areas is constrained by land tenure and financial resources.

Figure 13: Comparison of Sewage Infrastructure Between Samples, n=41



Sewage infrastructure in Kyetsarpyien is more systematic, whereby households use pit latrines constructed from concrete rings (80%) and, to a lesser extent, flush toilets (10%). Sewage infrastructure has improved over the gradual development of the quarter, As one household explained, "before, there is no systematic sanitation system, but now mostly it is protected. It is better living standards" (HH6.S2.M). Comparatively, land tenure and the longer time frame of settlement account for differences in sewage infrastructure between case studies. Further, case studies exemplify how the development of sewage infrastructure is ultimately the responsibility of households, in which access and the ability to invest in infrastructure is shaped by land tenure and financial capital.

5.2.3. Waste Disposal

Karapyien is not serviced by municipal waste collection and, as a result, households litter garbage behind their homes, or burn waste in the dry season. As one household explained, "we throw away the garbage near the house. Sometimes we throw away in the stream… the municipal never comes" (HH3.S1.M). The build-up of garbage in the nearby stream has led to the increasing severity of flooding in recent years, which is discussed in greater detail in section 5.3.3. Waste collection services in Kyetsarpyien is irregular and, as a result, households dispose of their waste directly into the Dawei River, or burn waste in the dry season. As one household explained, "we have been provided one container to collect the garbage. Because this is not a sustainable service for us so this

is why there is no place to throw away our garbage, so we throw into the river" (HH17.S2.M). Field observation suggests that the burning of waste in the dry season likely negatively affects air quality in Kyetsarpyien, leading to poor respiratory health amongst households. Waste collection is limited and inaccessible between case studies, raising issue to the pollution and blockage of water resources and drainage from waste.

5.2.4 Water Supply

Water for drinking and household use in Karapyien is derived from private shallow wells; however, access in this sample is differentiated between households based on land tenure. Squatting and renting households do not have their own shallow wells and are thus reliant on neighbours and the monastery for water access. As one household explained, "there is no well in my house so I go to collect water… for household use nearby my house, and for drinking water from the monastery" (HH12.S1.M). Water quality in shallow wells however, is poor and requires the use of a filtration system. As one household explained, "we do not drink the water, just household use, this part of the village is dirty water, oily water. And smells… because the mud is in the water" (HH1.S1.F). Squatting and renting households construct filters from fishing nets, sand, and leaves to improve water quality, whereas households with home ownership have store-bought filters. For drinking water, renting and squatting households carry water from the monastery; whereas households with home ownership derive water from their own shallow well or from the well of a neighbour (Figure 13). As one household explained, "we don't need to share with other families, because each house has a well… in the upper community where I live, one house has one well" (HH8.S1.M). Access to water is therefore differentiated in Karapyien based on land tenure, insofar as households without home ownership are dependent on social capital for water access in light of limited physical infrastructure and resource constraints. The dependence of households on neighbours and the monastery for water access illustrates the importance of social capital in service provisioning in light of limited infrastructure.

Access to water in Kyetsarpyien is dependent on private suppliers rather than from shallow wells as the proximity of the quarter to the Dawei River causes salt water to intrude into groundwater. Water for household use is either accessed by pipe or by vehicle, whereas drinking water is derived from private suppliers that distribute water (Figure 14). Most households did not raise costs associated with water access as an immediate challenge; however, poorer households did raise water costs as an additional challenge on household expenditure. As one household said, "it is a

struggle… we cannot produce so why not we have to buy. It is necessary" (HH21.S2.M). In the rainy season, households collect rainwater as an additional source of drinking and household water. The varied sources of water access in Kyestarpyien illustrates the connection of the quarter to service providers enabling water access. Comparing between case studies, households in Karapyien rely on social capital in light of limited physical infrastructure, whereas households in Kyetsarpyien are reliant on financial resources in return for service provisioning. The two case studies juxtapose the differential access to physical infrastructure and service provisioning between peri-urban and semi-urban areas in Dawei

Figure 14: Drinking Water Sources and Home Ownership in Karapyien (%), n=19

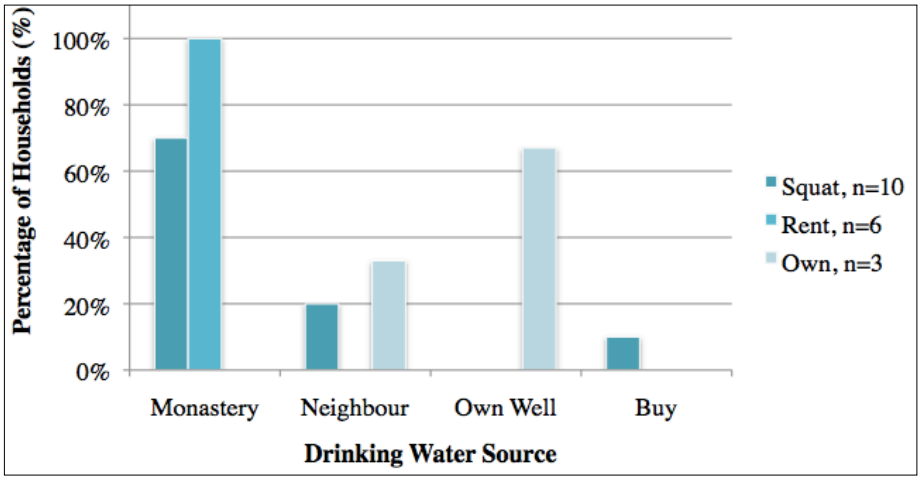
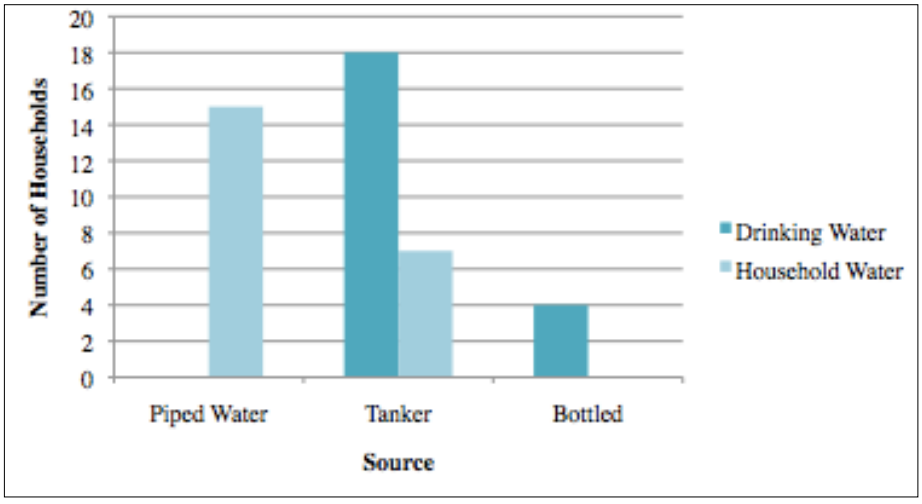


Figure 15: Sources of Drinking and Household Water in Kyetsarpyien (%), n=22



5.2.5 Drainage

There is no drainage infrastructure in Karapyien, which causes lowland areas to flood with shallow stagnant pools of water in the rainy season. Households are raised above the ground by bamboo stilts to cope with varying flood conditions. The stream running between households is blocked by the build-up of sediment and garbage, which causes severe flooding in the rainy season. The absence of infrastructure and the lack of natural drainage maintenance in turn heighten flood exposure. In Kyetsarpyien, drainage infrastructure is rudimentary insofar as a wooden trough lines the road, which is cleared by households in preparation for the monsoon season. Drainage infrastructure differs between the two case studies, given the longer time frame and formality of settlement. Moreover, issues stemming from waste management and natural drainage maintenance heighten flood exposure. The discussion of flooding, and artificial and natural drainage is continued in section 5.3.3..

Karapyien and Kyetsarpyien illustrate how urban infrastructure and services vary between urban contexts in Dawei, which is shaped by differences around land tenure, length of settlement, and surrounding environments. Karapyien exemplifies the quandary of the landless urban poor squatting on or renting land in the urban periphery due to the inability to afford housing and rental prices within the city. Land tenure is fundamental to shaping infrastructure access as investments in sewage, drainage, water supply, and electricity is ultimately dependent on the capitals available to households to invest in property and infrastructure. Land tenure, and by extension, the informality of the settlement in Karapyien, informs the limited availability of infrastructure and services as the financial resource constraints of households ultimately undermines infrastructure development. Moreover, Karapyien illustrates the spatial marginalization of low-income groups to peri-urban areas where infrastructure is rudimentary, access to services is limited, and flood exposure is high. In this way, Karapyien exemplifies how spatial processes linked to land tenure, entitlements, and capital shape the distribution of resources and risk in urban areas.

Conversely, Kyetsarpyien represents a more urban context, in which the longer time frame of settlement as well as the visibility of the quarter to institutions shaping service delivery shapes the relatively better access of the quarter to infrastructure and services. This is illustrated through the multiple distributers providing water access and the subsidization of electricity to households. Although built infrastructure is rudimentary, the more urban context shapes the relatively better access of households to infrastructure and services. The differential access to urban infrastructure and services between case studies shapes differential sensitivity to system exposure insofar as

infrastructure quality and service provisioning can either mitigate or exacerbate the impact of shocks and stresses on households. The following section discusses the differential exposure and sensitivity between case studies in light of climatic and non-climatic stresses affecting water supply and flood risk.

5.3 System Exposure

This research seeks to consider the vulnerability of urban socio-ecological systems at the macro-level, while also considering how vulnerability is manifest in specific communities living in Dawei. The discussion of vulnerability at the meso level is framed according to the exposure and sensitivity of Karapyien and Kyetsarpyien to stresses affecting water supply and flooding in light of differential access to and quality of urban infrastructure and services. The following section begins with the analysis of the differential exposure and sensitivity of water supply to climatic and non-climatic stresses, examining Karapyien and Kyetsarpyien each in turn, followed by the discussion of differential exposure and sensitivity to flooding.

5.3.1 Drinking Water

In Karapyien seasonal fluctuations in water quality and quantity, as well discrepancies between supply and demand for household water, pose stress to water supply. Groundwater quantity and quality is seasonal between the wet and the dry season, in which trends suggest that water quantity in shallow wells is decreasing over time (HH13.S1.M). As one respondent explained, "it is less by less the water table… It is surrounding the water festival. And I think March and April... year after year it is getting lower" (HH17.S1.M). Trends in groundwater in Karapyien highlight how climatic changes in temperature and rainfall may exacerbate existing exposure to seasonal changes in groundwater quantity and quality.

The exposure of groundwater in Karapyien to climatic stress is compounded by discrepancies between supply and demand for household water. The lack of differentiated sources for household water shapes sensitivity as 17 households are dependent on two shallow wells. As one household explained, "even the whole village there are only 3 wells. One of the wells is not good for having a bath… they are only allowed to carry the water to the house. Only two wells they can have a bath. So you can imagine, many people, only two wells" (HH17.S1.M). The limited physical infrastructure in Karapyien shapes sensitivity to seasonal changes in water quantity, insofar as the demand for water exacerbates the limited supply. As one household explained, "in the summer… the water level is

reduced and the people around the area collect much more water in the hotter season… the well doesn't dry up, but it is very few" (HH11.S1.F). Discrepancies between supply and demand compound climatic stresses affecting household water. To cope with seasonal variations in water quantity, households cope by waiting to access water from the shallow wells of neighbours or by carrying water from greater distances. As one household explained, "so it depends on this well… but this cannot meet their demands so they need to look for another well... In the dry season they have to wait one time to another, because they are taking water at the same time, so there is no more water, so you have to wait" (HH5.S1.F). Discrepancies between supply and demand for household water in Karapyien illustrate how limited physical infrastructure heightens sensitivity to climatic stress.

Karapyien illustrates how the limited availability of infrastructure and services supplying water exacerbates the exposure of groundwater to seasonal variations in water quality and quantity. Discrepancies between supply and demand in turn heighten the sensitivity of households to climatic stresses affecting water supply. The sensitivity of households in Karapyien to seasonal variations in water quality and quantity is therefore heightened by discrepancies between supply and demand, and by extension, the lack of differentiated sources for household water supply. Moreover, discrepancies between supply and demand illustrate the need for urban infrastructure and services in peri-urban areas in light of the limited availability of shallow wells supplying household water.

Figure 16: Photograph of a Monk and Shallow Wells at Monastery in Karapyien

Source: Taylor Martin

Groundwater in Kyetsarpyien is exposed to saline intrusion and groundwater depletion; however, the varied means of water access supplied by private suppliers mitigates sensitivity to stress. As one household explained, "it is near the intrusion of salt. The marine stream passes through here. We cannot get good quality water" (HH1.S2.F). Household water is supplied by pipe, however the over extraction of groundwater from industry has resulted in the intrusion of salt water into the water table. As one household explained:

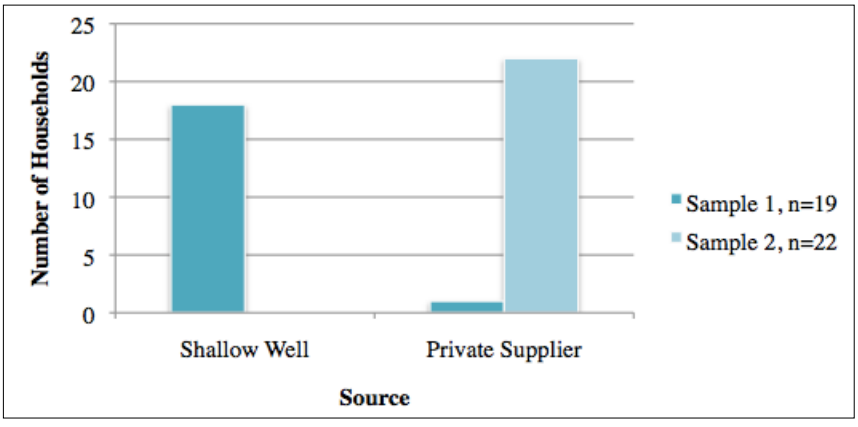
> "because of the ice factory they use more water so they are consuming more and more underground water there… it is very close by the river so there is space underground, bigger and bigger and this space comes from the salty water... So the table of underground water is lower, and already destroyed by the leaking of the river water. So nearby the big well depends on the whole village, so the whole village is getting worse and worse quality. Because so many people are taking water, and industry is using lots of water and the water table is getting lower and salt water comes in" (HH6.S2.M).

Reduced water quality in Kyetsarpyien highlights the interaction of climatic and non-climatic stresses affecting groundwater in Dawei insofar as the over extraction of groundwater exacerbates saline intrusion.

Triangulation interviews conducted with the piped water supplier in Kyetsarpyien suggest declining trends in water quality and quantity:

> "it is deeper between 6 inches to 1 foot, year after year, for example, last year, 2014, the pipe reached to twenty feet, this year it reaches to 20.5 or 21 feet. The water table is getting lower and lower each year… So 6 years ago I am starting to notice that it is getting lower and lower, lower and lower, year after year… it has been affected, by more population, more demand, and pollution" (WS1).

Figure 17: Comparison of Drinking Water Sources between Case Studies



The differential means of water access between case studies shapes sensitivity to system exposure. In Karapyien, water access is dependent on social capital and norms of generosity, in which water is shared within the community. Entitlements shape the differential sensitivity between

households in Karapyien insofar as households without land title are dependent on neighbours and the monastery for water, whereas households with home ownership derive water from their own shallow wells. Conversely, water access in Kyetsarpyien is dependent on financial and social capital insofar as households pay for water access from private suppliers, in which multiple and alternative modes of water access mitigate sensitivity to system exposure.

Despite differences between case studies in means of water access, both case studies illustrate the interaction of climatic and non-climatic stresses in shaping exposure and sensitivity. In Karapyien, the limited number of shallow wells providing household water heightens the sensitivity of groundwater to seasonal fluctuations in water quantity and quality. Conversely, in Kyetsarpyien, groundwater over extraction exacerbates the exposure of groundwater in riverbank areas to saline intrusion. As such, discrepancies between supply and demand in both case studies exacerbate the exposure of groundwater to climatic stress. Non-climatic stresses interact with climate change insofar as urbanization and population growth exacerbates existing discrepancies between supply and demand for groundwater. Additionally, longer-term trends in temperature, rainfall, and sea level rise exacerbate the exposure of groundwater to seasonal water scarcity and saline intrusion.

The sensitivity between case studies to climatic and non-climatic stresses affecting water supply is shaped by the relative entitlements of households in their means of water access. The sensitivity of Karapyien to stresses affecting water supply is exacerbated by the limited means of access and the lack of physical infrastructure supplying water to households. Conversely, in Kyetsarpyien, the exposure of groundwater to saline intrusion is mitigated through the various means of water access to households. The differential means of water access between case studies exemplifies how sensitivity to exposure is shaped by the entitlements available to households, while illustrating how communities living in different urban contexts draw on various combinations of social, human, and financial capital to secure water access. Grounding the analysis of the exposure of Dawei's water supply at the household level sheds light on how climatic and non-climatic stresses interact in light of discrepancies between the supply and demand for groundwater, and infrastructure and service provisioning. The vulnerability of groundwater in Dawei is thus shaped by the interaction of multiple stresses insofar as climate change presents one area of exposure that compounds institutional constraints in infrastructure and service provisioning.

5.3.3 Flooding

In the consideration of flood exposure, Karapyien and Kyetsarpyien experience annual flooding in the monsoon season; however, the frequency, duration, and severity of flooding differs considerably between case studies (Table 7). In Karapyien, serious flooding occurs between 2-3 times per year during periods of heavy continuous rainfall, which causes the creek that runs adjacent to households to overflow and flood surrounding areas. Flood levels are "neck deep" (HH15.S1.F), "height level" (HH14.S1.M), and "chest height" (HH7.S1.F). Conversely, flooding in Kyetsarpyien is less serious and is limited to the western edge of the quarter closest to Strand Road. Flood levels are modest, reaching up to the ankle, while the duration of flooding lasts between 1-2 hours during periods of high tide on the Dawei River. The following section discusses flood exposure in Karapyien and Kyetsarpyien, examining each in turn in light of differential sensitivity, impacts, and coping and adaptation responses.

Table 6: Comparison of Flooding between Case Studies

	Karapyien	**Kyetsarpyien**
Frequency	1-2 times a year	1-2 times a year
Severity	High	Low
Water Levels	Neck deep, 2 metres	Ankle deep, 1 foot
Duration	5-7 days	1-2 hours
Environmental Factors	Heavy rainfall and poor natural and artificial drainage	Heavy rainfall and high tide levels on the Dawei River
Drainage Infrastructure	No built drainage infrastructure to mitigate flood exposure	Drainage trough that lines households, maintained by individual households
Impacts	Transportation and livelihoods, health and dengue, damages to built infrastructure and housing, flooding of sewage	Transportation and livelihoods, health and dengue
Coping	Seek shelter in monastery, receive food rations and water	
Adaptation	Building bamboo raft to aid in flood response due to increasing severity	

High levels of flood exposure in Karapyien is shaped by the location of the settlement within a flood plain, and factors of artificial and natural drainage. As one household explained, "in the former time there is no flood under my house. Now there is a flood because there is no drainage system… the water is not easy to flow" (HH13.S1.M). Households noted the increasing severity of flooding in recent years, explaining, "recent years in the season it is getting worse than other years…

the water level is nearing to meet my window. You can imagine all of the housing is getting covered… this year is getting more… nearly 1 metre higher than before" (HH14.S1.M). Another respondent explained, "in my experience, last year and this year, this year is getting worse… the water level is more high… in the last time, last year, only waist height, so in the recent season it is up to the neck" (HH14.S1.M).

The increasing severity of flooding in Karapyien is linked to changing rainfall patterns insofar as rainfall is becoming heavier and more concentrated. The decreasing quality of natural drainage, however, is more pertinent to explaining heightened flood levels. As one household explained, "in the early years, the drainage system is much better, even last year the government provided a good channel for the water flow but it is still blocked… It is narrow. In the rainy season there is more garbage and so it is more blocked" (HH17.S1.M). Heightened flood exposure is thus indirectly linked to waste management through the blockage of natural drainage channels. Government efforts to clear garbage and deepen the stream channel have failed to mitigate overall flood risk by remaining symptomatic rather than addressing issues of waste management through systematic garbage collection.

Serious flooding results in impacts ranging from difficulties in transportation, disruptions to livelihoods, damages to housing and built infrastructure, and impacts on health and sanitation. Difficulties in transportation as a result of flooding are linked to the disruption of livelihoods, especially for livelihoods directly dependent on transportation such as a porter or driver. As one household explained, "for the poor families, they are affected by the floods… the poor people around here cannot go to work while flooding" (HH18.S1.M). Impacts from flooding on transportation highlight the interrelationship between flooding, livelihoods, and income.

Households also noted damage to housing and built infrastructure as a result of loose debris and garbage awash in the floodwater. Moreover, flooding and poor drainage heightens the exposure of households to health shocks as wet environmental conditions results in higher incidences of dengue in the rainy season. As one household explained, "because there is more water and it is flooded… during the time of the flood, there are more mosquitoes" (HH4.S1.F). Additionally, flooding causes sewage to overflow into surrounding areas and the nearby stream as a result of the overflow of pit latrines. As one household explained, "it floods all the pit. It is not covered properly. So it goes everywhere. The level of the waste is higher because the water intrusion from the flood" (HH3.S1.M). Although respondents did not specify negative impacts from the leakage of sewage into surface water, it points to the potential exposure of water supply to contamination.

The presence of strong networks of social capital in Karapyien and the greater community in Dawei aids in flood response and relief. For immediate flood response, an informal rescue team is assembled by community members to transport households to the nearby monastery by use of a bamboo raft. As one household explained, "shwe ya myo [meaning family-community in Myanmar], the men come and help us... from our house. We help each other by taking families to the monastery by the bamboo boat" (HH11.S1.F). One of the members of the rescue team explained, "I join with the rescue team. We are looking for the children who are very young and living at the house, so this is why we are going. We know very detailed about the single person so we go the other side of the housing and we look for the single person and we pick up using the bamboo raft" (HH14.S1.M). The transportation of households to the monastery via bamboo raft illustrates a high degree of bonding social capital between households to respond to flooding (Aldrich & Meyer, 2015).

The emergency response exercised in Karapyien represents a form of adaptation to cope with increasing flood levels. The construction of the bamboo raft by households occurred only in recent years to cope with increasing flood levels, whereas in former times transportation to the monastery was done via foot. As one rescue team member explained, "last year the water level is increasing, water level takes time so we have a long time to prepare and carry the things. So recent years it is very quick so this is why suddenly I got the idea I need to make some options so that is why. Disaster risk reduction. Preparedness. I have experienced such a disaster so I got the idea" (HH14.S1.M). The construction of the bamboo raft thus represents a form of community-based adaptation, while demonstrating the social learning on behalf of households to internalize past experiences and adapt to increasing flood levels.

Wider social networks are also important for supporting flood relief in Karapyien insofar as households take refuge at the nearby monastery where they are provided shelter, food, water and medicine. As one household explained, "at that time all of the people living in the houses must move to the monastery and relocate… in shelter. And there, we are living from shared rations of food from the community" (HH17.S1.M). The wider community aids in flood relief insofar as households and civil society organizations donate dry rations to support relief efforts. As one household explained, donations come from "two parts, one is the community living in the surrounding areas. And if not enough, some of the young aid people collect money and spend the money for food in the town" (HH17.S1.M). The monastery represents a form of bridging social capital by providing households with access to network resources from the larger community (Aldrich & Meyer, 2015). Strong social

networks between households in Karapyien, the monastery, and the wider community illustrate the importance of social capital to cope with and adapt to flooding.

Figure 18: Photograph of Floodplain in Karapyien

Source: Taylor Martin

Addressing underlying drivers of flood exposure, however, require more collaborative efforts between households in Karapyien and the municipal office. As one household explained, "if I am preparing for the creek, I am alone, I need some help… for cleaning the garbage in the creek, it is very easy to make the bamboo raft, for cleaning some things I need some help. It's one thing to make the raft but it's harder to clean the things as the creek is blocked" (HH14.S1.M). The mitigation of flood exposure thus requires efforts that work between local communities exposed to flooding and local institutions in order to address systemic issues of drainage and waste management.

Flood exposure in Kyetsarpyien is dependent on heavy rainfall and tidal fluctuations on the Dawei River insofar as flooding occurs during periods when heavy rainfall coincides with periods of high tide. As one household explained, "when the rain is heavy in the rainy season it floods… high tide and heavy rain if coincidence" (HH1.S2.F). Flood levels are modest and the duration of flooding is short, lasting for up to 1-2 hours. Although current levels of flood exposure are not serious, the

dependence of flooding on rainfall and tidal fluctuations on the Dawei River suggests that climatic stresses of heavier rainfall and sea level rise heightens prospective flood risk.

Impacts from flooding in Kyetsarpyien affect transportation, livelihoods, and health, however; due to moderate levels of severity, impacts are less pronounced than in Karapyien. Households raised flooding impacts in the context of employment insofar as flooding disrupts livelihoods tied to transportation. As one household explained, "all of the way are the floods, in that time there is no transportation so we are working in the market so there is a block from the flood so there are no trucks that come here… (HH4.S2.F). Another respondent employed as a porter explained, "so for us, we have work all year around, but only 7 days a year there is no job because of the flood" (HH5.S2.F). This coincides with findings that suggest that transport connectivity between Dawei and rural areas is cut off during periods of flooding. As one key informant explained, "if you go around, all these areas are flooded areas, in the rainy season, all these areas are flooded, you cannot go to Ye, or Myiek because it floods around this, flooded areas" (KI.12). Although localized flooding in Kyetsarpyien does not pose any major impacts on households, the dependence of livelihoods on transportation highlights the relationship between flooding and lost earnings. As such, cascading impacts from flooding on transportation, market access, and livelihoods illustrates the direct and indirect impacts of flooding on households.

Similar to findings in Karapyien, flooding heightens the exposure of households to seasonal health shocks insofar as wet environmental conditions results in the higher incidence of dengue in the rainy season. As one household explained, "so in the rainy season, two impacts, one is the flood, it blocks the transportation and my job, and another one is the mosquitoes" (HH4.S2.F). Flooding and poor drainage are thus linked to the exposure of households to health shocks, illustrating the relationship between flooding, and seasonal health issues.

5.4 Conclusion

This chapter attempted to bridge the analysis of the vulnerability of urban socio-ecological systems with a focused analysis of how urban vulnerability is manifest at the household level. The analysis of the relative entitlements between case studies illustrates how urban development and infrastructure access is largely determined by the financial resources available to households. The two case studies juxtapose the differential sensitivity between peri-urban and semi-urban areas to system exposure in light of access to infrastructure and services. The case of Karapyien exemplifies the unique vulnerability of an informal settlement situated in a flood plain, in which urban growth

outpaces the development of urban infrastructure and services. Water supply, sewage, electricity access, drainage, and waste disposal are thus highly rudimentary, while service provisioning is limited. Land tenure is critical in shaping infrastructure and service access, insofar as households without land title are unable and unwilling to invest in the development of infrastructure given their limited financial resources and the insecurity of land tenure. Given low levels of physical infrastructure, households rely on a high degree of social capital to access essential services, which is exemplified through the case of water. Conversely, Kyetsarpyien represents a more urban context in Dawei that has relatively better access to infrastructure and services given the longer time frame of settlement, the security of land tenure, and the connectivity of the quarter to service providers.

Despite differences between case studies, they both illustrate how the financial resources available to households ultimately shape access to infrastructure and by extension levels of urban development. Moreover, the relative entitlements of each case study exemplify how urban infrastructure and services shapes sensitivity to stresses affecting water supply and flood risk. The limited development of infrastructure and the availability of services in Karapyien heighten sensitivity to stresses affecting water supply insofar as the limited availability of shallow wells heightens sensitivity to seasonal variations in water availability insofar as demand is greater than supply. Comparatively, although groundwater in Kyetsarpyien is directly exposed to saltwater intrusion, the varied means of water access mitigates the sensitivity of households to exposure. The differential means of water access between case studies exemplify how sensitivity to exposure is shaped by the entitlements available to households, while illustrating how communities living in different urban contexts draw on various combinations of social, human, and financial capital to access water.

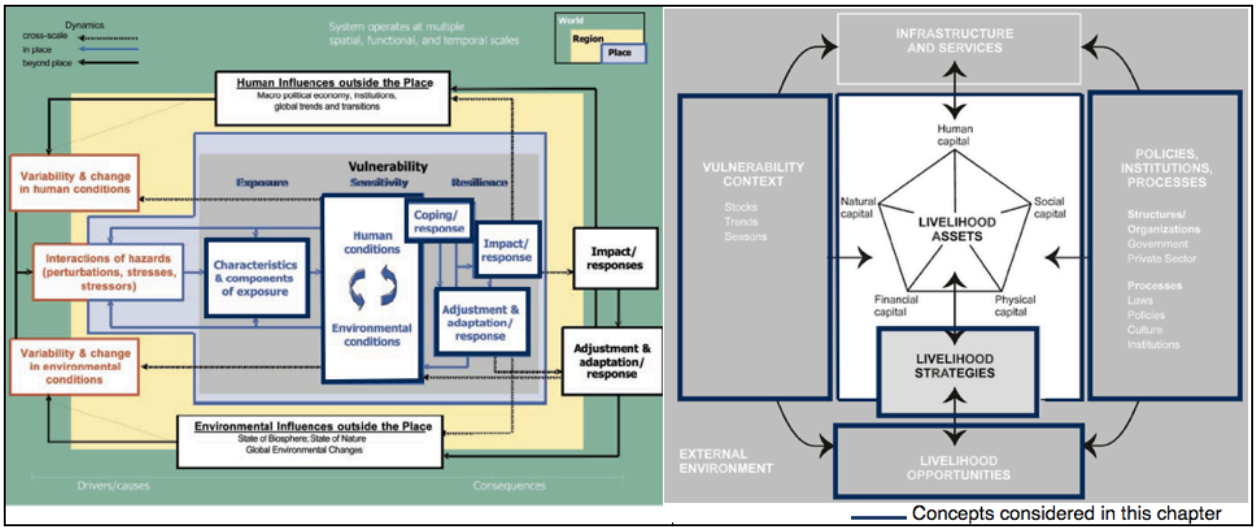
In the consideration of flooding, both case studies illustrate how flood exposure often coincides with factors of socio-economic status as Karapyien and Kyetsarpyien represent lower income groups living in Dawei. Flood exposure in Karapyien is shaped in part by the location of the settlement in a flood plain, the informality of the settlement, and the insecurity of land tenure. Additionally, the absence of drainage infrastructure and the blockage of natural drainage from waste heightens the sensitivity of households to flood exposure. Although flooding occurs annually in Kyetsarpyien, the nature, severity, and impacts of flooding are much less severe. Despite differences between case studies, they both illustrate the cascading impacts of flooding on transportation, livelihoods, and health. Importantly, households exercise a high degree of resilience to cope with and adapt to flooding which is poignantly demonstrated through flood response and relief in Karapyien.

In addition to the analysis of the exposure and sensitivity of households to climatic and non-climatic stress affecting Dawei's urban systems, this research places importance on integrating a livelihoods approach in assessing household vulnerability. The next chapter discusses urban vulnerability through the application of a livelihoods approach to assess the existing exposure, sensitivity, and resilience of households.

6.0 Household Vulnerability and Livelihoods

This chapter discusses urban vulnerability through the analysis of the livelihood strategies, challenges, capacities, and priorities of households in Karapyien and Kyetsarpyien. This chapter considers vulnerability according to the exposure, sensitivity, and resilience of households in light of their lived realities and existing challenges (Figure 19).The following chapter begins with an analysis of the livelihood strategies and employment patterns found across households in each case study, followed by an analysis of the challenges faced across households. The chapter concludes with a comparative analysis of the coping and adaptive strategies used by households in Karapyien and Kyetsarpyien.

Figure 19: Concepts Considered in Chapter 6



Source: Turner et al., 2003; Lloyd Jones, 2002

6.1 Livelihood Strategies

Sustainable livelihood approaches are often used to complement vulnerability frameworks, which offer a people-centred approach to understand vulnerability at the household level. The consideration of the livelihood strategies and employment patterns of households between case studies grounds the analysis of household vulnerability in light of how people live their everyday lives and the constraints that people face in the pursuit of their livelihood goals (Ashley & Carney, 1999).

In Karapyien, common primary livelihood strategies for men are in construction, working as a mason or carpenter or working in transportation as a driver or porter. Common primary livelihood

strategies for women are in the processing of cashew nuts for export, and selling goods, vegetables, and homemade food items as a hawker or vendor. Due to seasonal employment patterns, households engage in secondary livelihood strategies during the rainy season, which for men are as casual labour in construction, and for women as vendors in the market. Other households engage in informal and self-employed secondary livelihood strategies, such as catching fish in the nearby stream or collecting plastic around the city. Livelihoods in Karapyien are thus informal insofar as households lack job security as either waged labour or through self-employed strategies. In Kyetsarpyien, primary livelihood strategies for men are as fishers, catching fish and shrimp in the Dawei River, and in transportation; whereas women work as porters or vendors in the market. Similar to Karapyien, households engage in secondary livelihood strategies due to seasonal employment patterns. Secondary livelihood strategies for men are as a porter or as casual labour in construction, whereas women engage in primary livelihood strategies throughout the year.

In both case studies, more than half of households interviewed engage in seasonal employment patterns, accounting for 58 percent and 59 percent of households in Karapyien and Kyetsarpyien respectively. Wet conditions during the monsoon season results in a slight seasonal depression in local economic activity, leading to less employment and unstable earnings for households. As one Karapyien household explained, "in the rainy season, we have no work, we earn no money. At this time it is very difficult" (HH3.S1.M).

Livelihoods that follow seasonal employment patterns in Karapyien are in transportation and construction respective of flooding and the lower demand for waged labour in the rainy season. As one household explained in reference to flooding and livelihoods, "at that time there is no job opportunities after the flood. All of the roads are getting wet, very slippery so it is hard to control even on foot, so my job depends on transportation… no job opportunities in the rainy season. That is why in the rainy season I need to take a rest" (HH17.S1.M). In Kyetsarpyien, seasonal livelihoods are in fishing and transportation as a result of difficult fishing conditions in the rainy season and flooding. As one fisherman explained, "around June and July, it is a bit difficult to do fishing because this time there is too much rain and the water surface level is high then. So the current is too strong" (HH7.S2.M).

To compensate for fewer earnings during the rainy season, households adopt secondary livelihood strategies. As one respondent from Karapyien explained, "I work for 8 months, and the rest of the months, I have to look for another job. The four months (rainy season), I work in hard labour, daily wages" (HH5.S1.F). In Karapyien, secondary livelihoods are in construction and self-

employed strategies such as selling vegetables, washing clothes, collecting garbage, or fishing in the nearby stream. In Kyetsarpyien, secondary livelihood strategies are in transportation and construction. In both case studies, households characterized employment and earnings from secondary livelihood strategies as casual and unstable, causing households to experience greater financial strain. As one respondent from Karapyien explained, "we have no regular jobs. For example my husband has no job today, he has to do daily wages or hard labour, if he can do he [can] pay for our household, if he cannot we borrow money" (HH1.S1.F). The casual and unstable character of secondary livelihood strategies in turn heightens the vulnerability of households in the rainy season insofar as households have less financial resources to buffer shocks and stress.

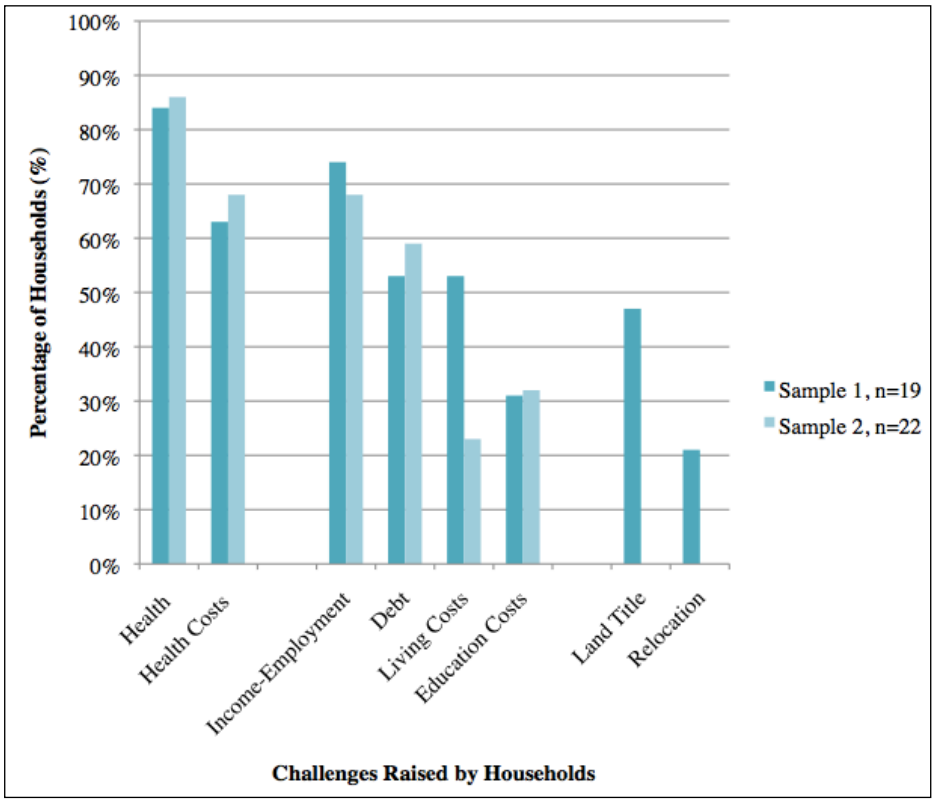
The analysis of the employment patterns and livelihood strategies of households in Karapyien and Kyetsarpyien provides a lens to contextualize the existing sensitivity of households to shocks and stress. Seasonal livelihood patterns and the limited livelihood opportunities available to households undermine their financial means to pursue livelihood goals, improve household wellbeing, and address underlying drivers of vulnerability. The following section builds on the discussion of the existing sensitivity of households through the analysis of the everyday challenges, and capacities of households to respond to shocks and stress.

6.2 Household Challenges

Between case studies, health and financial wellbeing emerged as two outstanding themes in the discussion of the challenges faced across households. Challenges related to health were raised in the context of health costs, and the inability to engage in livelihood strategies as a result of poor health. Findings suggest that health shocks are the most widespread shock experienced by households in Karapyien and Kyetsarpyien, as lack of financial resources forces families to incur debt to cover health costs and compensate for lost income.

Challenges related to employment and income were raised by households in the context of needing better job opportunities, more stable employment, and ultimately the need for more financial resources. Households raised the challenge of income and employment in light of the need for more financial resources to cope with shocks and stress and achieve livelihood aspirations such as meeting household expenditure, attaining higher levels of education, and securing land tenure. Moreover, the financial resource constraints of households informs challenges related to debt, which was raised by households in the context of needing to borrow money to cover health care expenses, especially during periods of unstable and seasonal unemployment.

Figure 20: Household Challenges noted between Case Studies (%), n=41



6.2.1 Health

In both case studies, health was the most commonly cited challenge raised across households in light of the inability to afford health care costs and the impact of ill health on livelihood strategies and earnings. These findings align to research that suggests that health shocks are the most common household level shock experienced by households in Myanmar (Dutta, 2015). Flu, dengue, hypertension, heart disease, diabetes, and respiratory illnesses were the most commonly cited health problems faced by households. Costs associated with health care and medicine are unaffordable to the majority of households in Karapyien and Kyetsarpyien. As one household explained, "I cannot buy medicine so I am suffering, I cannot go to the clinic. I have no money" (HH1.S2.F). Households are thus highly sensitive to health shocks given financial resource constraints and their inability to afford treatment.

Moreover, health problems compound the financial difficulties of households insofar as illnesses inhibit the ability for earners to engage in livelihood strategies. As one household from Karapyien explained, "before, I drove the tricycle (rickshaw), but now I have some health problems so I stopped driving the taxi. We only have the earning from my wife… the main challenge is

because of my health problems, I need to work for the family, but I cannot" (HH.12.S1.M). Chronic illness and health shocks can have devastating impacts on household finances as providers suffering from prevailing health issues are unable to work and contribute to household earnings. The inability for earners to contribute to household income highlights how human and financial capital are critical to shaping household wellbeing in respect to health and poverty.

The impact of health shocks on livelihoods exacerbates the financial resource constraints of households and heightens sensitivity to shocks and stress. As one respondent explained, "the problem is that we don't have enough money. Our earning is very low so there is not enough money for food. Especially, previously it wasn't so serious. I have broken my legs so it is very difficult for me to work" (HH1.S2.F). Moreover, health shocks have pronounced impacts on household finances as multiple earners are unable to engage in livelihoods. As one respondent explained, "in my family, we have three people working… when I am sick, not only me, but also my son and my husband have to take care of me in the hospital… this means that all three of us need to quit our jobs… so this is why this is a challenge" (HH.13.S2.MF). Health problems can have devastating impacts on household finances insofar as multiple earners are unable to engage in livelihoods, which in turn heightens the sensitivity of households to shocks and stress. The impact of health problems on livelihoods and earnings appears to be more widespread in Kyetsarpyien (41%) than in Karapyien (26%). Although it is beyond the scope of this research to discern causal relationships surrounding health, environmental factors related to the more urban environment and larger household size may account for differences between case studies.

Health challenges are more prevalent during the rainy season, which corresponds with periods of seasonal unemployment and fewer earnings. As one household explained, "in the rainy season, my children got dengue fever. This is a major issue for us, in the rainy season… because there is more water and it is flooded. When the time of the flood, there are more mosquitoes" (HH4.S1.F). The prevalence of illnesses, such as dengue, is higher in the rainy season, which corresponds with periods of financial stress as a result of seasonal employment. As one household from Karapyien explained, "my baby got dengue fever, so there is not enough money at this time. So I think about where I can get the money… at this time, this is the biggest challenge" (HH1.S1.F). Households are thus sensitive to health shocks during the rainy season as income is unstable and earnings are low at this time of the year. In addition to the seasonality of health shocks, chronic health problems are exacerbated in the rainy season due to wet environmental conditions. As one respondent explained, "because of my health condition… because of my foot. In the rainy season it is

getting wet a lot. So my leg is soaked with water and so this is very difficult to work in the water" (HH17.S1.M). Households with family members suffering from chronic illnesses such as sustained injuries or respiratory diseases are more sensitive during the rainy season given the difficulty of earners to work in wet conditions.

To cope with the impact of health shocks on finances, households will either spend savings or borrow money to cover health care costs and meet daily expenditure. As one respondent explained, "I have a bitter experience about this, I got this problem and I have to take a rest for ten days. At this time there is no income so I need to borrow money from other people… My earning just covers the daily spending. When there is a health problem, I cannot control" (HH.12.S2.MF). Households are thus highly vulnerable to falling into poverty from the incurrence of debt as a result of the impact of ill health. As one respondent explained, "my health is not very good in the rainy season, so I cannot work so much. I cannot work outside in the rainy so I get less money in the rainy season, and so we borrow money at this time to cover medical charges" (HH.12.S2.MF). The incursion of debt due to health shocks are the most pronounced examples of households falling into poverty. As one Kyetsarpyien household explained, "we are looking for money to pay the interest rate. This is the struggle of life. It is like swimming in the middle of the sea so how can we escape this struggle… we have been struggling to pay back for a year. You know this is just like a chain of serious problems-like a cycle" (HH.S2.15). The need to pay back large debts can lead households to be caught in a poverty trap as households struggle to pay interest every month. The relationship between health shocks and debt illustrates the vulnerability of low-income households of falling into poverty. Moreover, health shocks and chronic illness impoverish households by reducing their ability to buffer shocks and stress and meet household expenditure.

Table 7: List of Household Challenges

Challenges	Description	Ranking	
		Karapyien	Kyetsarpyien
Health	Health is the most widespread challenge experienced between case studies. Health shocks and chronic illness negatively impact the financial and human capital of households through lost income, the inability to engage in livelihood strategies, and health costs. Health is a seasonal challenge insofar as wet environmental conditions in the rainy season and poor drainage are linked to higher exposure to health shocks such as dengue. The convergence of seasonal health issues and low earnings in the rainy season highlight the sensitivity of households to exposure to health problems. Health shocks are the most	1 n=16	1 n=19

	common reason as to why households are in debt.		
Health-Costs	Health shocks and chronic illness strain the financial resources of households due to costs associated with healthcare, transportation, and medicine. Myanmar's weak healthcare system places the burden of healthcare costs on households.	3 n=12	3 n=15
Health-Livelihoods	Health shocks and chronic illness negatively impact the human and financial capital of a household by affecting the ability for earners to engage in livelihood strategies. Earners cannot work either because of poor health or because they need to take care of ill family members.	9 n=5	6 n=9
Livelihoods - Income	Seasonal livelihood strategies and low earnings results in limited financial resources available to households to buffer shocks and stress. Financial resource constraints and lack of savings inform challenges of debt, and the inability to afford health, living, and education costs.	2 n=14	2 n=15
Debt	Low earnings and lack of savings lead households to borrow money to cover expenditure during seasonal unemployment and health costs. Seasonal livelihoods lead to low-earning households to be caught in a poverty trap, due to seasonal earning, saving, spending and borrowing cycles. Seasonal debt was more widespread for households in Karapyien (26%) than in Kyetsarpyien (14%).	4 n=10	4 n=13
Living Costs	Low earnings and limited financial resources cause low income households, living 'hand to mouth' to struggle to cover household expenditure and food costs. Rising food and living costs compound financial difficulties experienced by households.	5 n=10	7 n=5
Education Costs	Low earnings and lack of financial resources limit the ability for households to afford tuition and education costs for children. The inability to afford tuition costs hinders the development of human capital and the upward mobility of households.	7 n=6	6 n=7
Land Title	Lack of home ownership presents a source of insecurity for households. Low earnings and the inability to save hinders the ability for households to secure land title and home ownership.	6 n=9	0 n=0
Relocation	Lack of home ownership is linked to fears raised by squatting households of relocation by government. Rising land and housing prices compound financial difficulties for landless households to be able to afford housing.	10 n=4	0 n=0

6.2.2 Finance

The challenge of low earnings and unstable livelihoods was widespread across households in Karapyien and Kyetsarpyien. The need for financial stability in terms of earnings and employment was considered as fundamental to overcoming all other challenges that households faced, including

debt, daily expenditure, home ownership, and costs associated with healthcare and education. As one household from Karapyien explained:

> "we need a reliable job. This means that we can get a regular salary, and by making this salary, we can face what sort of problems there are because we have a reliable job. Because now my husband does not have a regular job, this is the problem, we need a regular salary because we can control our challenges. The problem is that our job is not reliable. There is no job, there is no money, we cannot face the challenges" (HH1.S1.F).

Households framed the need for more stable employment in light of the financial means to meet daily expenditure and cover living costs (HH10.S2.F) (HH19.S2.M).

Given the financial instability of households in the rainy season, households are more sensitive at the time to shocks and stress. As one household from Kyetsarpyien explained:

> "sometimes they have a social problem together with the other households because some of the other households are in a terrible situation so they have to help and share their food with other households. At this time it is more difficult than other situation… mostly in the rainy season... because of less job opportunities" (HH.12.S2.MF).

Across households in Karapyien and Kyetsarpyien, respondents highlighted the relationship between lower earnings in the rainy season and greater financial difficulties as lack of income and earnings places strain on the ability for households to meet daily expenditure. Seasonal unemployment heightens the sensitivity of households to shocks or stress as lack of income, and financial capital undermines the capacity of households to cope with challenges. As one household explained, "in that time [rainy season]… we do not want to face health problems, if there is not a health problem it is okay" (HH2.S1.F). Due to the seasonality of employment and earnings, households are more sensitive during the rainy season to shocks and stress.

Given the seasonality and instability of livelihoods, households have low savings and are therefore reliant on borrowing money to cope during periods of financial stress and buffer shocks. Accordingly, the seasonality of livelihoods causes household finances to follow a seasonal cycle of earnings and savings in the dry season and spending and borrowing in the rainy season. The seasonality of household finances results in a seasonal cycle of debt insofar as households will borrow money in the rainy season and pay back debts in the dry season when employment is relatively more stable. As one household from Karapyien explained:

> "so sometimes even in the dry season there is no job so we have to use our saving money… Sometimes we have to borrow. So if we face this problem we can give only the interest rate in the rainy season, so for the pay back we have to wait until the dry season. So we are not able to pay back in the rainy season so we have to wait to pay back in the dry season" (HH16.S1.F).

The seasonality of livelihoods and household finances undermines the financial wellbeing of households due to low earnings, savings, and debt. A household from Kyetsarpyien explained, "at those times, our money situation is not so good, so we have to borrow money from the money lender, so if we borrow 300,000 in the rainy season, in the dry season we have to pay around 600,000" (HH19.S2.M). The seasonality of earnings and debt undermines the ability of households to attain financial stability and accrue savings, which has the potential to trap households in a cycle of poverty. Causes of debt are related to seasonal earnings; the need for financial resources to invest in livelihood strategies; and health shocks. The seasonality of livelihoods and finances heightens the sensitivity of households in the rainy season, however households are sensitive throughout the year due to low earnings and savings. Seasonal debt was more widespread across households in Karapyien (26%) than in Kyetsarpyien (14%), suggesting that challenges related to seasonal livelihoods and finances is more pronounced in Karapyien.

The most vulnerable households are living 'hand to mouth'. As one household from Karapyien expressed, "the main problem is poverty, lack of earning money. It's a main challenge because if I have no money I cannot get food, water, everything. So I cannot earn. If I can earn it is okay, but if I cannot earn it is a problem" (HH9.S1.F). Low returns and the instability of livelihoods result in the limited financial resources available to households to meet daily expenditure and in turn buffer shocks and stress. The financial challenge of covering daily living costs was more widespread for households in Karapyien (53%) than in Kyetsarpyien (23%). This complements findings that indicate that financial difficulties related to income and employment and seasonal debt is more widespread Karapyien, suggesting that households in Karapyien are relatively more sensitive to shocks and stress given greater challenges related to livelihoods.

In both case studies, the challenge of covering daily expenditure is especially pronounced for female headed households who struggle with the double burden of childcare and livelihoods. As one female headed household in Kyetsarpyien expressed, "the problem is poverty. I do not have enough money from day to day. So when I cannot go to work I borrow money. If I cannot go to work I have no money to buy food, I have to borrow. If I can work, no problem" (HH2.S2.F). Female headed households are thus highly sensitive to shocks and stress given the dependence of daily earnings on one source of income and the inability for households to accrue savings.

The inflation of living and food costs represents a stress that heightens the existing financial resource constraints of households to meet daily expenditure. As one household explained, "less job opportunities, money inflation directly impacts us. Because of money inflation our income is not

changing, but the cost of living is" (HH20.S2.MF). Another household explained that living costs had increased from USD $4.00-$7.00 per day (4000-7000 kyat) over the past year, highlighting the difficulty faced by low income households to meet daily expenditure in light of rising food costs and the limited viability of livelihood opportunities (HH4.S2.F). Rising food and living costs heighten the sensitivity of households to shocks and stress by compounding the financial constraints that households already face in terms of meeting daily expenditure and food intake.

Between case studies, education was raised as an aspiration and a challenge as households in Karapyien (31%) and Kyetsarpyien (32%) equally struggle to afford tuition costs. The inability of households to afford education costs is informed by the education system in Myanmar, in which teachers run private tuition classes to compensate for below subsistence salaries. The teaching of final exam materials in tuition classes makes tuition a compulsory component to the passing of grade levels. As one household explained, "this is the education system because at the school they have to attend private tuition. If they don't they cannot pass their regular examination… the government teachers give tuition… if you do not attend tuition the student cannot pass their exams, they misuse their responsibility" (HH1.S1.F). The inability of households to afford tuition costs highlights how financial resource constraints limit the capacities of households to achieve livelihood aspirations of education. As one household expressed, "I want my children to be educated, but I cannot afford to pay for their education. So this is a major issue for my feelings" (HH4.S1.F).

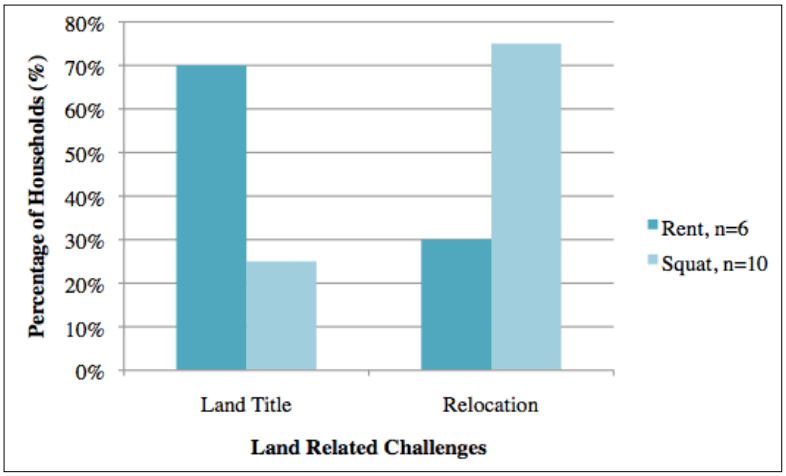
The inability for households to send their children to tuition classes results in children being held back or withdrawing from school due to the inability to be able to progress in grade levels. As one household stated, "for the 7th standard the tuition costs are more higher so we cannot afford to send to tuition so that is why we start to think, to quit the school for next year. If we cannot send her to tuition she cannot pass" (HH20.S2.MF). Another household explained, "I cannot afford to pay the tuition fees. My son is eight years he is still in kindergarten, in the same class, 3rd grade, I cannot afford to pay for the tuition fees" (HH.10.S1.F). The inability for households to afford tuition costs highlights the relationship between financial resources and human capital, which ultimately undermines the ability for households to attain higher education levels and achieve livelihood aspirations.

6.2.3 Home Ownership

Challenges related to land title and home ownership were exclusively raised by households in Karapyien given that the majority of households rent property or squat on government land with the

permission of the ward administrator. Interestingly, renting households raised challenges related to land title in the context of the desire for home ownership, whereas, squatting households raised land title more so in light of fears of forced relocation (Figure 17). Livelihoods and the financial resource constraints of households shapes land tenure insofar as squatting and renting households are unable to afford home ownership. As one renting household stated, "housing means I need more money. I need to save money. That is why I want a more reliable and higher income job. So this is a hope and a challenge. And the second challenge is for my house" (HH14.S1.M). Unstable and seasonal livelihoods undermine the financial resources available to households to secure land tenure, which highlights the relationship between earnings, savings, and the ability for households to achieve livelihood aspirations.

Figure 21: Land Related Challenges in Karapyien and Home Ownership (%), n=19



Squatting households raised the challenge of land title more in reference to fears of relocation in light of rumours of a government led road development project. As one squatting household explained:

> "the main challenge is the land because it is not our own, but the government. And so the government announced to remove our house. We are worried about where we will move and where we will live, we are hearing about the news, and we are not happy because we have to move whenever the government asks us to. We have no idea and so we are worried all the time" (HH11.S1.F).

Anxieties surrounding the potential displacement of households as a result of road development highlights the importance of land tenure in shaping vulnerability insofar as households do not have legal land title. Moreover, the risk of relocation as a result of a government-led project to improve road connectivity illustrates the risk of marginalizing low-income groups in decisions surrounding urban development.

In light of the inability for low-income households to afford land title, rising land and housing prices in Dawei exacerbate the inability of households to afford permanent housing. As one household expressed, "the biggest challenge is land. We cannot afford... the price of land has come up in the last ten years by ten times. Too high because of the SEZ" (HH2.S1.F). The relationship between increasing land and housing prices and the rise of land speculation surrounding the Dawei SEZ points to how regional integration has far reaching implications for exacerbating challenges related to home ownership for low-income households.

In addition to understanding larger patterns in livelihoods and the challenges faced across case studies, it is also important to account for the differential sensitivity between households based on health, household composition, livelihood strategies, gender, age, and land title. Importantly, factors shaping the differential vulnerability of households interact. For instance, a female-headed household that is suffering from chronic illness is more sensitive to shocks and stress than a household that has multiple family members engaged in various livelihoods. Across case studies, households that are more sensitive to shocks and stress are female-headed; households with family members suffering from chronic illness; elderly households without children; and households that lack home ownership. Importantly, the challenges experienced by households interact and compound one another to shape household vulnerability.

Table 8: Differential Sensitivity between Households

Gender
Female-headed households are highly sensitive to shocks and stress as the female head is the sole provider for their household and faces the greatest difficulty in overcoming challenges related to livelihoods and debt. Aye San Win is a thirty-year-old widow. She has three children and lives in a house that she built on her brother's property. Her house is falling apart and she cannot afford to repair it. She earns her income by selling brooms around the city, though her earning is very low. As she related, "I have a lot of trouble to earn a living for our livelihood… sometimes the selling brooms is not good and at that time we cannot take our food regularly and so sometimes it is very difficult to get food" (HH10.S1.F). Difficulties stemming from her livelihood place the strain on the ability for Aye San to provide for the daily food intake of her household. As Aye San expressed, "the youngest one is not very healthy. Actually she is 4 years old but she looks 2 or 3 years old. She is unhealthy. She has health problems. Occasionally she is sick. I think it is malnutrition. I cannot afford very good food for them" (HH10.S1.F). Financial challenges also impact the ability for Aye San to educate her children. As Aye San relayed, "I cannot afford to pay the tuition fees. My son is eight years old and he is still in kindergarten" (HH10.S1.F). In light of the struggle for Aye San to earn enough income to provide for her family, she borrows money in order to meet daily expenditure. As Aye San expressed, "the problem is money. The biggest problem is money, for my livelihood. So I lend my money… the biggest challenge is indebtedness" (HH10.S1.F). She continued, "I have courage,

I struggle, whatever, I do not want to give my children to the others. I take care of them like the hen covers the chickens" (HH10.S1.F). Aye San's struggle to provide for the wellbeing of her children illustrates the sensitivity of female-headed households to shocks and stress in light of existing challenges stemming from livelihoods and income.

Health

Households with family members suffering from chronic illness are highly sensitive to shocks and stress as households struggle with fewer earnings due to the inability for earners to engage in livelihood strategies.

The story of Ke Sein illustrates the sensitivity of households that have family members suffering from chronic illness. Ke Sein is fifty-seven years old and has been living in Kyetsarpyien since she was born. Twelve people live in her household. The sole source of income for her household is from her daughter who works as a porter in the fish market. Ke Seine cannot work because she has broken her legs and can no longer work as a porter. As she explained, "the problem is that we don't have enough money. Our earning is very low so there is not enough money for food. Especially, previously it wasn't so serious, but I have broken my legs so it is very difficult to work" (HH1.S2.F). She continued, "we cannot earn enough money for our children. The food, shelter, clothes, called say wad neye. All included. Most serious problem. In short it is our earning and income" (HH1.S2.F).

Age

Age is an important factor influencing the sensitivity of households to shocks and stress as households struggle in earning income in addition to experiencing health problems and chronic illness.

The sensitivity of elderly households suffering from chronic illness is exemplified by a couple in their sixties living in Kyetsarpyien. Aung Tun is blind and his wife Su Swe was recently hit by a motorbike, and now suffers from a hip injury. Aung Tun is unable to work because of his health. Su Swe is the sole source of income for the household, working as a street vendor selling vegetables. Household earnings are only enough to provide for daily food costs and as a result she needs to borrow money to purchase vegetables for selling. Challenges stemming from livelihoods and income are compounded by health problems and age. As Aung Tun explained in respect to the challenge of livelihoods, "as long as she can work it is okay for daily spending. She cannot maybe difficult… It is more difficult because both of us are getting worse and worse health condition" (HH21.S2.M). The case of Aung Tun and Su Swe illustrates the intersecting profiles of vulnerability in which chronic illness, age, and lack of labour supply results in heightened sensitivity of the household to shocks and stress.

Home Ownership

Landlessness is another factor shaping sensitivity as households that rent property or squat on government land are subject to eviction based on the will of homeowners or from government.

The challenge of homeownership is exemplified by the case of Aung Myo and his wife San Kyi who rent property in the paddy fields in Karapyien. The couple is in their late twenties and have three daughters. They both work in construction in the dry season. In the rainy season when there no work, Aung Myo works odd jobs to meet household expenditure. Although they are able to earn enough money to cover daily expenditure, they are unable to save. The inability to save earnings inhibits their aspirations for home ownership. As San Kyi explained, "the problem is that we can cover our income, but we cannot afford to buy a house based on our savings. We want a better life,

a more stable life" (HH16.S1.F). The rising cost of living and housing compounds the challenge for Aung Myo and San Kyi to be able to save and secure home ownership. As San Kyi explained, "in recent years the price of real estate and the market is going up so some of the people want to sell their house. So this is why… it is difficult to afford a house" (HH16.S1.F). The challenge of home ownership for Aung Myo and San Kyi illustrates how rising land prices compound existing challenges for low-income households to secure land tenure. The case of Aung Myo and San Kyi illustrates the relationship between livelihoods, lack of savings, and the inability to afford home ownership.

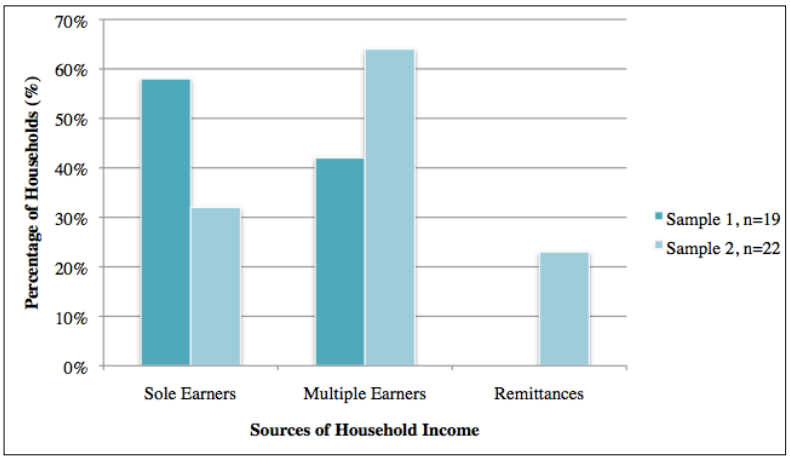
6.3. Coping, Adaptation, and Resilience

In addition to the analysis of household vulnerability through a livelihoods perspective, this research seeks to emphasize the coping and adaptive capacities of households to respond to shocks and stress. The nature of people's livelihoods fundamentally shapes vulnerability by determining the financial resources available to households to meet livelihood objectives, respond to health shocks, and cope during periods of financial stress. Given the seasonality of livelihoods in Karapyien and Kyetsarpyien, households employ various strategies to cope with seasonal fluctuations in household finances. To cope with financial stress in the rainy season, households will adjust household expenditure and food intake, sell assets, and spend savings earned during the dry season. As one household explained, "in the hot season every house, we work and work, sometimes we save some money… In the rainy season first we use the saving money, then the money is gone, so then we use some spare things and sell. And then we can make some money and we use this money" (HH15.S1.F).

In addition to adjustments to household expenditure, households engage in multiple livelihood strategies to compensate for fewer earnings in the rainy season. The adoption of multiple livelihood strategies varies across households, ranging from stable forms of employment to casual and irregular work. As one respondent from Kyetsarpyien explained, "I work for four months in betel nut processing. After that I am going outside to the mouth of the river to catch fish in the hot season. In the rainy season, I am catching shrimp nearby in the river... I have three kinds of jobs" (HH12.S2.MF). The adoption of multiple livelihood strategies helps buffer the impact of seasonal fluctuations in employment and earnings by providing households with alternative forms of income. Despite efforts to engage in alternative forms of employment during the rainy season, secondary livelihoods are often casual and unstable, which tend to be in manual labour and construction. As one Kyetsarpyien household explained, "so in the rainy season there is no stable job so it depends on the options so if someone needs some assistance for their job like a porter or something so I will be hired. So I work odd jobs in the rainy season" (HH15.S2.F). Other households engage in self-devised

strategies, ranging from selling homemade local foods to catching fish in the stream for sale. The nature of these livelihoods are highly informal, which provides households with a means to cover daily expenditure during periods of fewer earnings, however households are unable to save money. The unstable and informal character of employment in the rainy season highlights the need for more long-term livelihood strategies that provide a stable flow of income to households.

Figure 22: Sources of Income Between Samples, n=41



Between case studies, the adoption of secondary livelihood strategies by households is more prevalent in Karapyien (33%) than Kyetsarpyien (19%), suggesting that the former is more dependent on secondary livelihoods to cope with fewer earnings in the rainy season than the latter. Conversely, households in Kyetsarpyien are more dependent on multiple earners to cope with financial stress rather than solely relying on secondary livelihoods (Figure 18). Households that have multiple family members contributing to household income are more resilient insofar that multiple earners can buffer seasonal livelihood patterns. Due to the smaller household size in Karapyien, it is less common for households to have multiple earners contributing to household income; whereas, households in Kyetsarpyien receive income from multiple earners. As one Kyetsarpyien household explained:

> "so even if we are not in good condition for business we are so so. Our daughter works in the porter service in the market, and our son is the same. We have the same challenges, and even though, we face the challenge like a forest. There is the wind and the storm, if there is only one tree, it is easy to collapse. How about the forest... we can prevent together" (HH19.S2.M).

Households that derive income from multiple earners are able to buffer the impact of seasonal earnings by diversifying income sources. The multiple sources of income for households in

Kyetsarpyien is informed by the larger labour supply available to households as children are able to contribute to earnings. Moreover, households in Kyetsarpyien also rely on remittances sent from relatives working in Thailand. As one Kyetsarpyien household explained: "because all of the children are grown up and also the children are working in Thailand. They can get supporting money from the children, and from Thailand" (HH18.S2.M). The multiple sources of income to households in Kyetsarpyien shapes their resilience to buffer periods of financial stress.

In addition to coping strategies stemming from adjustments to household expenditure and livelihoods, social capital is an important source of support for households. Although social capital emerged in both case studies, networks of support between households appeared to be stronger in Karapyien than Kyetsarpyien. Households in Karapyien often cited the importance of the wider community in helping each other during periods of financial difficulty in the rainy season by sharing food or lending money. As one household explained, "we are living as a family and we support each other. Each family. Everybody supports each other. If one family suffers, other families support" (HH8.S1.M). Another household explained in reference to how households help each other during periods of financial difficulty in the rainy season,

> "even in the rainy season, there are no job opportunities, sometimes we can share with each other, it is okay… So mostly the people who are living here, we are individual households, sometimes we are united. So we can share. The people in the neighbourhood they need some food, so they go to the household for dinner or food. The next day the next household invites them. They share food. If they have nothing to sell or nothing to eat, they can borrow from anybody. At that time the neighbour is in a bad situation, so they sell valuables or they borrow money. The nature of the poor people in Myanmar, they fight for their adaptation together, if they have not, they can share, they do not have much amount of food, but they share, they struggle together" (HH15.S1.F).

Strong networks of bonding social capital in Karapyien help households cope during periods of financial stress insofar as households share resources and food. Moreover, the monastery aids households in coping with periods of financial stress by providing an additional source of support for households by providing food or water.

The importance of social capital in coping with financial stress and flood relief is ultimately linked to the cultural context of Theravada Buddhism in Myanmar. The importance of the Buddhist concept of dāna in structuring social norms of generosity and kindness in Myanmar society informs the prominence of social capital in structuring networks of relief. Dāna translates from Sanskrit as the selfless act of generosity, which is observed in its purest from through the act of donating to relieve the suffering of others (Jaquet & Walton, 2013). The concept of dāna and its role in structuring social

norms of generosity in Myanmar informs the prominence of social capital in coping with financial stress, supporting flood relief, and sharing water amongst households in Karapyien.

The coping and adaptive strategies employed by households highlight the importance of social and human capital in coping with and adapting to shocks and stress. Given differences in the availability of labour supply, households in Kyetsarpyien are able to draw on multiple earners and sources of income to cope with financial stress, whereas households in Karapyien are more dependent on adopting alternative livelihood strategies and social capital. Comparatively, households in Karapyien are more sensitive to shocks and stress than Kyetsarpyien given differences in household labour supply and sources of income. However, both case studies illustrate the constraints faced by households to reduce overall vulnerability to shocks and stress and achieve livelihood aspirations.

6.4 Conclusion

This chapter presented findings of urban vulnerability through a livelihoods approach that considers the exposure, sensitivity, and resilience of households in Karapyien and Kyetsarpyien. Findings illustrate the exposure and sensitivity of households to shocks and stress in light of seasonal and unstable livelihood opportunities and financial resource constraints. Seasonal earnings causes households to be caught in a poverty trap insofar as household finances follow a seasonal cycle of earnings, savings, and borrowing.Households are highly vulnerable to shocks and stress in the rainy season given heightened financial difficulties in light of fewer earnings. Moreover, the instability and seasonality of livelihoods and earnings undermines the ability for households to achieve livelihood objectives such as covering costs associated with daily expenditure, education, or home ownership. Rising food and housing costs exacerbate the existing financial resource constraints of households to afford daily food expenditure and accommodation. The financial resource constraints of low-income households highlight the importance of livelihoods in shaping sensitivity to shocks and stress given larger trends in inflation and land speculation. As such, addressing the underlying vulnerability of households thus needs to consider how to enhance the capacities of households to buffer shocks and stress and attain livelihood objectives that improve wellbeing.

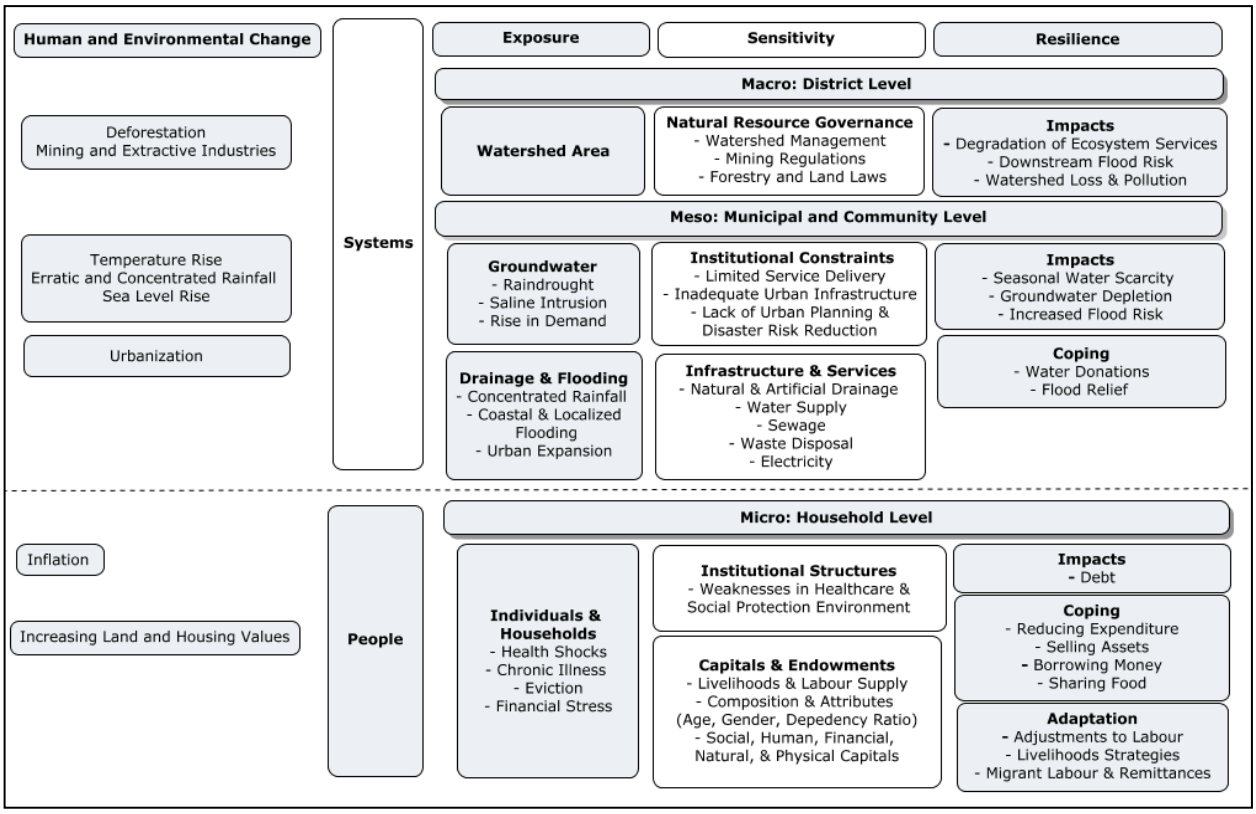
Given the financial constraints of households and lack of savings, households are highly sensitive to shocks and stress. Illness and chronic health problems represent the most widespread shock faced by households in light of the inability to afford health care costs, and the impact of ill health on livelihood strategies and earnings. Health shocks can thus lead to devastating impacts on

household wellbeing as a result of impacts on human and financial capital. Moreover, the seasonality of health shocks corresponds with the seasonality of livelihoods, highlighting how household sensitivity is heightened during the rainy season. Moreover, findings illustrate how vulnerability is differentially distributed between households and case studies given attributes of gender, age, and health, as well as entitlements and the range of capitals available to households. The consideration of the everyday challenges faced by households through a livelihoods approach provides context for understanding the existing sensitivity of low-income households in light of their priorities, constraints, and capacities to overcome shocks and stress. Importantly, climate change interacts with and compounds the existing sensitivity of households through direct and indirect impacts on factors affecting household wellbeing. Given the existing sensitivity of households in terms of livelihoods, poverty, health, water access and flood risk, households are highly vulnerable to the impacts of climate change. Interventions that seek to address vulnerability to climate change thus require a grounded perspective of the existing vulnerability of low-income groups.

7.0 Bridging Systems and People-Centred Approaches in Urban Vulnerability Research

Urban vulnerability is a multi-faceted area of inquiry that spans the consideration of nested scales, cascading impacts, institutional structures, and equity and entitlements. This research attempts to encompass the scope and complexity of urban vulnerability by bridging systems and people-centred approaches in the analysis of the exposure, sensitivity, and resilience of urban systems and households to climatic and non-climatic shocks and stresses in Dawei. The analysis of urban vulnerability is presented according to elements of exposure, sensitivity, and resilience at the macro, meso, and micro level (Figure 23). The analysis of vulnerability at the macro-level considers the exposure and sensitivity of urban socio-ecological systems to climatic and non-climatic stress; the meso-level through the analysis of the differential vulnerability of two communities in Dawei in light of access to urban infrastructure and services; and lastly, the micro-level through the analysis of household vulnerability through the application of a livelihoods approach.

Figure 23: Bridging Systems and People-Centred Approaches in Findings



This chapter discusses urban vulnerability through the analysis of the interaction of multiple scales, beginning with the consideration of the exposure and sensitivity of Dawei's urban systems

and wider socio-ecological systems to climatic and non-climatic stress. Thereafter, the meso-level is discussed in light of the differential vulnerability between case studies relative to access to infrastructure and services. Thereafter, the micro-level is discussed through the consideration of the livelihood strategies, constraints, and capacities of households to cope with and respond to stress. The discussion will conclude with key points for consideration in bridging systems and people-centred approaches in urban vulnerability research.

7.1 Urban Socio-Ecological Systems

The analysis of the exposure and sensitivity of urban socio-ecological systems to climatic and non-climatic stress grounds the understanding of the wider vulnerability context in Dawei to understand exposure and sensitivity at the meso and micro level. Systems approaches value the analysis of urban areas as complex socio-ecological systems that form dependencies with sub-systems and wider systems in surrounding areas (Friend & Moench, 2013). Systems approaches are multi-scalar insofar that exposure and sensitivity is not only considered in light of urban systems and sub-systems, but also, wider ecological systems. Similarly, drivers of stress are multi-scalar insofar that larger social, political and economic relationships and processes drive system exposure. In the context of Dawei, climatic stress is induced by global relationships of capital and fossil fuel extraction and consumption, while regional integration and flows of capital surrounding large-scale infrastructure projects and extractive industries drive non-climatic stresses of urbanization, deforestation, and mining. Understanding the exposure of urban socio-ecological systems thus requires the consideration of nested scales along with the social, political, and economic drivers of stress.

Findings suggest that climatic and non-climatic stresses present sources of exposure for Dawei's water supply and flood risk. Accordingly, increasing temperatures, rainfall fluctuations, and sea level rise expose Dawei's water supply to water scarcity and saline intrusion; whereas non-climatic stresses of urbanization exacerbates exposure by placing greater demand on finite groundwater resources. Climatic and non-climatic stresses interact, in which urbanization exacerbates the exposure of Dawei's groundwater to water scarcity and saline intrusion by altering rates of groundwater recharge. In the consideration of flooding, climatic stresses of rainfall fluctuations and sea level rise and non-climatic stresses of urbanization and the development of formal and informal settlements in flood prone areas heightens flood exposure. Importantly, stresses stemming from deforestation and mining also shape exposure by affecting the health and functioning

of Dawei's watershed area. Accordingly, deforestation in Dawei heightens the risk of downstream flooding and rates of groundwater recharge; whereas mining raises issue to the pollution of water resources. The multi-scalar nature of urban vulnerability thus illustrates how mitigation and adaptation strategies must address the drivers of stress that shape exposure and sensitivity.

It is important to not only consider exposure in light of existing stresses, but also how these stresses evolve over time. Temperature rise, rainfall fluctuations, and sea level rise will become increasingly pronounced, heightening the exposure of Dawei's water supply to water scarcity and saline intrusion, while exacerbating current levels of flood exposure. Similarly, urbanization and population growth will continue to shape exposure and sensitivity in Dawei, in which growing demand will place increasing stress on finite groundwater resources, and urban development will heighten flood exposure. The consideration of drivers of non-climatic stress is helpful for understanding how current trends will exasperate existing vulnerabilities. Greater regional integration in the form of the road link to Thailand and the development of the Dawei SEZ will likely heighten existing sources of exposure for water supply and flooding. Deforestation is likely to accelerate, given that it is being driven by land speculation surrounding the Dawei SEZ, while the road link to Thailand will open up new areas for forest loss. Further, the continued development of the Dawei SEZ and related industries will present a myriad of non-climatic stresses as the scale and size of industry will ultimately result in profound changes to Dawei's wider supporting socio-ecological systems.

Given that climate change will become increasingly more pronounced and non-climatic stresses will likely continue without government intervention, there is a need for institutional structures to consider short term and long term planning in developing mitigation and adaptation strategies. Importantly, planning for and adapting to climate change and mitigating non-climatic stresses require an integrated and scalar approach to water resource management. Such an approach would not only need to plan for and adapt to climatic changes in temperature, rainfall, and sea level rise, but also attend to stresses posed by urbanization, deforestation, and mining. In the consideration of climate change, levels of government can plan for and adapt to increasing temperatures, rainfall fluctuations, and sea level rise in the management of water supply and flood risk. Urbanization can similarly be integrated into considerations of planning for future growth and the development of infrastructure and services. Institutional structures and processes can integrate the underlying drivers of exposure into planning and management in order to build on the long-term adaptive capacities required to address vulnerability (Solecki, Leichenko, & O'Brien, 2011).

Although institutional structures and processes are critical to mitigate and adapt to stress, there are considerable challenges posed to addressing drivers of vulnerability. For one, the multiple scales shaping the exposure of urban systems requires coordinated efforts between levels of government and departments, spanning local, township, district, and regional levels. Deforestation and the pollution of water resources in the Dawei District demonstrates the need to manage drivers of stress affecting Dawei's wider socio-ecological systems, while highlighting the importance of integrated resource management in the mitigation of risk. Although mitigation and adaptation to stress is possible, capacity gaps, resource constraints, and governance structures ultimately challenge the ability for institutional structures to work vertically and horizontally across government levels and departments (Laukkonen et al., 2009). Addressing governance gaps required for the mitigation of risk therefore needs to address structural limitations in terms of capacity, regulation, resource constraints, and coordination between and across levels of government.

7.2 Entitlements, Exposure, and Sensitivity

The analysis of urban vulnerability at the meso-level grounds the understanding of how exposure, sensitivity, and resilience are manifest at the urban spatial scale. Importantly, institutional structures and processes at the municipal level shape sensitivity to exposure given their role in managing urban systems, developing infrastructure, and providing services. However, financial and human resource constraints undermine the capacity of the municipal office to manage urban systems in a way that mitigates rather than exacerbates sensitivity to stress. Institutional gaps are highlighted through the limited provisioning of infrastructure and services in Dawei in light of water supply, waste collection, natural and artificial drainage, and sewage. Discrepancies between the responsibilities and deliverables of the municipal office in infrastructure and service provisioning in turn heighten the sensitivity of Dawei's urban systems and population to exposure. Accordingly, the limited infrastructure providing water in Dawei exacerbates sensitivity to water shortages, which is illustrated through the reliance of the Dawei Hospital on water donations in the dry season. Similarly, the limited provisioning of drainage infrastructure, the lack of maintenance of natural drainage, as well as issues stemming from waste management heighten sensitivity to flood exposure. Although relief efforts to respond to water scarcity and flooding illustrate the impressive networks in Dawei to cope with stress, they also point to the need for institutional structures to develop long term strategies that adapt to exposure and plan for prospective infrastructure needs.

While the understanding of the drivers and sources of stress affecting urban socio-ecological systems provides a birds-eye view of vulnerability, the consideration of how exposure and sensitivity are differentially distributed according to socio-spatial processes is helpful for providing a more in-depth understanding of how vulnerability is manifest at the meso and micro level (Krellenberg et al., 2014). The analysis of differential vulnerability draws from social approaches to vulnerability research as well as urban political ecology in the consideration of how risk is distributed based on access to resources and entitlements. The consideration of the entitlements available to communities is useful for analyzing how social, economic, and institutional factors distribute risk between social groups based on access to resources, the availability of livelihood strategies, as well as the provisioning of urban infrastructure and services (Kelly & Adger, 2000).

The consideration of differential vulnerability in Dawei is illustrated through the analysis of the differential exposure, sensitivity, and resilience of Karapyien and Kyetsarpyien. The varying degree of exposure between case studies is assessed in light of stresses affecting water supply and flooding, while sensitivity is considered via differential access to infrastructure and services. The first case study Karapyien represents an informal settlement in a peri-urban area, in which access to infrastructure and services is limited. The insecurity of land tenure and the short length of occupancy for the majority of households illustrate how the growth of the settlement outpaces the development of drainage infrastructure, sewage, electricity, and water supply. Conversely, Kyetsarpyien illustrates a more urban context, in which the longer timeframe of settlement and higher population density has allowed for infrastructure and services to develop and improve gradually. Importantly, entitlements are unevenly distributed between households in each community, which is illustrated through the case of home ownership in Karapyien. Accordingly, access to water, sewage, and electricity is highly dependent on land tenure, in which renting and squatting households have relatively less physical infrastructure than home owning households. Lack of land title and ultimately lack of financial resources inhibits households from investing in physical infrastructure, illustrating how home ownership affects differential entitlements.

The consideration of the differential vulnerability of case studies is framed according to exposure and sensitivity in light of entitlements. In the consideration of stresses affecting water supply, the differential means of access between case studies illustrates how entitlements shape sensitivity to exposure. In Karapyien, access to water is dependent on social and human capital, in which the majority of households are dependent on neighbours and the monastery as households lack physical infrastructure in the form of their own private well. The limited availability of shallow wells

in Karapyien highlights how the lack of physical infrastructure heightens sensitivity to stresses affecting water supply, in which discrepancies between supply and demand exacerbates the exposure of shallow wells to seasonal fluctuations in water quality and quantity. Conversely, the case of Kyetsarpyien illustrates how sensitivity to exposure is mitigated through the various means of water access. The varied means of water access in Kyetsarpyien mitigates exposure to stresses affecting water supply as water from shallow wells is unavailable, and water accessed via pipe is poor as a result of saline intrusion and groundwater over extraction. Despite the direct exposure of groundwater in Kyetsarpyien, the delivery of water via vehicle mitigates sensitivity to exposure. The differential access to infrastructure and services between case studies illustrates how rights and entitlements are linked to system access and institutional structures and processes, which in turn shape sensitivity (Tyler & Moench, 2012).

In the consideration of flooding, the differential severity and duration of flooding between case studies illustrates the uneven distribution of flood exposure in urban areas. The case of flooding in Karapyien illustrates the common example found in urban areas in Asia of a low-income population living in an informal settlement located within a flood plain (Friend & Moench, 2013). Flood exposure in Karapyien is differentially distributed based on home ownership as squatting and renting households are located in the 'lower area' and households with land tenure are situated in the 'upper area'. The relationship between lack of home ownership and heightened flood exposure illustrates how entitlements inform differential exposure and sensitivity between households. Although flooding occurs in Kyetsarpyien, flooding is modest and shaped by the distance between the community and the Dawei River and the formality of the settlement.

Importantly, institutional structures and processes play a strong role in shaping vulnerability through the management of urban systems, while shaping differential access to infrastructure and services. Accordingly, the lack of drainage infrastructure and management of natural drainage heightens sensitivity in Karapyien as the increasing severity of flooding stems from issues of waste management. The blockage of the stream from waste exemplifies the relationship between waste management, drainage, and flood exposure, while pointing to how institutional structures and gaps in municipal processes can exasperate risk (Friend & Moench, 2013). Further, cascading impacts from flooding on health, transportation, and livelihoods illustrates the highly intricate and complex interdependencies that form between exposure and sensitivity. The relationship between flooding and the disruption of transportation and its impacts on livelihoods illustrates the dependence of urban areas on critical infrastructure and transportation networks for the functioning of markets (Friend &

Moench, 2013). As such, flooding in Dawei illustrates how factors influencing exposure, sensitivity, and impacts are shaped by relationships between and across urban systems.

Important to the discussion of exposure and sensitivity is the consideration of the coping and adaptation strategies employed by households to respond to flooding. The case of increasing flood exposure in Karapyien exemplifies how households develop community based adaptation strategies to cope with increasing flood levels and severity. The development of coping strategies to respond to immediate flooding by constructing a raft to transport households to the monastery illustrates the resilience of households to respond to increasing flood exposure. The case of adapting to increasing flood exposure in Karapyien illustrates the responsiveness and resourcefulness of households to organize and mobilize resources to respond to flooding, while demonstrating the capacity to learn through past experiences (Tyler & Moench, 2012). Furthermore the social networks between households in Karapyien, the monastery, and the wider community illustrates how social capital aids in flood response and relief. However, systemic issues of waste management that inform flood exposure in Karapyien require more coordinated efforts between the municipal office and households in order to address underlying drivers of exposure. This points again to importance of institutional structures in addressing underlying drivers of vulnerability through the management of urban systems.

7.3 Household Sensitivity and Livelihoods

The application of a livelihoods approach to the analysis of vulnerability at the micro-level grounds the understanding of the existing exposure, sensitivity, and resilience of households in Dawei. The consideration of the everyday challenges, constraints, and priorities of households in Karapyien and Kyetsarpyien illustrates how climate change interacts with and compounds the existing vulnerability of low-income groups. Despite differential degrees of exposure and entitlements between case studies, the challenges faced by households are strikingly similar and are ultimately related to financial wellbeing and health. Findings suggest that seasonal livelihood patterns and underemployment cause households to struggle financially to cover daily expenditure, save earnings, achieve aspirations of home ownership, and attain higher levels of education. The seasonality and instability of livelihood strategies shape the seasonal cycle of earning, saving, spending and borrowing for households. Seasonal livelihood patterns and the inability to save earnings throughout the year in turn heightens household sensitivity by undermining the financial resources available to buffer shocks and periods of stress.

In the comparison of the differential sensitivity of case studies, findings suggest that households in Karapyien struggle more with financial challenges related to seasonal and unstable livelihoods, seasonal debt, and the ability to cover daily expenditure. The greater financial difficulty experienced by households in Karapyien is shaped by sources of income and household size. Households in Karapyien have less labour supply than households in Kyetsarpyien, while remittances from family members working in Thailand is common for households in Kyetsarpyien. Importantly, sensitivity is differentially distributed across households in each community, in which gender, age, health, and home ownership factor into household sensitivity to shocks and stress. Findings indicate that female-headed households are most vulnerable due to the double burden of labour, struggling to earn enough income from their livelihoods to support daily expenditure; while households with family members suffering from chronic illness are more sensitive as they lack financial resources to buffer shocks and stress. Similarly, age factors into sensitivity as older households struggle to earn enough income from their livelihoods while facing greater challenges related to chronic illnesses. Households that lack home ownership are more sensitive to shocks and stress as they face the threat of eviction, while having limited access to infrastructure and services.

In addition to how financial challenges inform the existing sensitivity of households, health problems and chronic illness present the most widespread household level shock experienced in Karapyien and Kyetsarpyien, respective of health costs, lost income due to the inability to engage in livelihood strategies, and ensuing financial challenges. The impact of health shocks and chronic illness on the livelihood strategies and financial resources of a household make it difficult to cope through conventional strategies of adjusting labour supply and expenditure. Importantly, the sensitivity of households to health shocks is informed by larger institutional structures, in which weaknesses in Myanmar's healthcare and social protection environment places the brunt of coping with health shocks on households. Sudden illness or chronic health problems are thus highly related to debt, in which households will borrow money to cover health care costs and living expenses. Health shocks can thus have devastating impacts on the financial wellbeing of a household, which can cause families to fall deep into poverty as a result of the incursion of debt to cover daily living expenses and health costs. Similarly, chronic illness undermines the ability for earners to engage in livelihood strategies, thereby shifting the balance between household earnings and expenditure.

The seasonality of livelihoods and earnings, health problems, and flood exposure illustrates how household sensitivity is heightened during the rainy season. At this time, households are more sensitive to health shocks and the incursion of debt as earnings are low, employment is unstable, and

health shocks are more frequent. Importantly, climate change compounds the existing sensitivity of low-income households to illness as increasing temperatures and shifting rainfall patterns create favourable conditions for the spread of infectious and mosquito borne diseases (NAPA, 2012; Kovats & Akhtar, 2008). The existing exposure of households to health shocks is thus heightened by climate change, illustrating how climate change compounds the existing vulnerability of low-income households.

In addition to the analysis of the existing vulnerability of households in light of health and financial challenges is the consideration of land and home ownership. Karapyien illustrates the precarious occupancy of low-income households in informal settlements as squatter households are highly exposed to flooding, while lacking physical infrastructure such as drainage, sewage, electricity, and water supply. Although households are exposed to serious flooding, they are able to cope and adapt based on their ability to mobilize resources, depend on and support one another, and learn from past experiences (Tyler & Moench, 2012). However, challenges related to housing are more difficult to overcome as low earnings and savings undermines the ability for households to afford land. As a result, squatting and renting households are exposed to the risk of eviction and displacement. Additionally, rising land and housing costs in Dawei heightens the challenge for low-income households to afford land in urban areas. Importantly, drivers of land prices in Dawei are highly related to the rise of land speculation surrounding the Dawei SEZ, illustrating how regional integration and investment flows shape the vulnerability context that further constrains the ability for low income households to afford housing. Regional integration as a driver of rising land and housing prices illustrates how challenges faced by low-income groups are shaped by larger socio-political and economic processes (Kelly &Adger, 2000).

Importantly, the vulnerability of households is dynamic and shaped by the capacities and constraints of households to cope with, respond to, and adapt to shocks and stress. While shocks and stress have the potential to cause households to fall deeper into poverty, they also present an opportunity for households to mobilize resources and combine available capital to cope and adapt to changing social and environmental conditions. Findings suggest that households adjust expenditure to cope with periods of seasonal employment, while adopting alternative livelihood strategies to compensate for fewer earnings. The adoption of strategies to diversify income sources is linked to the greater resilience of a household to shocks and stress by buffering exposure to seasonal variability in income (Adger, 1998). The case of migration and remittances in Kyetsarpyien illustrates the

adaptation of livelihood strategies to enhance the livelihood security and opportunities of households (Adger, 1998).

While adjustments to household expenditure and livelihood strategies present a form of coping and adaptation, social capital and networks present an important source of coping for households. The presence of social capital between households is especially prominent in Karapyien in light of greater financial difficulty experienced by households and lack of flexibility in adjusting household labour supply to cope with unstable earnings. As such, households in Karapyien rely on one another during periods of financial stress by borrowing food and money from neighbours in addition to employing secondary livelihood strategies. In response to flood exposure, households in Karapyien mobilize resources to transport households to the monastery, illustrating the importance of social networks to adapt to the increasing severity of flooding. Moreover, the monastery provides a critical resource for households in Karapyien by bridging resources donated from the wider community to aid in flood relief. Additionally, social capital also aids in compensating for the lack of infrastructure and services available to households in Karapyien as squatting and renting households rely on neighbours and the monastery for access to water, illustrating how social networks can compensate for lack of formal entitlements.

The importance of social capital in coping with financial stress and flood relief is widely documented in the literature, though social capital is ultimately linked to the cultural context of Theravada Buddhism in Myanmar. The concept of dāna and its role in structuring social norms of generosity in Myanmar informs the prominence of social capital in coping with financial stress, supporting flood relief, and sharing water amongst households in Karapyien. Dāna is also observed through the wider social networks in Dawei, which is critical to coping with exposure to flooding and water scarcity. The donation of dry rations to the monastery from the wider community to support flood relief efforts in Karapyien as well as the widespread donation of water to relieve water scarce areas illustrates the importance of dāna in aiding in flood relief and water scarcity. As such, the prominence of social capital and networks in coping with exposure illustrates how social networks and moral beliefs in *metta-* loving kindness, *karuna-* compassion, and *dāna-* generosity, can compensate for gaps in institutional structures and processes that inform sensitivity. Despite the need for more coordinated efforts that build on the long term adaptive capacity of institutions in Dawei, the prominence of social capital in coping with shocks and stress illustrates how humanity is far more beautiful and resilient than vulnerable and sad (Friend & Moench, 2013).

7.4 Conclusion

Given the scope and complexity of the interdependencies that form within and between urban socio-ecological systems, it can be challenging to untangle the relationships that shape urban vulnerability. This research has attempted to bridge systems and people-centred approaches through the analysis of the vulnerability of urban socio-ecological systems to shocks and stress with a livelihoods approach that centres on the perspectives and priorities of vulnerable groups. In turn, this research has focused efforts on providing a multi-scalar perspective to assessing vulnerability through the consideration of the exposure and sensitivity of urban socio-ecological systems to climatic and non-climatic shocks and stress; how exposure and sensitivity is distributed between urban contexts via access to infrastructure and services; and finally, the existing vulnerability of low income households.

The analysis of the exposure and sensitivity of urban socio-ecological systems at the macro level provides valuable insights into the various stresses that shape urban vulnerability to environmental change. To understand the various underlying drivers of stress requires the consideration of the multi-scalar social, economic, and political relationships that shape the exposure and sensitivity of urban socio-ecological systems. Importantly, vulnerability is shaped by various sources of stress in which climatic and non-climatic stresses interact to inform exposure. The consideration of climatic and non-climatic stress provides a foundation for mainstreaming adaptation to climate change into wider concerns related to sustainable urban development, land use planning, and resource management. Moreover, the consideration of climatic and non-climatic stresses at the macro level provides insight into understanding the gaps in institutional structures and processes that shape vulnerability.

The analysis of urban vulnerability at the meso and micro level attempts to bridge the exposure and sensitivity of urban socio-ecological systems with how institutional structures and processes shape the distribution of risks based on access to resources and differential entitlements (Friend and Moench, 2012). This approach provides insight for assessing how exposure and sensitivity is differentially distributed between urban contexts based on access to infrastructure and services. Importantly, analyses of household vulnerability not only need to consider system exposure, but also the existing sensitivity of households to shocks and stress. The application of a livelihoods approach to understanding the everyday challenges and priorities of households provides insight into how climate change interacts with the existing vulnerability of low-income groups. The application

of a livelihoods approach highlights opportunities for addressing structural causes of poverty in addition to areas of exposure and sensitivity stemming from urban systems.

Integral to bridging systems and people-centred approaches is the importance of institutional structures in shaping urban vulnerability. Accordingly, institutions link agents to systems by enabling or constraining the capacity of individuals or households to engage in decision-making processes about urban development and access to resources and services (Tyler & Moench, 2012). The importance of institutional structures in the mitigation or exacerbation of risks cannot be overlooked. Lagging infrastructure development and service provisioning, resource constraints, capacity gaps in urban planning and the management of wider supporting socio-ecological systems heighten the sensitivity of urban areas to climatic and non-climatic stress. Given the importance of institutional structures and processes in shaping and addressing vulnerability, there is a need to address the resource constraints and coordination failures that undermine the capacities required for institutions to mitigate and adapt to climate change. This is especially important for planning for climate change and greater urbanization as present action and investment will ultimately determine the capacity of institutional structures in mitigating and adapting to prospective shocks and stress.

The multi-scalar relationships that form between drivers of stress and the management of urban socio-ecological systems requires concerted efforts on behalf of researchers to disentangle the complex and nuanced character of urban vulnerability. The scope and breadth required for understanding sources of exposure and its interaction with factors influencing sensitivity in urban areas requires multiple levels of analysis and thematic areas of focus. Given the importance of institutional structures in shaping vulnerability through the management of risk, the provisioning of infrastructure, and the distribution of resources, this research suggests that further research should focus on understanding the constraints that local institutions face in terms of addressing vulnerability. As such, it suggested that further research should focus on analyzing the complex linkages between institutional structures and processes with urban systems in Dawei, with a focus on understanding the underlying structural constraints that inform sensitivity. The newly elected democratic government in Myanmar presents an opportunity for action research to identify structural constraints undermining local governance in managing and providing urban infrastructure and services, and mainstreaming climate resilience into urban planning.

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APPENDICES

Appendix A:
Logical Framework

1. How do select vulnerable groups frame sources of vulnerability in their lives?

Purpose:

•To understand sensitivity and coping capacity.

•To understand existing stresses and priorities.

Sub-Questions:

What are the everyday and situational challenges faced by these groups?

What are their priorities? What matters to these people? What is of most concern to these groups?

What constraints do these groups face in achieving wellbeing?

Field Questions:

- What are the challenges that you and your family face (eg. debt, illness, eviction, underemployment, lack of services, water and sanitation)?
- What are your priorities? What do you strive for?
- What challenges do you think place the greatest constraint to your wellbeing?

2. How do issues of system access and quality compound the existing stresses faced by select vulnerable groups?

Purpose:

•To understand sensitivity and exposure in terms of urban systems (ie. water access; sanitation- waste disposal, sewage; electricity; drainage).

•To understand how urban systems place additional stress on participants.

Sub-Questions:

How do issues of system access and quality factor into the vulnerability of these groups?

Do groups have access to urban infrastructure and services?

What is the quality of the infrastructure and services provided to these groups?

How do issues of access and system quality impact the vulnerability or sensitivity of these groups to shocks or stress?

Field Questions:

What challenges do you face in terms of access to or quality of urban infrastructure and services?

Water

- *Do you face any challenges in getting access to clean drinking water?*
- How do you get water?
- Is this water safe to drink?
- Do you always have access to safe drinking water?
- Are there any times when you cannot get clean drinking water? What happens?
- How much do you have to pay for water? Can you and your family afford to pay for water?
- What impacts does this have on you and your family?

Drainage

- *Do you face any challenges in terms of drainage or flooding?*
- Does it ever flood here? How often? Is it serious?
- What happens when it floods? How does it impact you and your family? Does it have any effect on your water supply?

Sanitation

- *Do you face any challenges in terms of waste disposal and sanitation?*
- How do you dispose of your garbage?
- How do you dispose of your wastewater?
- How do you dispose of your sewage?
- Does this have any impacts on you and your family?
- Does this have any health impacts?

- Does this impact the quality of your water supply?

Electricity
- Do you face any challenges in accessing electricity?
- Do you have access to electricity?
- Can your family afford to pay for electricity use?
- Does this have any impacts on your family?

3. How do select vulnerable groups cope with and respond to these stresses?

Purpose:
•To understand coping and adaptive capacity.
•To emphasize the agency of individuals and groups to address and overcome sources of vulnerability.

Sub-Questions:
How do groups cope with these stresses?
When they face these stresses or challenges, how do they respond?
What do they do? What resources do they draw on?
Have these groups done anything to plan or prepare in the case of future stresses?

Field Questions:
Note: Interview questions that will answer question 3 will directly follow questions asked to answer questions 1 and 2.
- How do you deal with these challenges? How do you deal with these impacts?
- What do you and your family do to deal with these impacts?
- What do you do to overcome these challenges?
- What strategies do you, your family, or community use to overcome these challenges?
- What resources do you draw on to deal with or overcome these challenges (eg. human, social, physical, financial, natural)?

Appendix B:
Coding Rubrics

F. 1. Key Informant Coding Rubric

Economy	Refers generally to factors relating to the economy and livelihoods in Dawei.
Unemployment	Refers to issues relating to unstable employment, unemployment, and lack of job opportunities.
Migrant Labour	Refers to migrant labour in terms of out-migration from Dawei to other countries and in-migration from upper Myanmar.
Agriculture	Refers generally to the agricultural sector of Dawei in relation to rice production, and betel nut, cashew nut, and rubber plantations.
Fisheries	Refers generally to the fisheries sector in Dawei.
Land	Refers generally to issues relating to land.
Land Tenure	Refers to issues relating to land ownership, land titles, and land tenure.
Land Grabbing	Refers to issues relating to land confiscation and compensation.
Land Prices	Refers to the cost of land and property, especially in relating to rising land prices.
Water	
Dawei River	Refers to the ecology, hydrology, and geology of the Dawei river.
Streams	Refers to the streams in Dawei city.
Health	Refers generally to health issues and seasonal trends in health in Dawei.
Diseases	Refers to diseases that are endemic to the Dawei population.
Seasonality	Refers to seasonal trends in health problems and issues.
Institutions	Refers generally to structures, processes, and institutions in Dawei.
Local Governance	Refers to local government in Dawei, specifically in relation to the Development Affairs Organization (DAO), the Township Development Affairs Committee (TDAC), and the Township Development Support Committee.
Laws	Refers generally to laws in Dawei and Myanmar at large.
Tax	Refers to issues relating to tax collection in Dawei.
Corruption	Refers to issues relating to corruption in government as the local and regional level.
Good Quotes	
Changes	Refers to the question: "what are the biggest changes that you've noticed happening in the city?"
Climate Change	Refers to changes related to climate, especially in terms of temperature rise, rainfall patterns, and impacts.
Temperature	Refers to changes in terms of temperature, specifically temperature rise in Dawei.
Rainfall	Refers to changes in rainfall patterns, specifically in Dawei.
Impacts	Refers to climate change in terms of impacts.

Deforestation	Refers to changes in terms of forest cover in Dawei, specifically in relation to loss or depletion of forests.
Flooding	Refers to deforestation in terms of impacts in relation to flood potential and watershed management.
Land Grabbing	Refers to deforestation in relation to land confiscation in Dawei.
Water Supply	Refers to deforestation in specific respect to impacts on the water supply and watersheds in Dawei.
Urbanization	Refers generally to urbanization trends and changes in the city of Dawei.
Urban Changes	Refers generally to urban changes in Dawei, specifically in reference to the question: "what are some of the biggest changes that you've noticed in the city of Dawei?"
Transportation	Refers to changes in terms of general transportation, including roads, and traffic in Dawei.
Housing	Refers to changes in terms of housing and buildings in Dawei.
Land Prices	Refers to changes in terms of land and property prices in Dawei.
Population	Refers to changes in population in Dawei.
Urban Growth	Refers to factors and dynamics of urban growth in Dawei, inclusive of urban expansion and development.
Drivers	Refers specifically to drivers of urban growth in Dawei.
Urban Planning	Refers to urban growth and expansion as it relates to urban planning.
Town Plan	Refers to urban growth and expansion as it relates to the town plan of Dawei.
Urban Issues	Refers to the question of "what are some of biggest urban issues in Dawei?"
Town Planning	Refers to responses that discuss the issue of urban planning and systematic urban development.
Land grabbing	Refers to responses that discuss the issue of land grabbing and the confiscation of land in Dawei.
Electricity	Refers to responses that discuss the issue of electricity cost and access in Dawei.
Development projects	Refers to responses that discuss the issue of development projects, specifically in relation to the SEZ, and associated resource developments.
Hazard	Refers generally to hazards that are endemic to Dawei.
Flood	Refers specifically to flood hazards in Dawei.
Areas/Affected Populations	Refers to flood areas and populations that are affected by floods in Dawei city.
Response	Refers to responses to flooding in Dawei on behalf of the government, civil society, and local communities.
Government	Refers to government responses to flooding in Dawei, both in terms of immediate response, and adaptive responses.
Community	Refers to responses on behalf of civil society and local communities to flooding, both in terms of immediate coping, and adaptive responses.
Preparedness	Refers to actions and efforts that promote preparedness for flooding in Dawei.
Duration	Refers to the duration of flood episodes in Dawei.

Frequency	Refers to the frequency of flood episodes in Dawei.
Magnitude	Refers to the magnitude or intensity of flood episodes in Dawei.
Impacts	Refers generally to impacts from flooding in Dawei.
Health	Refers specifically to flood impacts on health.
Water	Refers specifically to flood impacts on drinking water.
Transport	Refers specifically to flood impacts on transportation.
Fire	Refers generally to fire hazards in Dawei city.
Landslide	Refers generally to landslide hazards in Dawei.
Vulnerable Groups	Refers generally to groups, populations, or communities in Dawei that are seen as 'vulnerable' to climate change.
Women	Refers specifically to responses that refer to women as vulnerable to climate change.
Outskirts	Refers specifically to responses that refer to communities and populations that live in the 'outskirts' of Dawei city as vulnerable.
Poor	Refers specifically to responses that refer to poorer communities as vulnerable.
Daily Wages	Refers specifically to responses that refer to daily labourers as vulnerable.
Kyesabyein	Refers specifically to responses that refer to Kyesabyien as vulnerable.
Urban Systems	Refers generally to urban systems, including drinking water, sanitation, drainage, electricity, and transportation.
Sanitation	Refers generally to sanitation systems in Dawei, inclusive of solid and liquid waste.
Waste Disposal	Refers to waste disposal in Dawei.
Waste Collection	Refers to waste collection in Dawei.
Sewage	Refers generally to human waste and sewage systems in Dawei.
Flush Toilets	Refers to flush toilets.
Pit Latrines	Refers to pit latrines.
Electricity	Refers generally to electricity in Dawei.
Cost	Refers to issues of cost and the affordability of electricity in Dawei.
Source	Refers to the source of electricity in Dawei.
Accessibility	Refers to issues relating to the accessibility of electricity for Dawei population.
Transportation	Refers generally to transportation options and issues in Dawei.
Roads	Refers specifically to transportation by roads in Dawei.
Railway	Refers specifically to transportation issues relating to the development of the railway in Dawei.
Airport	Refers specifically to the airport in Dawei.
Drinking Water	Refers generally to drinking water in Dawei.
Source	Refers to drinking water sources in Dawei as it relates to access.
Municipal	Refers to drinking water sources that are supplied by the municipal government.
Private	Refers to drinking water sources that are supplied by private companies.
Shallow Well	Refers to drinking water sources derived from shallow wells.
Tube Well	Refers to drinking water sources derived from tube wells.
Threats	Refers to threats that may undermine the drinking water supply in

	Dawei.
Water Plan	Refers to the proposed plan for Dawei's water supply.
Water Quantity	Refers generally to issues relating to water quantity.
Scarcity	Refers to issues relating to water scarcity in the Dawei region.
Seasonality	Refers to issues relating to the seasonality of water scarcity in Dawei.
Water Levels	Refers to issues of water scarcity in relation to the water table in Dawei.
Affected Areas	Refers to areas that are affected by water scarcity in Dawei.
Sharing	Refers to the action of sharing water in Dawei.
Neighbours	Refers to the action of sharing water amongst neighbours in Dawei.
Donations	Refers to the action of sharing water through donations on behalf of civil society, the private sector, and government.
Changes	Refers to perceptions of change in water quality or qater quantity in Dawei.
Water Quality	Refers to issues relating specifically to water quality in Dawei.
Seasonality	Refers to issues relating to seasonal changes in water quality in Dawei.
Testing	Refers to the testing of the water quality in Dawei.
Salt Water Intrusion	Refers to the issue of salt water intrusion in Dawei.
Poor Quality	Refers to issues of poor quality water in Dawei.
Areas	Refers specifically to areas that are affected by poor water quality in Dawei.
Pollution	Refers to water quality issues in Dawei relating to the pollution of surface and ground water.
Mining	Refers to issues relating to the pollution of surface water from mining projects in Dawei.
Waste	Refers to issues relating the pollution of water from waste.
Arsenic	Refers to issues relating to the pollution of water from arsenic.

F.2. Household Coding Rubric

Household Data	
Occupancy	Refers to the length of a participants' occupancy of a location.
Household Size	Refers to household size and composition.
Home Ownership	
Rent	*Refers to household's who rent their house.*
Own	*Refers to household's who own their house.*
Squat	*Refers to household's who do not pay rent or own their home.*
Livelihoods	Refers generally to types of livelihoods engaged in by households.
Livelihood strategies	Refers to the combination of strategies used to earn a living.
Unstable employment	Refers to general issues of casual or unstable employment opportunities.
Seasonal unemployment	Refers specifically to unemployment or irregular employment during the rainy season.
Reason for Settlement	Refers to reasons for a household to move their current area of dwelling.
Question 1: Urban	**What are some of the biggest changes you have noticed happening**

Changes	**in the city? Have these changes affected you in any way?**
Roads	Refers to changes related to the construction or improvement of roads.
Buildings	Refers to changes related to the construction or growth of new buildings.
Rental costs	Refers to changes related to increasing rental costs in Dawei.
Land prices	Refers to changes related to increasing land prices in Dawei.
Living costs	Refers to changes related to increasing living costs, including food.
Question 2: Environmental Changes	**Have you noticed any environmental changes? Have these environmental changes affected you in any way? Have they added any stress to your life?**
Flooding	Refers to environmental changes related to the increased prevalence of flooding.
Stream	Refers to environmental changes related to natural drainage.
Erratic rainfall	Refers to environmental changes related to more erratic rainfall patterns.
Heavy rain	Refers to environmental changes related to more intense periods of heavy rainfall.
Temperature rise	Refers to environmental changes related to temperature rise.
Question 3: Social Changes	**Have you noticed any social changes? Have these social changes affected you in any way? Have they added stress to your life?**
Housing	Refers to social changes related to the increased concentration of housing.
CSO'S	Refers to social changes related to the increased presence of civil society organizations in Dawei.
Question 4: Challenges	**What are the major challenges that you and your family face (eg. debt, illness, eviction, underemployment, lack of services, water and sanitation, conflict)?**
Flooding	Refers to household challenges related to flooding.
Land title	Refers to household challenges related to land title.
Relocation	Refers to household challenges related to relocation.
Living costs/ food	Refers to household challenges related to living and food costs.
Income/ Employment	Refers to household challenges related to income and employment.
Debt	Refers to household challenges related to debt or indebtedness.
Seasonal debt-employment	*Refers to issues of seasonal debt related to seasonal employment.*
Interest rates	*Refers to interest rates.*
Health	Refers to household challenges related to health issues.
Employment	*Refers to household challenges related to the inability to work due to health issues.*
Costs	*Refers to household challenges related to health costs.*
Dengue	*Refers to the specific mention of dengue.*
Respiratory	*Refers to the specific mention of respiratory health issues.*
Education	Refers to household challenges related to education.
Tuition costs	*Refers specifically challenges related to tuition costs.*
Impacts	Refers generally to impacts resulting from household challenges.
Coping	Refers to coping strategies used to cope with household challenges.
Social Capital	Refers to coping strategies associated with social capital. (ex.

	Borrowing money from neighbours, sharing water, community led saving strategies).
Financial Capital	Refers to coping strategies associated with financial capital (ex. Borrowing money from money lenders, reducing food intake or household spending, saving strategies).
Natural capital	Refers to coping strategies associated with natural capital (ex.)
Physical capital	Refers to coping strategies associated with physical capital
Human capital	Refers to coping strategies associated with human capital (ex. Building a raft, using knowledge).
Drinking Water	
Source	Refers to drinking water source.
Monastery	Refers to retrieving water from the monastery.
Individual well	Refers to retrieving water from their own well.
Neighbour	Refers to retrieving water from neighbor's well.
Private	Refers to retrieving water through purchasing from private supplier.
Rainwater collection	Refers to the collection of rainwater.
Payment collection	Refers to making payment for the collection of water.
Water quality	Refers generally to issues of water quality.
Seasonal water quality	Refers specifically to seasonal water quality.
Water quantity	Refers to changes in water quantity.
Seasonal water quantity	Refers specifically to seasonal changes in water quantity.
Question 9: Drainage and Flooding	**Does it ever flood here?**
Drainage	Refers to the quality of natural and artificial drainage.
Frequency	Refers to the frequency of flooding.
Duration	Refers to the duration of flooding.
Severity	Refers to the severity of flooding.
Flood level	Refers to flood levels.
Opinion	Refers to opinions of increasing or decreasing severity.
Flood impacts	Refers generally to impacts from flooding.
Food costs	Refers specifically to flooding impacts on food costs.
Work	Refers specifically to flooding impacts on the ability for households to work.
Transportation	Refers specifically to flooding impacts on transportation.
Snakes	
Sewage	Refers specifically to flooding impacts on sewage.
Housing damage	Refers specifically to flooding impacts on housing and the need for repairs.
Coping	Refers generally to coping mechanisms for dealing with flooding.
Protecting Belongings	Refers specifically to the action of placing belonging at higher levels to avoid damage or loss during flooding.
Monastery	Refers to coping mechanisms related to the monastery.
Community donations	Refers to coping mechanisms in the form of community donations.
Raft	Refers to coping mechanisms in the form of using a raft to aid in flood response.
Preparedness	Refers generally to preparedness for flooding.

Adaptation	Refers to actions that support adaptation to flooding.
Question 10: Waste disposal and sanitation	**How do you dispose of your waste and wastewater?**
Toilet Type	Refers generally to the type of toilet used.
Pit latrine	Refers to the use of pit latrines.
No toilet	Refers to the absence of a toilet.
Sharing	Refers to the sharing of a toilet.
Waste disposal	Refers generally to issues of waste disposal.
Littering	Refers specifically to the disposal of garbage by littering.
Burning	Refers specifically to the burning of garbage.
Question 11: Electricity Access	**Do you face any challenges in getting access to electricity?** **Do you have access to electricity?** **Can you afford to pay for electricity use?** **What are the impacts on your family?**
Costs	Refers to costs of electricity.
Access	Refers to access to electricity.
Question 12: Biggest Challenges	**Refers to the question of "what are the biggest changes that you and your family face?**
Water	Refers to household challenges related to access to drinking water.
Income and Employment	Refers to household challenges related to income and employment opportunities.
Indebtedness- Poverty	Refers to household challenges relate to indebtedness and poverty.
Land	Refers to household challenges related to housing ownership.
Rental	Refers to household challenges related to rental costs.
Relocation	Refers to household challenges surrounding the concern for relocation by government.
Other	
Gender	Refers to a gendered response or challenge.
Priorities	Refers to priorities of households.

Attribute	**Value**
Sex	*Male*
	Female
Age	*20-29*
	30-39
	40-49
	50-59
	60-69
	70-79
	80-89
Marital status	*Divorced*
	Married
	Widowed
Health issues	
Employment	Stable
	Unstable

Unemployment	Seasonal
Household income	*Multiple sources*
	One source
	Seasonal
Livelihoods	Labourer
Household Size	1-3
	4-6
	5-7
	8-10
	10+

Appendix C:
Key Informant Interview Questions

Key Informant Questions
Section 1: Trends

1. What are some of the biggest changes that you've noticed happening in the city?
   Examples: land use, weather: heat, flooding, storms, economic growth, urban expansion)?
   What have been the impacts of these changes on the city?

2. Is the city urbanizing/growing? If so, how fast?
   In which areas is the city growing?
   Why do you think the city is growing?

Section 2: Urban Development

3. Which urban services and infrastructure do you think are of most need of improvement? *Why?*

4. What would you say are the biggest urban development issues*/priorities in Dawei?
   Why?
   What would you say are the biggest challenges to addressing these issues?

Section 3: Drinking Water

5. Where do the majority of city residents get their drinking water?
   Is this water safe to drink?

6. Do all city residents have access to safe drinking water?
   Do some areas or wards of the city have worse access than others?

7. Do people have to pay to access safe drinking water?
   How much? Is it affordable to city residents?

8. Are there any potential issues/threats that may undermine people's access to safe drinking water?
   Examples: environmental threats… saline intrusion, water shortages in the dry season, flooding in the wet season, pollution… industrial runoff, agricultural pesticide runoff?
   What happens in the rainy season? (are water sources flooded, contaminated?)
   What happens in the dry season? (does water become scarce?)

9. Have there been any times when people did not have access to safe drinking water?
   What happened?
   How were people impacted?
   How did people respond?
   How did the government respond?
   Were certain groups more affected than others? (livelihood groups, wards, socioeconomic groups)

Section 4: Electricity

10. Where do the majority of city residents get their electricity?
    Do all city residents have access to electricity?

11. Is electricity affordable to city residents?
    Can everyone in the city afford to pay?

12. For how long is the electricity available?

13. Have there been any times when people did not have access to electricity?
    How were people impacted?
    What do people do when they do not have electricity?
    Are there certain groups that are impacted more than others?

Section 5: Sanitation

14. How do residents' dispose of their sewage and wastewater?
    Are all areas of the city serviced by waste disposal?

15. How do residents get access to sewage and wastewater disposal?
    Where is waste disposed?

16. Do people have to pay for waste disposal? How much?
    Can all residents afford to pay?
    What do they do if they cannot afford to pay, how do they dispose of their sewage?

Section 6: Drainage

17. What is the quality of drainage in the city?

18. Are certain areas or wards of the city prone to flooding?
    When do they flood?
    How severe is the flooding?
    How often do these areas or wards flood?

19. What are the impacts— *on residents?*
    — *on drinking water?*
    — *on wastewater?*
    — *on electricity?*

How do people respond?
How does the government respond?

Section 7: Hazards

20. Has the city experienced any hazardous events or disasters in the past?
    Example: flooding, landslides, intense storms, tsunamis

Which areas or wards of the city were affected?
(ask to point out which areas were affected on the city map).

Were certain groups or wards more affected than others? Why?

What were the impacts— on people? How did people cope?

What were the impacts on — drinking water?
— roads and transport?
— electricity supply?
— drainage?
— wastewater?

How did people respond?
How did the government respond?

21. Are there any government plans in place to *prepare for* or *respond to* disasters?

Are certain parts of the year more prone to hazards than others?
Do certain parts of the year pose challenges to residents within the city?

22. Who do you think are the most vulnerable groups or wards in the city to disasters or periods of stress?

Why?
Where do they live?
What do they do for work?

Section 8: Local Priorities

23. What are some of the biggest issues in Dawei that you've noticed? What issues do you think are of most importance to city residents?

Section 9: Social Groups

24. Can you describe the different kinds of people that live in the city? Are there differences that exist between wards, or in terms

Appendix D:
Participatory Mapping Exercises

Participatory Mapping Overlay of Vulnerability in Dawei

Appendix E:
Household Interview Questions

Participant No:
Sample Population No:
Interview date:
Location:
Interviewer:
Translator:
Time started:
Time completed:

P.1 Household Characteristics
Begin with informal conversation about contextual history of household:
- Occupancy and home ownership
- Life history
- Livelihood
- Family composition
- Schooling

Household Size & Occupation

Person	Gender and age	Main Livelihood activity	Secondary and other livelihood activities
1			
2			
3			
4			
5			

P.2 Semi-Structured Interview Questions

1. What are some of the biggest changes you have noticed happening in the city? Have these changes affected you in any way?

2. Have you noticed any environmental changes? Have these environmental changes affected you in any way? Have they added any stress to your life?

3. Have you noticed any social changes? Have these social changes affected you in any way? Have they added stress to your life?

4. What are the major challenges that you and your family face (eg. debt, illness, eviction, underemployment, lack of services, water and sanitation, conflict)?

5. How do these challenges impact you?

6. Which challenges do you think impact you the most? Why?

7. How do you deal with these challenges?
- What strategies do you, your family, or community use to try to overcome these challenges?
- What resources do you draw on (eg. human, social, physical, financial, natural)?

8. Do you struggle in getting access to clean drinking water?
- How do you get access to water?
- Is this water safe to drink?
- Do you always have access to safe drinking water?
- When did you not have access to clean drinking water?
- What happens to your and your family?
- What do you do? How do you and your family get access to clean drinking water?

9. Do you face any challenges in terms of drainage?
- Does it ever flood here?
- How often? Is it serious?
- What happens when it floods? What impacts does it have on your family?
- Does it have any affect on you access to clean water?
- What do you and your family do when it floods?
- How do you respond?
- Have you done anything to prepare for this flooding in the future?

10. Do you face any challenges in terms of waste disposal and sanitation?
- How do you dispose of your waste and wastewater?
- Does this have any health impacts on your family?
- Does this affect your water supply?

11. Do you face challenges in getting access to electricity?
- Do you have access to electricity?
- Can you afford to pay for electricity use?
- What are the impacts on your family?
- What does your family do to deal with or overcome these impacts?

12. After reflection, what would you say are the biggest challenges that you and your family face?

Ask respondents to summarize and clarify their responses to understand what sources of stress lay behind perceived impacts and consequences

Timeframe:
Household interviews should last approximately 60-90 minutes.