FINAL NARRATIVE REPORT

Urban Climate Resilience in Southeast Asia Partnership (UCRSEA)

Year III

Livelihoods Vulnerability Assessment of Flood-Prone Pralab Community in Khon Kaen, Thailand

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EXECUTIVE SUMMARY

Weak urban governance and changes of rainfall patterns in the past 20 years causes more frequent and severe flooding in the Khon Kaen City (KKc) in Northeast Thailand. Given the structural and financial constraints, lack of knowledge and growing uncertainty of climate variability, local authorities are facing increasingly difficulties in defining timely and efficient responses. A missing valid land use regulation for over ten years has drastically changed the physical infrastructure and ecosystems of KKc. This institutional gap has allowed developers to make large investments into low-priced flood-prone areas in the fringe zones of the city. Communities in the semirural-urban municipality of Pralab are considered to be among the most flood-affected groups.

This research provides a case study through a quantitative and qualitative assessment of the vulnerability of the livelihoods of Pralab's communities to flood to reveal the underlying challenges that determine the extent of floods and capacity to adapt to the changing environment. Therefore a vulnerability index was developed using a household survey, public documents (e.g. rainfall statistics), in-depth interviews and related research literature. The research also aimed to identify key coping and adaptive strategies of communities and relevant governmental authorities through in-depth interviews and shared learning dialogues with communities, policymakers and experts.

It was found that Pralab's residents have a growing financial insecurity due to agricultural losses and resulting debts that have accumulated over time as well as a high physical vulnerability with respect to lack of a wastewater treatment system and insufficient access to roads in the event of flood. The communities, however, have a good capacity to adapt to floods, given their balanced household dependency ratio, common house and land ownership and high community solidarity. A general transition yet from self-sufficient livelihood practices towards alternative employment with a stable income will be inevitable in order to strengthen their flood resilience.

Local authorities are required to go beyond current ad hoc coping strategies and consider long-term adaptive approaches. They have to advocate the new and climate-sensitive land use plan regulation, the introduction of new criteria for the road drainage piping system and the establishment of a new water gate upstream of Pra Keu stream. Finally, the inefficient flood disaster prevention and mitigation governance needs to be resolved to deliver necessary emergency services to the communities in a timely and adequate manner.

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ABBREVIATIONS

CRBO	Chi River Basin Organization
CRF	Climate Resilience Framework
CSNM	Center for Civil Society and Non-profit Management
ECHAM4	European Centre for Medium Range Weather Forecast
FERS	Faculty of Environment and Resource Studies
IDRC	International Development Research Council
IPCC	Intergovernmental Panel on Climate Change
IPaSS	International Partnerships for Sustainable Societies
KKc	Khon Kaen City
KKU	Khon Kaen University
LRT	Light Rail Transit
LVI	Livelihood Vulnerability Index
MOT	Ministry of Transport
MSL	Mueng Sila Municipality
MSU	Mahasarakham University
NKK	Nakhon Khon Kaen Municipality
PCI	Problem-Centred Interviews
RID	Royal Irrigation Department
SLA	Sustainable Livelihoods Approach
SLD	Shared Learning Dialogue
SSHRC	Social Science and Humanities Research Council
TBP	Tambon Ban Ped Municipality
TEI	Thailand Environment Institute
TMK	Tambon Mueng Kao Municipality
TPL	Tambon Pralab Municipality
UCRSEA	Urban Climate Resilience in Southeast Asia Partnership
UPE	Urban Political Ecology
WQI	Water Quality Index
WWTP	Wastewater Treatment Plant

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1. INTRODUCTION

The Urban Climate Resilience in Southeast Asia Partnership (UCRSEA) project is a multi-disciplinary initiative by scholars in Canada and partner located in four countries that are experiencing rapid urbanization and climate change related impacts, including Cambodia, Myanmar, Thailand and Vietnam. This project is supported by a five-year (2014-2019) International Partnerships for Sustainable Societies (IPaSS) grant, funded by both the International Development Research Council (IDRC) and the Social Science and Humanities Research Council (SSHRC), and coordinated by the University of Toronto and York University as well as the Thailand Environment Institute (TEI) in Bangkok. The project seeks to address vulnerabilities to climate change in highly urbanizing areas in Southeast Asian secondary cities and to create space to learn and to share knowledge and decisions about urban economic and social processes as well as the impacts of climate change.

The Faculty of Environment and Resource Studies (FERS) at Mahasarakham University (MSU) is a collaborating partner of UCRSEA in Thailand, and conducted two research projects, i) in Khon Kaen City (KKc) and ii) in Mukdahan.

This final narrative report is presenting the findings of the research project, a vulnerability assessment of the livelihoods of flood-prone Pralab community in KKc and adaptive responses, which was carried out from 1st of January to 15th of September 2017. The report gives in its introduction a problem definition, and explains the research purpose, research questions and research limitations. This is followed by a description of the applied conceptual framework, detailed methodology and use methods. Last, the key results, a discussion with recommendations as well as a conclusion are presented. In the appendices, the implementation plan is listed, the Livelihood Vulnerability Index tables, the household survey questionnaire and in-depth interview questionnaires.

1.1 Problem Definition

Driven by economic and industrial development, and population and wealth increase, KKc has experienced rapid urban growth since the 1990s. Urbanization also brought about challenges for decision-makers in meeting the increasing demand of water, energy, and housing. At the same time, emerging climate hazards and risks, including heat waves, air pollution and extreme weather events, made an effective urban governance and management difficult. KKc's urban growth had been characterized since 2006 for its widely unregulated urban planning due to the expired land use plan in 2006 (Promphakping *et al.*, 2015) opening a grey zone for investors to develop new infrastructure in flood prone areas; the 2015 renewed plan is still in approval process.[1]

Severe flooding and drought had stroke the city increasingly in the past 15 years. This was reflected in unusual precipitation patterns with more intense and shorter rainfall intervals, emphasizing climate variability in Khon Kaen (Thaiwater 2011). Statistics (Thaiwater 2015) show that the annual accumulated precipitation had been almost every year above the regional 48-year average (1327 mm) in the northeastern region between 2006 and 2014.

[1] Source: Interview with Provincial Public Works and Township Office in June 2017.

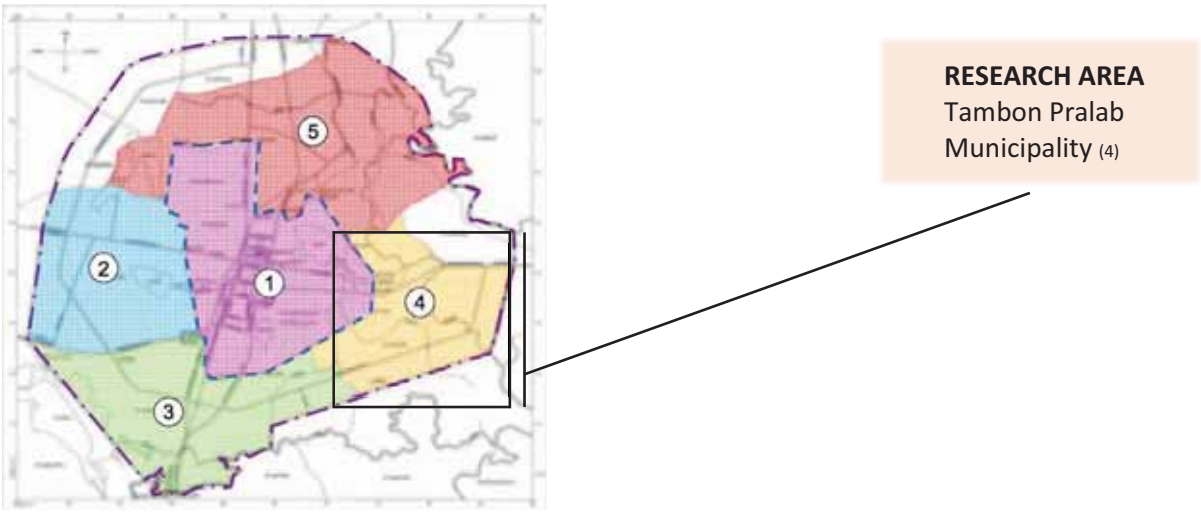


Figure 1: *Khon Kaen City boundary. 1) Nakhon Khon Kaen Municipality, 2) Tambon Ban Ped (TBP), 3) Tambon Mueng Kao (TMK), 4) Tambon Pralab Municipality (TPL), and 5) Mueng Sila (MSL), (Sakkarin, n.d.)*

The selected research site, Tambon Pralab Municipality (TPL; hereafter: Pralab), is located in the fringe area of KKc (Figure 1). Pralab's situation in the low-lands turned the area into one of the heaviest flooded municipalities of the city in 2004, 2008 and 2011 (Promphakping *et al.*, 2015). Particularly in the 2011 flood, the rainwater run-off was significantly slow and remained for up to three months in the area. Local government units had difficulties to respond to the flooding in a timely and effective manner, affecting the residents' livelihood (*ibid*.).

In order to understand the extent of the impact of flooding on the livelihood of residents in KKc as well as current coping strategies and adaptive capacities it was proposed to carry out a single case study in Pralab. This research was aimed to provide a detailed and profound assessment of the vulnerability of the communities to flood, and to develop on that basis policy recommendations which could mitigate vulnerability and strengthen climate resilience. It was anticipated that weak urban governance in KKc with respect to land and water management contributed to Pralab's vulnerability to flood. Therefore, it was expected that this research could point out the complexity and interconnection of issues of urban governance and environmental hazards as well as the impact on the livelihood of communities.

1.2 Research Questions

The research questions were as following:

1) How does flood impact the vulnerability of households in Pralab? What are the capacities of those households to cope with and adapt to flood?

2) How could an improved urban governance reduce the vulnerability of households in Pralab to flood and strengthen resilience?

1.3 Scope and Limits of the Research

The research activity built up on the findings of the previous MSU-UCRSEA research project in KKc (2014-2015) which identified the water system (including water use, supply and allocation) and land use and urban planning as KKc's key urban vulnerabilities to flood and drought.

Initially, it was proposed to conduct a vulnerability assessment of the impact of flood to the urban water system in KKc. However, after consultations with local government stakeholders, the research team decided to narrow the research scope from a comprehensive vulnerability assessment of the whole city to a comparative case study of the vulnerability to flood of two selected communities in KKc, one in Nakhon Khon Kaen (NKK) Municipality and one in adjacent Pralab. Both communities were identified by local stakeholders[2] as heavily flooded areas. While NKK experiences more frequent flash floods in certain areas, Pralab faces regular flooding in the whole municipality. Pralab presented an interesting case as a large proportion of its population is still dependent on agricultural and fish farming to secure their livelihood.

Finally, the research team decided to change the research format from a comparative case study to single case study due to following reasons:

1. In a consultation meeting with the sub-district head of Pralab in May 2017, it was found that a total number of 14 out of 19 villages in Pralab are regularly affected by flood. In order to gain a comprehensive understanding of the vulnerability of the livelihood of the Pralab community and achieve representativeness of data, it was found to be necessary to take all affected villages into the research focus wherefore more time and a higher budget was required.
2. The far smaller community area in NKK Municipality experiences merely flash floods wherein the vulnerability of communities was expected to be far lower than of the community in Pralab, and would deliver less relevant results for this research project.

[2] Source: Preliminary meeting with representatives in NKK and Pralab in March 2017.

2. CONCEPTUAL FRAMEWORK

This research incorporated three approaches into its conceptual framework, including the i) Climate Resilience Framework (CRF); ii) Urban Political Ecology (UPE); and, iii) Sustainable Livelihoods Approach (SLA).

Different from the 1st progress report, the research team decided to include the development of a Livelihood Vulnerability Index (LVI) and LVI-IPCC (Intergovernmental Panel on Climate Change) in order to clearly demonstrate the impact of flood on the livelihood of Pralab's communities. Therefore the SLA in which the LVI is embedded was chosen as an additional conceptual framework. The LVI was further used in the Shared Learning Dialogue (SLD) to illustrate the flood impact to particularly the communities in a simplified way. It was also instrumentalized to enhance the understanding of the local stakeholders on the severity of the flood vulnerability in Pralab and the need to strengthen policies and governance to increase resilience.

In the following the three concepts are described in detail and their relevance for this research outlined.

2.1 The Climate Resilience Framework

The research is embedded into the CRF which offers a conceptual framework for assessing vulnerabilities and risks, identifying resilience strategies and initiating an inclusive learning process to formulate measures and actions that can tackle the uncertainties of climate change in an urban environment (Reed *et al.*, 2013). It draws on resilience than adaptation to point to the interaction of urban systems (both ecosystems and infrastructure systems) which experience climate impacts linked to the effect on people, the actions of social agents (both individuals and organizations) who can plan and address climate effects directly, and to the institutional structures that can restrict and support actions of agents (Moench, Tyler and Lage, 2011):

- Agents refer to people and their organizations, such as individuals (e.g., farmers, consumers), households, communities, private and public sector organizations, or companies (e.g., government departments, private firms or civil society organizations). They are characterized through responsiveness, resourcefulness and the capacity to learn of past experiences.
- Institutions refer to rules, norms, believes and conventions or mechanisms to enforce those rules. Key institutions are land tenure, markets, rights of organization and standards.
- Systems are considered as both ecosystems and infrastructure systems. While the former refers to services such as water, food, and air as well as costal defence and water absorption, the latter refers to power, water distribution, drainage, transport, communication and information, and shelter. They must be flexible to modify structures which introduce new ways, redundant by buffering stocks to address extreme pressure, and safe failure to absorb cumulative shocks.

The Resilience Alliance (2002 cited after Moench, Tyler and Lage, 2011: 34) defines resilience as 'the ability to absorb disturbances, to be changed and then to reorganize and still have the same identity (retain the same basic structure and ways of functioning).' Despite some disagreement, there is clear consensus among scholars that cities must obtain a resilience approach to counter a wide range of

shocks and stresses, interlinked with efforts towards more urban development and sustainability (Leichenko, 2011).

It is argued that climate hazards are interdependent and have cascading effects at the local and global level, creating "nested and networked vulnerabilities" (Adger, Eakin and Winkels, 2009). Failures of the water system in KKc due to an insufficiently developed waste water treatment system, the 2011 century flood had cascading effects, leading to health problems such as skin diseases (Promphakping *et al.*, 2015).

The CRF also draws on the close interlinkage of urbanization and climate change related impacts. Urbanization is understood as a transformative process (Friend et al., 2016) wherein rapid and unplanned urban growth exacerbates climate hazards and vulnerability to poverty. Climate related shocks, such as flood, are not only determined by the location of the event but by how systems are networked and how different agents are affected and gain access and control over these systems.

In this research, it was found that there is a close linkage between urbanization and flood in KKc. Not only the low land elevation of the area increased the flood risk in Pralab but also urbanization in the fastest growing municipality NKK due to lack of land use regulations and proper water management, affecting the livelihood of Pralab community.

The objectives of this research project also aims to respond to the three following generic research questions of the UCRSEA conceptual framework:

1) How will climate change impact the poverty and vulnerability of urban residents in Southeast Asia?
2) What does knowledge, from both academic literature and action research, tell us about creating climate resilient urban governance that is inclusive and equitable?
3) How can we strengthen the agency of individuals, groups and institutions to improve economic, physical and social well-being in urban areas, particularly in response to climate change?

2.2 The Urban Political Ecology Concept

This research further utilizes the UPE approach because it rejects the separation of urban and environment (Marks, 2015) and underpins the argument that flood is not merely a result of climate change but social and political processes and governance failures. Angelo and Wachsmuth (2014: 17) argue that UPE is 'more than merely the study of nature in the city [but] could contribute to a new theory of urbanization that simultaneously foregrounds nature as it deemphasizes cities per se'. Initially the concept of political ecology was focused on land-use in non-urban spaces but gained more relevance for urban spaces through the work of Swyngedouw and Harvey in the 1990s (Angelo and Wachsmuth, 2014).

UPE is understood as a process of socio-natural and not only social transformation wherein the city becomes a product of a global 'metabolic socio-environmental process that stretches from the immediate environment to the remotest corners of the globe' (*ibid.:* 18 cited after Heynen *et al.,* 2006: 5). The concept reframes urban environmental problems critically in an economic, social and historical

context and argues that they are an outcome of political processes. Urbanization is also considered as a transformative process that 'presents itself as a historically specific accumulation of socio-environmental processes' (Swyngedouw *et al.*, 2002: 126). UPE attempts to understand social power relations, which social actors have access and control over, and which will be excluded from access and control over essential resources, as well as who benefits and suffers most from certain processes of socio-environmental change (*ibid.*).

Power relations could be described as determinants of uneven vulnerabilities and the city could be conceptualized as a changing landscape of power. In this research it is anticipated, that Pralab community experiences different vulnerabilities during flood that are in a large part determined by urban governance. However, as KKc is administered by five different municipalities, it is was anticipated that, depending on the underlying issue of governance, uneven vulnerabilities are produced, affecting Pralab community stronger in the event of heavy rainfall. Pralab community is considered to have unequal access or control over urban assets that influence and exacerbate people's livelihood. The usage of the UPE for this research should emphasize that political processes and uneven social power relationships largely shape the impact and extent of flood.

The notion "urban governance" uses the definition of the United Nations Habitat which states as following: 'It is a software that enables the urban hardware to function, the enabling environment requiring the adequate legal frameworks, efficient political, managerial and administrative processes, as well as strong and capable local institutions able to respond to the citizens needs (United Nations Habitat, 2016: 1)'. Urban governance becomes weak or ineffective when following characteristics are not fulfilled: Democratic and inclusive, long-term and integrated, multi-scale and multilevel, territorial, proficient and conscious of the digital age (United Nations General Assembly, 2016).

2.3 The Sustainable Livelihoods Approach

The SLA presents the conceptual framework for the LVI. It encompasses a critical assessment of five types of intangible and tangible household assets, i.e. human, social, natural, physical and financial (Chambers and Conway, 1992), their vulnerability context (shocks, trends and seasonality), and identifying strategies to influence relevant policies that could reduce vulnerability to flood (DFID, 1999). This approach draws on the assets or capabilities that men and women require to carry out their livelihoods strategies and to withstand shocks and stresses such as natural disasters (Hahn, Riederer and Foster, 2009; Farrington, Ramasut and Walker, 2002).

The LVI uses multiple indicators to assess human exposure to natural disasters such as flood and climate variability, social and economic characteristics of households that shape their adaptive capacities, and current health, land and water resource characteristics that define their sensitivity to climate change related impacts (Hahn, Riederer and Foster, 2009). The LVI analysis was first used in Mozambique (*ibid*.) and then used in several studies in Nepal, Ghana, Trinidad and Tobago (Lamichhane, 2010; Urothody and Larsen, 2010; Khajuira and Ravindranath, 2012; Etwire *et al*., 2013) as well as along the Cambodia-Vietnam border (Can et al., 2014; Can, Tu and Hoanh, 2013).

In the SLA, vulnerability is understood as 'lack of resilience to changes that threaten welfare […] [which] can take form of sudden shocks, long-term trends, or seasonal cycles […], [that] usually bring

increasing risk and uncertainty' (Moser, 2011: 5). The degree of vulnerability is based on external threat to a household's, individual's and community's welfare (Farrington, Ramasut and Walker, 2002). In this context, asset vulnerability recognizes poverty as more than income- or consumption poverty but multidimensional aspects of changing socio-economic wellbeing (Moser, 2011). Livelihood strategies are defined as planned activities of people to build their livelihood, including coping strategies to immediately respond to shocks as well as adaptive strategies to enhance their livelihood to create long-term resilience (Farrington, Ramasut and Walker, 2002).

The SLA was originally designated to analyze livelihoods in the rural context and only Moser (2011) developed the 'Assets Vulnerability Framework' to understand vulnerability of livelihoods in the urban areas. However, the urban-rural distinction is rather open for discussion as this is largely dependent on administrative definitions of one country and only looking at 'urban sustainable livelihoods' would be deceptive (Farrington, Ramasut and Walker, 2002). Particularly in the case of Pralab, the urban and rural boundaries are rather blurred and not clearly identifiable as large land areas are qualified as agricultural land which have more in common with rural areas than other parts of KKc.

The five major assets or capitals are described as following (DFID, 2011):

- *Human capital*: Skills, knowledge, ability to labor, education and good health that enables people to develop livelihood strategies.
- *Social capital*: Social resources that people need to pursue livelihood objectives, such as networks and connectedness, membership of formalized groups, relationships of trust, reciprocity and exchanges.
- *Natural capital*: Natural resource stocks from which resource flows and services are essential for pursuing livelihood strategies, such as land, forests, water, marine, air quality, storm protection, erosion, etc.
- *Physical capital*: Basic infrastructure and producer goods that are necessary to build up livelihoods and meet their basic needs; including affordable transport, secure shelter and buildings, adequate water supply and sanitation, clean and affordable energy, and access to information.
- *Financial capital*: Financial resources that people need to meet their livelihood objectives, including available stocks such as savings, and regular flows of money such as pensions or remittances.

3. METHODOLOGY AND METHODS

3.1 Methodology

The research applies a social science approach, both qualitative and quantitative. The qualitative analysis is relevant as it focuses on 'the correct choice of appropriate methods and theories, the recognition and analysis of different perspectives, the researchers' reflections on their research as part of the process of knowledge production, and the variety of approaches and methods' (Flick, 2009: 32). However, combining a qualitative and quantitative approach appeared in this research as most suitable as it is aiming at analysing the details of the vulnerability to flood, reflecting the subjective experience of community members as well as the "frequency and distribution" (*ibid*.) of assets that determine adaptive capacities of the people.

An inductive approach is used, which instead of starting from theories and testing them requires "sensitizing concepts" to study social contexts (*ibid.*). This means that not a traditional deductive methodology is applied that derives research questions from a general theoretical model and tests them against empirical evidence but argues from a single case observation to a general valid theory (*ibid.*).

However this research can present only a part of the vulnerability of the KKc's communities to flood due to the chosen research design which would not allow a generalization in the sense of the concept of the inductive qualitative social research. The subjective interpretation or reflection of the researchers will be a major component of the data analysis for the qualitative approach, following the principle of the hermeneutics which claims that certain actions have different meanings for different observers (Mayring, 2014).

The central design of this research is a case study as outlined earlier. This approach can highlight the specific features and characteristics of a single case and will allow a more detailed analysis (Flick, 2009). This design was also chosen as there is - in particular in the field of urban climate resilience - only limited academic research available for the area of focus. Pralab was also identified as one of the most flood-prone areas in KKc; governance is also highly sensitive issue in Pralab. A single case study could hereby emphasize the distinct gaps and needs.

The research uses a mixture of primary and secondary sources, drawing on the following:

i) A review of relevant plans, maps and documents with respect to urbanization patterns, historical climate variability, and water, land and waste management;
ii) Preliminary meetings with the representatives from the five municipalities in KKc and relevant departments in Khon Kaen Univeristy (KKU) to collect further documents and verify data;
iii) Household survey in Pralab to develop the LVI and LVI-IPCC and to identify suitable interview partners;
iv) Nine in-depth interviews with individuals from households in Pralab as well as several interviews[3] with representative officers in NKK Municipality, TPL Municipality, the

[3] Interviews are – as of 2 July 2017 – ongoing; an exact number of interviews has yet be provided as further interviews could still be initiated, depending on the findings in the interviews.

Regional Environmental Office, the Provincial and Local Disaster Prevention and Mitigation Office, Royal Irrigation Department, and Chi River Basin Organization;

v) Conduction of two SLDs: a) One with Pralab community members and village heads to map out the major vulnerabilities to flood, coping and adaptive strategies of the communities; b) One with selected village heads and relevant local government officials. Policy briefs will be the final output of the SLDs, targeting government agencies, as well as local and national media.

3.2 Methods

3.2.1 Data Collection

3.2.1.1 Desktop Review

A comprehensive review of secondary data, including plans, maps and documents respect to urbanization patterns, historical climate variability, and water, land and waste management in KKc was conducted to gain an understanding on how the urban development of the city and critical points of urban water and land management as well as changes in precipitation patterns construct urban flood.

3.2.1.2 Preliminary Meetings

In preliminary meetings, data was collected to complete gaps in the desktop review with the five municipalities in KKc and relevant departments in KKU, including the Water Resource Management Research Center at the Faculty of Engineering, Civil Engineering Department, Rajamangala University of Technology Isan, and the Civil Engineering Department. Further data collected through in-depth interviews completed the review of secondary data to underpin argumentation presented in the research findings.

3.2.1.3 Household Survey

A household survey was conducted to develop the LVI and LVI-IPCC as well as to identify interview partners who could provide constructive and relevant information for the research. After a first testing of the survey in the field, the survey questionnaire was revised and adjusted to the relevance for this research. The criteria for the survey questionnaire were determined ‘a priori’ based on the research purpose and secondary literature review, and are ‘abstract, because they have been developed independently of the concrete material analysed and before its collection and analysis’ (Flick, 2009: 115).

A number of 239 households were surveyed in 14 out of 19 villages in Pralab in June 2017. The villages were selected based on suggestion of the Sub-district Head of Pralab during a consultation meeting in May 2017. The survey was conducted based on the principle of contingency or random sampling as

almost all households were affected by flood[4] and no distinctive criteria could have been identified. The head of the villages were supporting the survey by pinpointing streets that have a high number of flood affected households. The survey has been conducted by the research team together with students from FERS-MSU. The survey questionnaire was constructed in line with the LVI list of types of components and sub-components and is presented in Annex II, Table 1.

3.2.1.4 Interview

The problem-centred interview (PCI) was chosen to collect further data to complement the LVI and meet the research objectives. This discursive-dialogic method reconstructs knowledge about relevant problems by involving "the interviewers and their knowledge in a dialogue with respondents and their perspectives" (Witzel and Reiter, 2012: 4). The PCI starts with the identification of a "societal problem with immediate relevance for individuals" (*ibid.*) which is in this research the impact of flood on the livelihood of communities.

The PCI is characterized by three central criteria (Flick, 2009):

i) Problem-centring: The researchers analyse a relevant social problem.
ii) Object-orientation: The research is constructed with respect to an object of research.
iii) Process-orientation: The analysis is based on a step-by-step approach.

It is 'semi-structured guide-oriented in-depth interview' (Witzel and Reiter, 2012: 9) and a combination of narratives and questions which allows the formulation of concrete questions based on the conceptual frameworks but also provides the opportunity of an open dialogue with narratives. This approach tries to counter "the tendency and capacity of people to unfold, complete, and elaborate a story by themselves (and without supposedly 'contaminating' contributions of the interviewer)" (*ibid*: 8) as in the case of the narrative interview. Hence, the PCI was qualified for this research due to its focus on a distinct problem with guided questions but no pre-constructed answer options that allows the interviewee to include personal reflexion.

Nine interviews had been conducted with selected households in Pralab on 22 to 24 June 2017 to gain information that can complete the analysis of the LVI and LVI-IPCC as well as provide in-depth information relevant to generate a throughout understanding of the vulnerability of Pralab's communities to flood.

15 interviews had been conducted between 24 June to 7 July 2017 with stakeholders in following local and provincial government offices and university:

- **NKK Municipality** - 3 Public Works and Town Authority Officers (1 civil engineering officer, 1 wastewater control officer, 1 land use planning officer)
- **Pralab Municipality** - 3 Public Works and Town Authority Officer (1 environment and health officer, 1 land use planning officer, 1 disaster prevention and mitigation officer)
- **Center for Civil Society and Non-profit Management (CSNM)** - Dr Buapun Promphakping (Professor at Faculty for Humanities and Social Science, Khon Kaen University & Director of CSNM)

[4] Data on flood damage has been requested from Pralab Municipality but has yet to be received. To complement the data, the information obtained in the household survey will be used.

- **Regional Environmental Office 10** - 1 Officer for Wastewater
- **Provincial Disaster Prevention and Mitigation Office** - Chief of Provincial Disaster Prevention and Mitigation Office
- **Provincial Office of Public Works and Town and Country Planning** – 1 land use planning officer
- **Chi River Basin Organization (CRBO)** - Director
- **Royal Irrigation Department (RID)** - Director
- **Ubolratana Dam** - Head of Dam Control
- **Meteorological Center Khon Kaen** - Director
- **Provincial Public Health Department** - 1 public health officer

3.2.1.5 Shared Learning Dialogue

In addition two SLDs were carried out after the completion of the household survey and interviews. Ideally, the SLD that is at the heart of the CRF brings together a diverse group of stakeholders with different backgrounds (scientific/local), different interests and decision-making power to initiate transparent discussions with an inclusive problem-approach. It represents an initiative that involves various types of stakeholders who do not frequently interact or communicate with each other under usual circumstances. In particular in regard to flooding in KKc, not only the communication between local government and communities appeared limited but also the dialogue between the different municipalities or administrations.

In previous UCRSEA SLDs, the participation of civil society members remained low and the number of government officers high. In this research, the team intended to put a strong focus on the involvement of community members of the affected areas in Pralab. Therefore, the research team targeted in one out of two SLDs solely community members. Despite the SLD's approach to bring particularly civil society and the local government stakeholders together, it was found that community members lack in sufficient understanding of the flood problem in Pralab and would require a more simplified SLD content.

The 1st SLD was held with community members and village heads on 9 September 2017 in Pralab. Participants were able to learn and reflect about the research findings and contributing factors of flood in Pralab and its impact to the livelihood of communities. They showed high interest and engagement in discussions and group tasks.

The 2nd SLD was held with government stakeholders from local and provincial offices as well as one female community leader[5] on 14 September 2017 in Pralab. The research team presented the results of the LVI and LVI-IPCC as well as the outputs of 1st SLD with the community members. This allowed government officers to understand the perspective, concerns and strategies of communities, and further integrate the information into their own discussions.

A range of participatory rural appraisal tools were employed in both SLDs that were developed in line with the LVI components and three core elements of the CRF, i.e. systems, agents and institutions.

[5] Due to severe rainfall in August and September 2017, most community leaders and village heads were occupied finding strategies to cope with the flood and other emerging issues, and thus, not able to attend the 2nd SLD.

These tools included strength and weakness analysis, matrixes, and problem or solution preference ranking.

Stakeholders of both SLDs were able to increase their comprehension of the impact of flood on communities' livelihood and to create first approaches for the development of policy recommendations that could mitigate the vulnerability and increase the resilience of Pralab to flood.

3.2.2 Data Analysis

3.2.2.1 The Livelihood Vulnerability Index

The LVI was constructed to assess the impact of flood on the livelihood of Pralab community. A composite index was presented, compromising 11 components (Annex II, Table 1) as well as the IPCC's three contributing factors to vulnerability, i.e. exposure, sensitivity and adaptive capacities. The vulnerability context of the 11 components was formed based on a secondary literature review of general indicators to study flood and their impact on the livelihood of Pralab community and their agricultural activities.

The 11 components, classified under the five household capitals of the SLA, i.e. human, social, natural, physical and financial, compromise health, livelihood strategy, education, land, natural resources, natural disasters and climate variability, socio-demography, social networks, housing and production means, urban systems, and finance and income (Annex II, Table 1). Each of the 11 major components include several sub-components or indicators which were assessed through the household survey on the flood impact in Pralab and secondary data on precipitation patterns. The primarily usage of primary household data is hereby essential to avoid inaccuracies of secondary data.

Contrary to vulnerability assessments around climate projections, the LVI builds up on measuring the strength of the current livelihood of communities and their strategies to address climate change related exposures (Hahn, Riederer and Foster, 2009). The LVI is also designed as a practical tool for policy-makers to understand the underlying factors contributing to climate vulnerability at the community level (*ibid.*).

Data collection for LVI

A number of 239 households were surveyed in 14 out of 19 villages in Pralab in June 2017. The villages were selected based on suggestion of the Sub-district Head of Pralab during a consultation meeting in May 2017. The survey was conducted based on the principle of contingency or random sampling as almost all households were affected by flood and no distinctive criteria could have been identified. The head of the villages were supporting the survey by pinpointing streets that have a high number of flood affected households. The survey was conducted by the research team with support from FERS-MSU students. The survey questionnaire was constructed in line with the LVI list of types of components and sub-components and is presented in Annex II, Table 1.

Calculating the LVI

The LVI and LVI-IPCC calculation was adopted from the formulas developed by Hahn, Riederer and Foster (2009). The LVI applies a balanced weighted average (Sullivan, 2002) approach whereby each sub-component contributes equally to the overall index although each major component has different numbers of sub-components (Hahn, Riederer and Foster, 2009). It is a simplified approach that uses equal weights to all major components. As the sub-components are calculated through different scales they had to be brought on the same standard using the equation of the human development index to calculate the life expectancy index (*ibid*; UNDP, 2015):

$$index_{S_P} = \frac{S_P - S_{min}}{S_{max} - S_{min}} \quad (1)$$

Where s_P is sub-component for Pralab *P*, and s_{min} and s_{max} are the minimum and maximum values; for each sub-component uses data from all 13 villages.

Subsequently to the standardization of the sub-component values, the value of each major component was calculated (Hahn, Riederer and Foster, 2009) using equation (2):

$$M_P = \frac{\sum_{i=1}^{n} index_{s_P i}}{n} \quad (2)$$

Where M_P = one of the 11 major components for Pralab *P* [Health (H), Livelihood Strategy (LS), Education (E), Land (L), Natural Resource (NR), Natural Disasters and Climate Variability (NDCV), Socio-Demography (SD), Social Networks (SN), Housing and Production Means (HP), Urban Systems (US), and Finances and Incomes (FI)]*;* $index_{SPi}$ represented the value of the sub-component *s* indexed by *i* of major component M_P; n is the number of sub-components in each major component.

After the calculation of the values for each of the 11 major components for Pralab, they were averaged using equation (3) or aggregated to values for the five livelihood assets [Human Capital (H), Natural Capital (N), Social Capital (S), Physical Capital (P) and Financial Capital (F)] before used in equation (4) to obtain the weighted average LVI for Pralab:

$$LVI_P = \frac{\sum_{i=1}^{11} w_{Mi} M_{Pi}}{\sum_{i=1}^{11} w_{Mi}} \quad (3)$$

$$LVI_P = \frac{w_H H_P + w_N N_P + w_S S_P + w_P P_P + w_F F_P}{w_H + w_N + w_S + w_P + w_F} \quad (4)$$

Where LVI_P is the Livelihood Vulnerability Index of Pralab *P;* w_{Mi} is the weight of each major component (w_H w_N w_S w_P w_F) which are the weight value of each of the five livelihood asset or capital. The LVI was scaled from 0 (least vulnerable) to 1 (most vulnerable).

Calculating the LVI-IPCC

The LVI-IPCC was calculated through an alternative method based on the three IPCC contributing factors to vulnerability. Table 3 (Annex II) compromises the organization and allocation of the 11 major components to exposure, adaptive capacity and sensitivity (Hahn, Riederer and Foster, 2009). The LVI-IPCC was calculated with the same equation (1) - (3) that were applied for the calculation of the sub-components and five livelihood assets. The following equation was used (*ibid.*):

$$CF_P = \frac{\sum_{i=1}^{n} w_{Mi} M_{Pi}}{\sum_{i=1}^{n} w_{Mi}} \quad (5)$$

Where CF_P is an IPCC defined contributing factor, i.e. exposure, adaptive capacity, and sensitivity, for Pralab *P;* M_{Pi} are the major components for Pralab indexed by *i;* w_{Mi} is the weight of each major component; and *n* is the number of major components in each contributing factor.

Once the three contributing factors to vulnerability were calculated, they were combined using equation (6):

$$LVI - IPCC_P = (e_P - a_P) * s_P \quad (6)$$

Where $LVI\text{-}IPCC_P$ is the LVI for Pralab *P* expressed using the IPCC vulnerability framework; *e* is the value for exposure of Pralab *P* (equivalent to the NDCV major component), *a* is the value for adaptive capacity of Pralab *P* (weighted average of the LS, E, SD, SN, FI, and HP major components), and *s* is the value for sensitivity of Pralab *P* (weighted average of the H, L, NR, and US major components). The scale of the LVI-IPPC ranged from -1 (least vulnerable) to 1 (most vulnerable).

3.2.2.2 Qualitative Content Analysis

The qualitative content analysis was chosen for the analysis of the data collected in the interviews and SLDs. This scheme allows a step-by-step analysis of material and puts categories its center (Mayring, 2000). This methods fit the material for the analysis as relevant content for the specific research questions occur at different points of the material (*ibid.*). Moreover, the inductive category development was used as the major approach of the qualitative content analysis (Figure 2).

Mayring (2000) explains that in this step model the main idea of the procedure is "to formulate a criterion of definition, derived from theoretical background and research question, which determines the aspects of the textual material taken into account". The categories are deducted step-by-step while the material is worked through. After a revision, they are reduced to main categories and their reliability checked (*ibid.*).

The inductive category application of the qualitative content analysis allows to establish the category system based on the material or collected data itself and not from the theoretical considerations (Mayring, 2014). This procedure appears also more applicable as less relevant previous research is available like in the deductive system where categories are formed solely from theory (*ibid.*). It "aims at a true description without bias owing to the preconceptions of the researcher, an understanding of the material based on the material" (Mayring, 2014: 79).

However, the criterion for the selection process of the category formation had to be set prior to the analysis based on theoretical considerations (Mayring, 2014*)*. In addition, the core characteristics of LVI components were considered in the development of the categories.

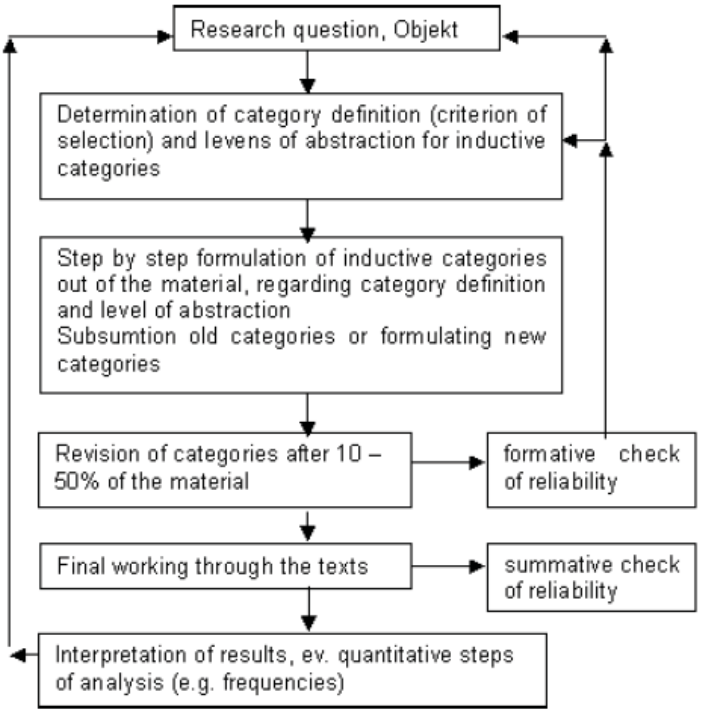


Figure 2: *Step model of inductive category application (Mayring, 2000)*

3.2.3 Citizen Science Component

In addition, the research team has decided to conduct a "citizen science" through a collaboration with a local high school in Pralab. This approach is based on the idea to let students take water quality samples of the major stream in Pralab to analyze and monitor the surface water quality over a few weeks. This initiative had been put on hold until October as the water sampling would not deliver accurate values given the high dilution of the water during rainy season (June to October).

Initially the research team aimed to use the collected data in the SLDs and let students tell their own perception on the water quality deterioration. It was decided to present the student findings in the upcoming cultural event (ทอดกระถิน, Krathin Ritual; between November and December 2017, exact date has yet to be confirmed) organized by Pralab sub-district head.

This cultural event that aims to advocate the flood and wastewater problem in Pralab should be held at a major pond in Pralab, close to the wastewater treatment plant in NKK. The event aims to promote fish farming which is a major economic activity in Pralab and good health through a Buddhist ceremony, and to expose the impact of wastewater discharge into the natural water bodies in Pralab on fish farming. It must be noted that Pralab is one of the major fish providers for KKc. The provincial governor of Khon Kaen should be invited to gain broader recognition and support for the impact of the wastewater issue on the environment, society and health of people in KKc.

This research could support the success of the event through its findings in relation to the impact of flood to health as well as the "stories of students" based on their citizen science on the water quality deterioration of the natural bodies.

4. RESULTS

Traditionally, KKc as part of the northeast of Thailand had always been connected with drought but the issue of flood gained only after the 2011 century flood higher attention among city leaders. Secondary cities such as KKc are expected to expand further into its fringe areas and unusual rainfall patterns are creating increasing climate uncertainty. If urban areas are poorly managed, the city will face more difficulties in defining adequate and resilient responses to severe flooding. Therefore the causes of flooding have to be fully understood as well as the impact on the livelihood of its residents. The case study of Pralab is aimed to exemplify the need to strengthen relevant policies in order to make KKc more resilient to future climate variability.

In the following the impact of and responses to flood in Pralab community is analyzed, including the causes of flooding. Interviews with government offices were marked with a hashtag (#) and a capital letter from A to K (e.g., Interview #A and #F) to guarantee anonymity of the statements of the interviewed offices and simplify the analysis process. Interviews with community members were marked the same way with a hashtag (#), followed by number 1 to 9 (e.g., Interview #1 and #7). The outcomes of the SLDs are also marked with a hashtag (#) and number 1 for the SLD with community members (SLD#1) and number 2 for the SLD with government stakeholders (SLD#2).

4.1 Impact of Flood

The research found that the major causes of flooding in Pralab are its situation in the low-land of KKc, changes or precipitation patterns with more intense and shorter intervals of rainfall as well as weak urban governance, including land use, infrastructure development and water governance.

Pralab community was found to be moderately vulnerable to flood with a particular high physical and financial vulnerability (Table 3, Annex II). This may indicate that the impact of flood is not significantly high in Pralab, however, it must be noted that the scale at which the vulnerability assessment was carried out may not have been appropriate in this case. Pralab is considered a high flood risk area in KKc. At a global scale on which the LVI was developed Pralab may show a lower vulnerability. If a regional based scale was available, Pralab may have had a higher overall vulnerability to flood.

Nevertheless, the analysis scored urban systems and housing and production means highly vulnerable (Table 3, Annex II). This is mainly reflected in the long duration of flood water in the area and nonexistent access to wastewater treatment. Finances and incomes also reached a high vulnerability score as most households reported a significant income reduction or lack of income due to flood damage in agricultural and fish farming. Large financial debts, lack of insurance and insufficient compensation to recover from the losses also contributed to the high financial vulnerability.

Pralab's sensitivity to flood that is composed of the major components, health, land, natural resources and urban systems, was found highest in the LVI-IPCC. This refers again mainly to the lack of adequate wastewater treatment and high mean standard deviation of average precipitation by month. On the contrary, the adaptive capacity, composed of the major components livelihood strategies, education, socio-demography, social networks, finance and income and housing and production means, was scored relatively high. This shows that Pralab's community has a good basis to strengthen their

capacity to adapt to flood, such as through permanent employment as an alternative to agricultural farming. Most households hold ownership for their house and their dependency ratio is also relatively balanced which provides the opportunity of younger family members to pursue higher education and an occupation with a stable income.

The following section presents first the findings on the causes of flood in Pralab which are crucial to understand the impact of, and, responses to flood. This is followed by the vulnerability assessment of the livelihoods or LVI and LVI-IPCC that point out the impact of flood on the livelihood of households in Pralab.

4.1.1 Causes of Flood

Three major causes of flood in Pralab had been identified: i) Land elevation level differences, ii) changes of rainfall patterns, and, iii) weak urban governance (Interview #A). KKc experienced the most severe floods in 2008 and 2011 (Figure 3).

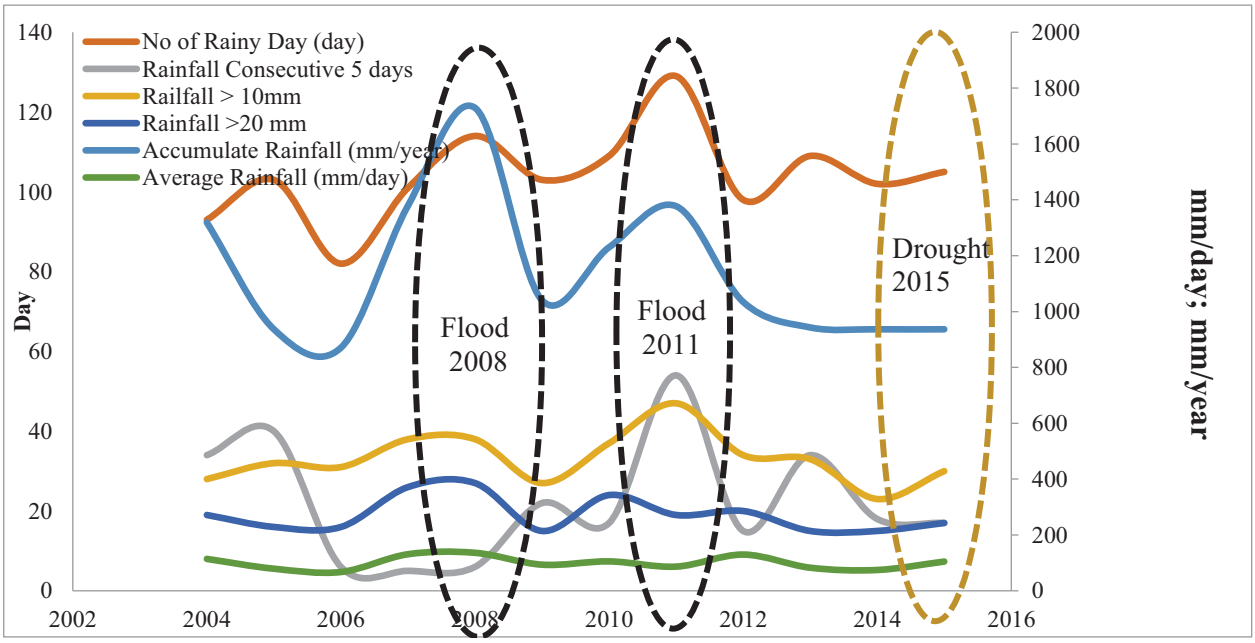


Figure 3: *Rainfall Index of Khon Kaen Province from 2004 to 2015 (Northeastern Meteorological Center, n.d.)*

The 2011 flood refers to the high number of rainy days (> 120 days) with consecutive rainfall of more than 50 days (Figure 3). This was the major reason that – as already mentioned – rainwater remained in 2011 for up to 90 days in some areas of Pralab (Promphakping *et al.*, 2015).

4.1.1.1 Land Elevation Level Differences

The major cause for flooding in Pralab was found to be its situation in the low-lands of KKc (Figure 4, Interview #A). It was found that rainwater in KKc runs off (Figure 5 and 6) from the highest land level point (157 m) in NKK municipality in the northwest to the lowest land level point (149 m) in Pralab in

the southeast (Interview #A). This characteristic made Pralab a known flood risk area that is not suitable for major urban development.

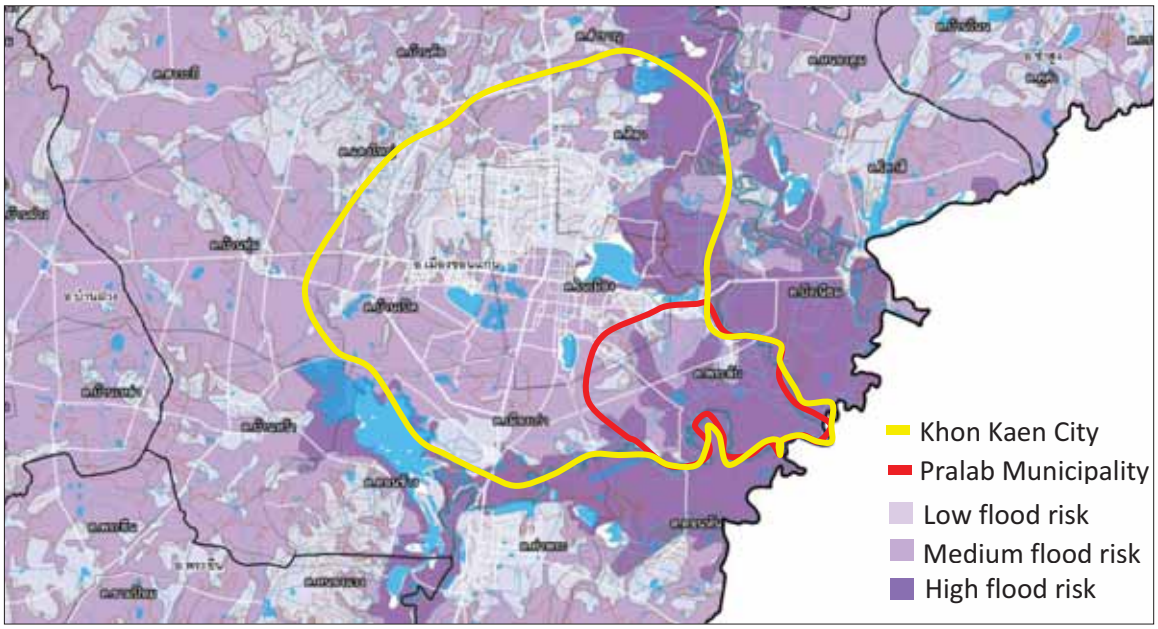


Figure 4: *Flood risk areas in KKc and Pralab risk areas*[6]

Figure 5: Water run-off in KKc[7]

[6] Data was sourced from the GIS database of the Water Resource Management Research Center at the Faculty of Engineering, Civil Engineering Department, Rajamangala University of Technology Isan in Khon Kaen; the data was received during a preliminary meeting in March 2017.

[7] Source: Google maps (accessed 20 March 2017).

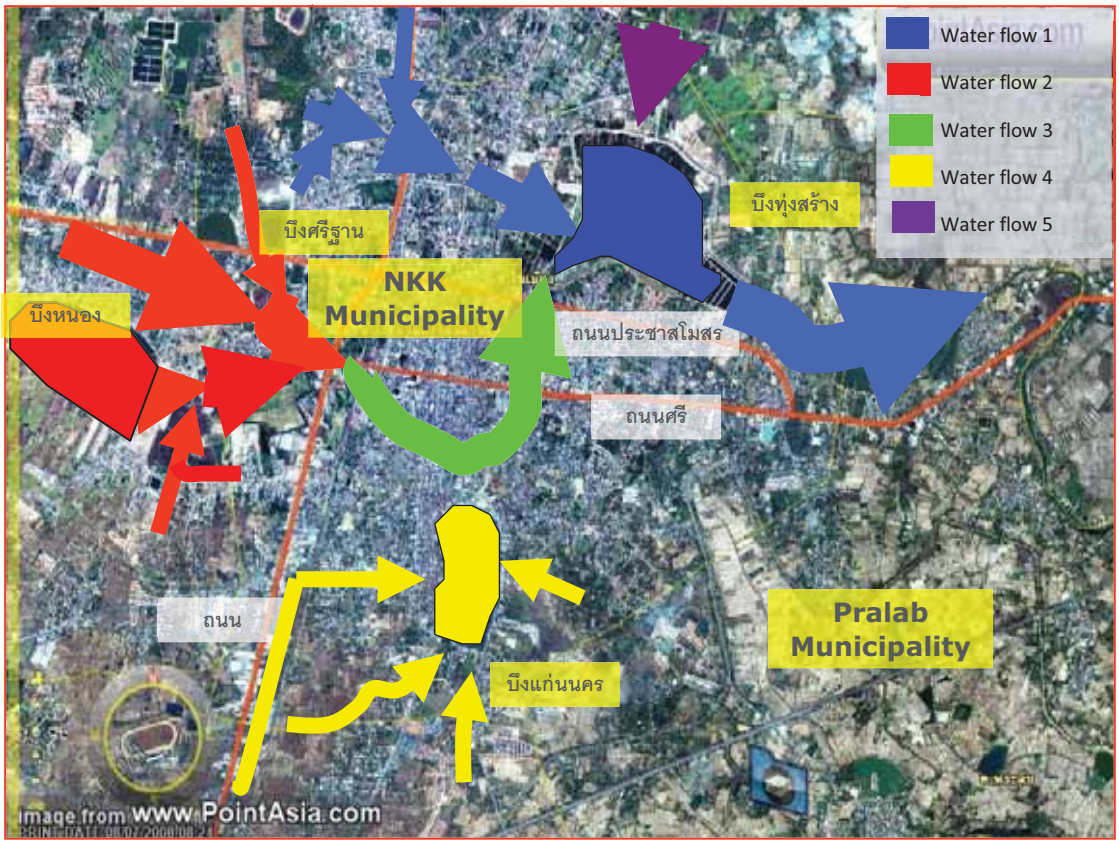
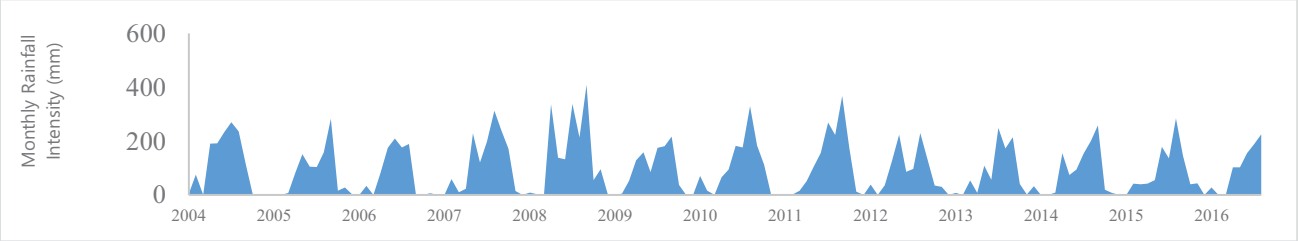


Figure 6: *Rainwater run-off flow in KKc, indicating water capture areas in the central areas*[8]

4.1.1.2 Changes of Rainfall Patterns

The second cause of flooding in Pralab was found to be changes of rainfall patterns with more intense and shorter intervals (Interview #A, #H and #J). Precipitation statistics (Figure 7) for Khon Kaen province show that the monthly intensity was significantly high in 2008 and 2011. The highest rainfall was reached in 2008 and the highest number of rainy days in 2011. The rainfall intensity per event (Figure 7), however, and rainfall pattern (Figure 8) indicate more irregular patterns wherein the intensity was higher than the average in 2004, 2007, 2008, 2009, 2012, 2015 and 2016.



[8] Source: Plans developed by NKK Municipality; received in March 2017.

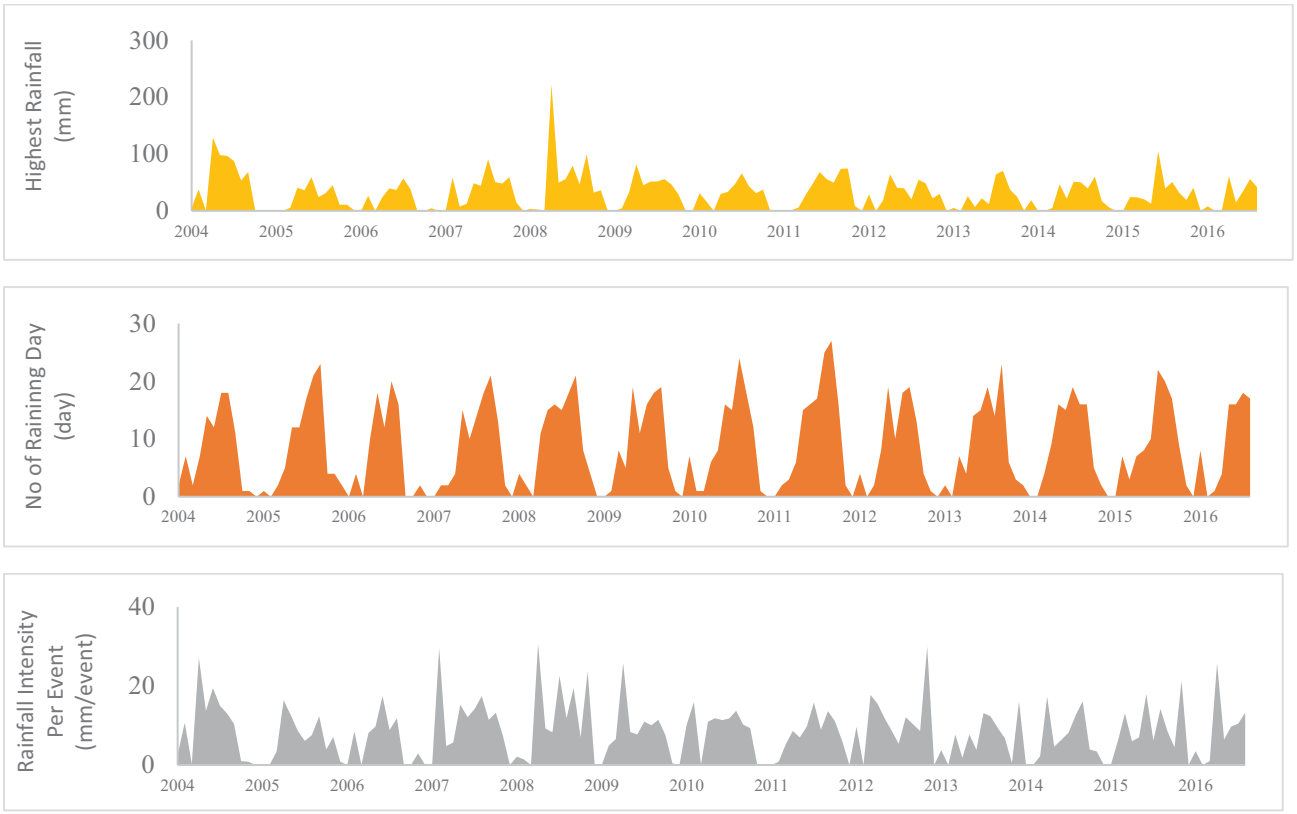


Figure 7: *Rainfall statistics of Khon Kaen Province from 2004 to 2017 (Northeastern Meteorological Center, n.d.)*

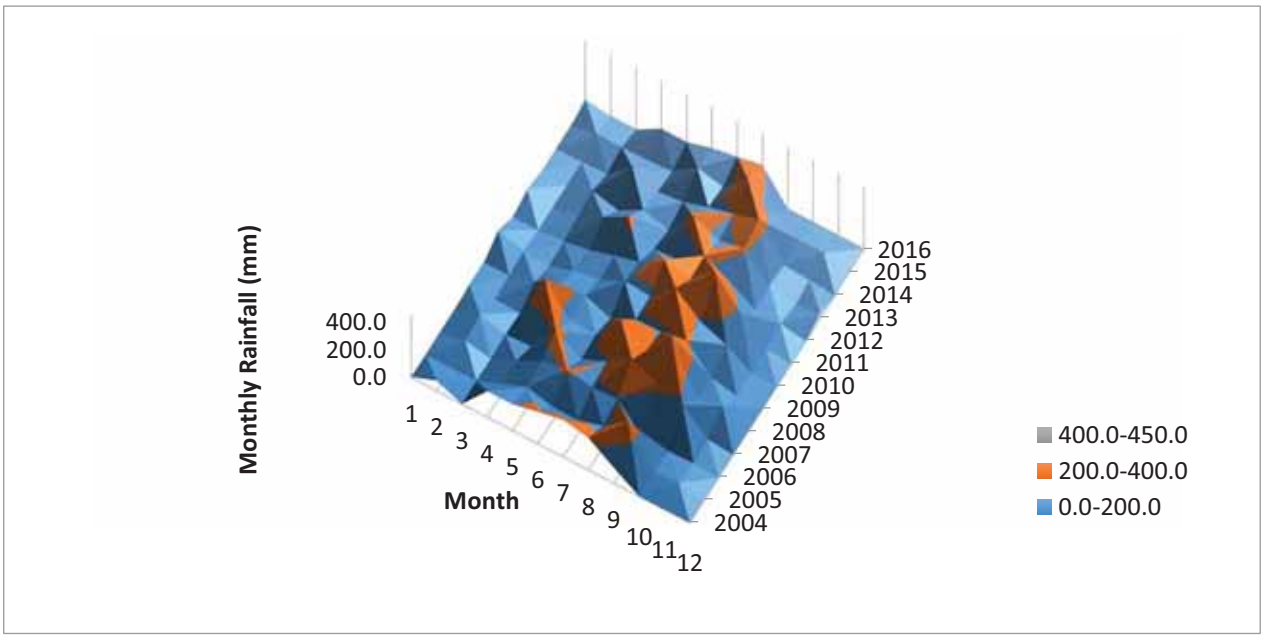


Figure 8: *Rainfall pattern of Khon Kaen Province during 2004 to 2016 (Northeastern Meteorological Center, n.d.)*

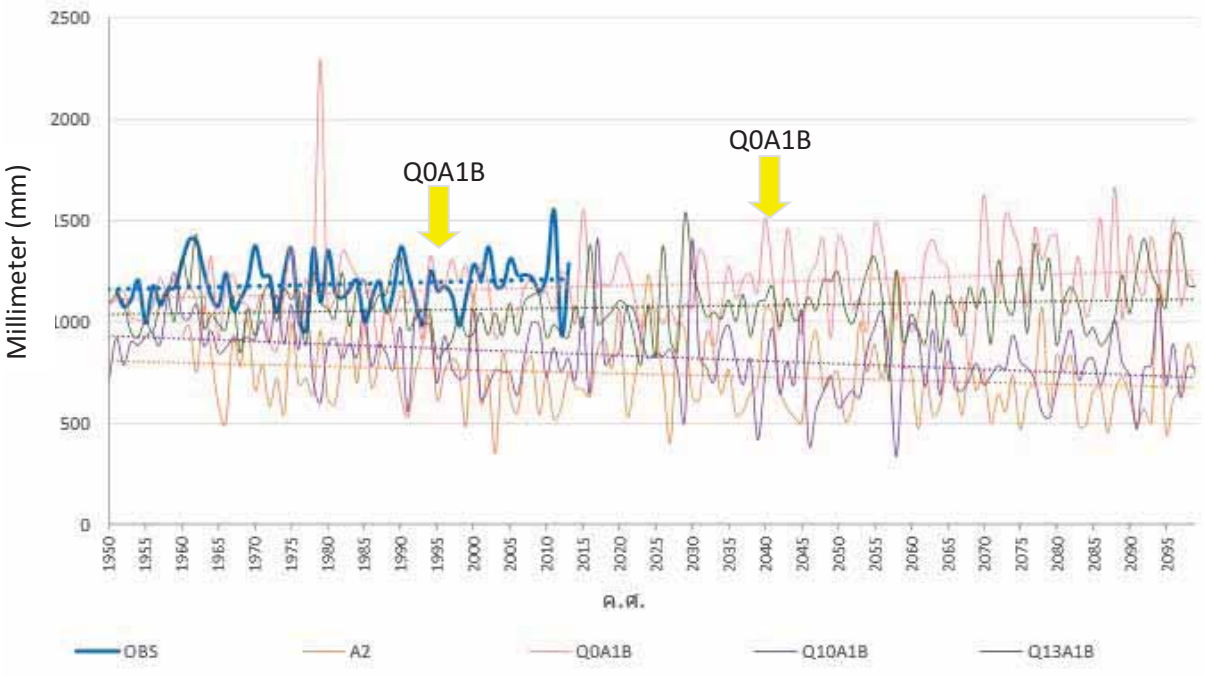


Figure 9: *Rainfall statistics of Northeast Region from 1950 to 2013 (in blue line) and forecasting using ECHAMA4[9] from 1950 to 2099 (Northeastern Meteorological Center, n.d.)*

The statistics demonstrate a slightly increasing rainfall throughout the past 30 years (Figure 9). A forecast scenario until 2099 shows an increasing trend of rainfall that peaks significantly high (almost 1500 mm) in an interval of about five years (Figure 9: Q0A1B, orange line). The simulation (Q0A1B) was run based on high economic and population growth assumptions using fossil fuel as well as renewable energy sources. This scenario indicates that in particular with speedy and unplanned urbanization in the northeast of Thailand, KKc and flood risk areas such as Pralab are likely to face more events of severe flooding. As of July 2017, the water level in KKc had already a very early water inflow and might cause severe flooding in October or November 2017 as it was the case in 2011 (Interview #H).

4.1.1.3 Weak Urban Governance

The third reason of flood in Pralab was found to be weak urban governance (Interview #A, #B, #C, #D, #E, #F, #G, #H and #I). Urban governance entails institutions, guidelines, regulatory and management mechanisms wherein the local government is a key actor but not exclusively (United Nations General Assembly, 2016). Weak urban governance in Pralab is reflected in land use changes, improper infrastructure (both roads and buildings) development, poor waste management, insufficient wastewater treatment and water governance.

[9] ECHAM4 was upgraded from European Centre for Medium Range Weather Forecast: ECMWF of Max Planck Institute for Meteorology and German Climate Computing Centre, Germany and Weather Forecast Model HadCM3 (Hadley Centre Coupled Model, Version 3) which was developed by The Met Office Hadley Centre for Climate Prediction and Research, England. The actual measurement was collected for 30 years. The model was analyzed using four scenarios; 1) A2; 2) Q0A1B; 3) Q10A1B and; 4) Q13A1B (sourced from http://climate.tmd.go.th/files/253).

Land use changes

Land use changes that reduced the overall pervious areas in KKc had been found to be one of the most significant indicators for severe floods in Pralab (Interview #A, #B, #G and #I). Green land that used to be important for water run-off and storage were developed with new infrastructure such as the "Central Plaza" mall in the center of NKK municipality. But also the construction of major highways, for instance, the city ring road (Figure 10) blocked the natural floodway in the event of heavy rainfall and divert the water with higher volumes into other areas – particularly the low-lands (Interview #G).

Figure 10: *Major highways in KKc in 2016*[10]

The described land use changes are mainly affiliated with the missing land use regulation for the whole city since 2006. The previous valid land use plan expired in 2004 and was extended until 2006. A new plan had been submitted in 2015 (Figure 11) but is still in approval process; it is expected to be approved in 2019 (Interview #A, #B and #I). Most municipalities, including Pralab, did not make use of a policy that allows each municipality to draft their own land use plan regulation until the submitted city regulation became effective but continued using the expired version of the land use plan (Interview #A and #B). This opened a grey zone for several investors to develop flood risk areas in Pralab (Interview #B).

Especially developments along the ring road and major highways such as hotels, gas stations and small factories were approved. These areas are not designated anymore as residential or commercial areas in the new land use plan (Interview #B) but as rural and environmental conservation area (Figure 11; green slash pattern). Low-land in Pralab is compared to land in other municipalities in KKc still affordable for residents to purchase (Interview #B). The municipality announced a warning not to purchase any more land in Pralab for residential or commercial development, however, the lack of a valid land use regulation allowed an easy issuance of permits (Interview #B).

The Provincial Office of Public Works and Town and Country Planning that is in charge of developing the new plan had consulted all municipalities on the development of the new land use plan (Interview #I). The plan is considers population growth and density forecasts for the next 20 years as well as the

[10] Sourced from google earth software.

planned Light Rail Transit (LRT) construction (Interview #I). It aims to keep NKK municipality as the compact city that concentrates economic growth in the center; green areas cannot be preserved here anymore (Interview #I).

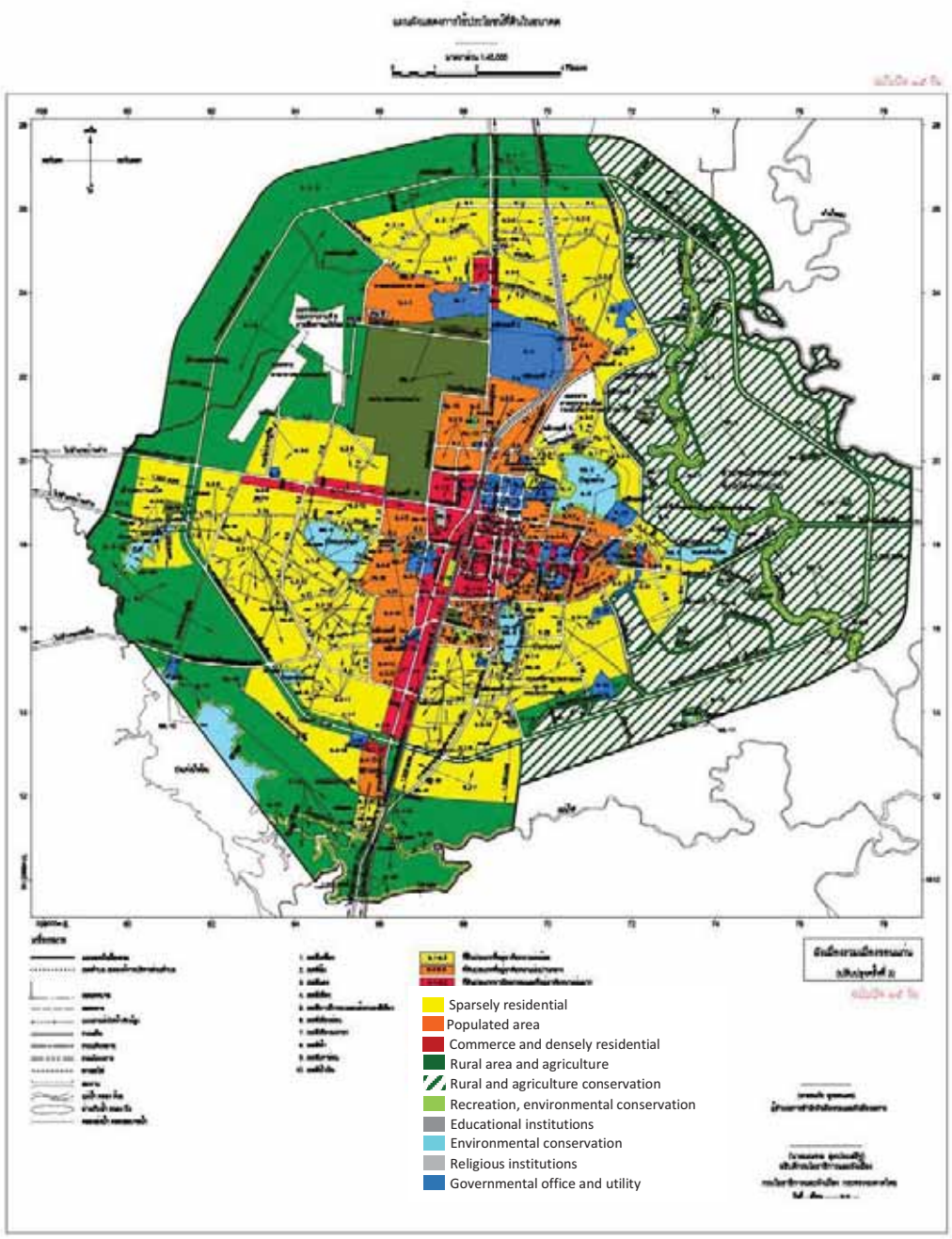


Figure 11: *New land use planning regulation of KKc (in approval process)*[11]

The west of KKc will be designated as residential and green areas while the east, including the majority of Pralab, will be a conservation area (Interview #I). This is mostly due to its flood proneness (below 149 m is considered a flood risk area) where further residential or commercial development cannot

[11] Sourced from Provincial Office of Public Works and Town and Country Planning in July 2017.

be permitted but also because Pralab is irrigated land and should be preserved for agricultural production (Interview #I).

Most municipalities were opposing the suggestions of the provincial office as it would hinder the establishment of more business opportunities (Interview #I). This plan would be a milestone to counter more land use changes that cause flooding in Pralab. Moreover, the new land use regulation will not allow any industrial development and be valid for an unlimited period (Interview #I).

Improper infrastructure development

Most municipalities in KKc established their road drainage piping systems using less cost-intensive criteria that were introduced in 1997. These criteria are obsolete as they are not suited for the concrete pavements (Interview #A). The drainage piping system was designed using a run-off coefficient of 0.15 which is usually applied for below 10% impervious areas (Interview #A). Nowadays, many areas in KKc have an impervious area of 85-90% and are exposed to more frequent high intensive heavy rainfall wherefore these pipes are too small (Interview #A).

There are currently new criteria planned to be introduced in NKK municipality with larger pipes that can withstand the current rainfall intensity (heavier and with shorter intervals) and will replace major pipes; the budget and regulation should be approved and implemented by 2018 (Interview #A). On the contrary, in Pralab no clear criteria are followed for the establishment of the road drainage piping system due to budget limitations; some areas have pipes, others canals (Interview #B).

Attention among city leaders in KKc was particularly called to an improvement of the road drainage piping system after the 2011 flood (Interview #A). Once pipes in key areas in NKK municipality are replaced, the rainwater run-off will be significantly improved and flooding in Pralab could be reduced. In view of further urbanization, the drainage piping system in smaller municipalities will also require an improvement.

Despite the decentralized administrative structure in Thailand as defined in the 1997 constitution (United Nations, 2004), national highways such as the three major highways in KKc are set under the responsibility of the Ministry of Transport (MOT). Municipalities in KKc are not effectively consulted when new roads are constructed by the MOT in their respective administrative areas (Interview #A). NKK municipality explained that the MOT does not carefully consider natural flood ways in their planning nor establish an effective drainage system (Interview #A). The current construction of the national high-speed train exemplifies weak governance between national and local governmental authorities. Columns of the construction are already blocking existing drainage pipes with implications for the water run-off during heavy rainfall (Interview #A). It must be noted that various areas in KKc such as military bases or universities have their own specific agencies regulating infrastructure development and house construction (Promphakping *et al.*, 2015). Thus, critical urban systems are unevenly developed, contributing to flooding.

Furthermore, land and house elevations that are not properly following the regulations of the Building Control Act 8 make the control of floods more difficult for Pralab municipality. The enforcement of

the act was reported to be problematic due to lack of monitoring of the required water management for the elevation which is often inefficient. The city ring road of KKc is exemplifying for inefficient land elevation that causes flood.

Poor waste management

During heavy rainfall, garbage bins tend to fall down and waste that is carried with the floodwater into the streets cover drainage grids, preventing rainwater from running off properly (Interview #A). Despite collaborating initiatives with the public health department to clean up the blocked grids, it remains an issue during heavy rainfall (Interview #A). An improved general waste management could forestall the waste problem in the event of severe flooding.

Insufficient wastewater treatment

NKK is the only municipality in KKC that has a Wastewater Treatment Plant (WWTP) and designed drainage system which was established in 1998 with financial support from the Ministry of Science Technology and Environment[12] (Interview #A). The WWTP of NKK municipality is designed as an aerated lagoon with a capacity of 78,000 m^3/d and covers only an area of 80% (Interview #A). The WWTP receives wastewater from following three different areas: i) NKK municipality, ii) Khon Kaen University and, iii) some areas of TBP municipality (Interview #A). The highlighted area in red (Figure 12) that is low-land and adjacent to Pralab indicates the major area that is not covered by the WWTP and discharges untreated wastewater directly to Pra Kue stream.

The treated water that is discharged into Pra Kue stream meets effluent standards (Interview #A) but the stream shows still an extreme poor water quality (Figure 13) as untreated wastewater from all other municipalities runs off into Pra Keu stream. The water quality parameter of the Pra Keu stream does not meet the surface water standard and falls into “Type 5” of the surface water quality standard (Interview #D). This standard is only suitable for transportation but not for consumption and agricultural activities (Pollution Control Department, n.d.).

Pralab’ communities use the water from the stream for fish, rice and vegetable farming (Interview #D) which may cause health problems for both farmers and consumers. During heavy rainfall, the stream may also overflow and lead to health issues for communities in Pralab as in the case of 2011 flood; many residents complained about skin diseases as a result of contaminated floodwater (Promphakping *et al.*, 2015). The water quality of Pra Keu stream was extremely poor with a high ammoniac concentration due to food wastes (Interview #D). NKK municipality has plans to establish a wetland to treat the area that cannot be covered by the WWTP (Interview #A). Other municipalities appear undecided on how to handle the wastewater from their own municipalities (Interview #D).

[12] The Ministry of Science Technology and Environment is now separated into two ministries, i.e. Ministry of Science and Technology and Ministry of Natural Resources and Environment.

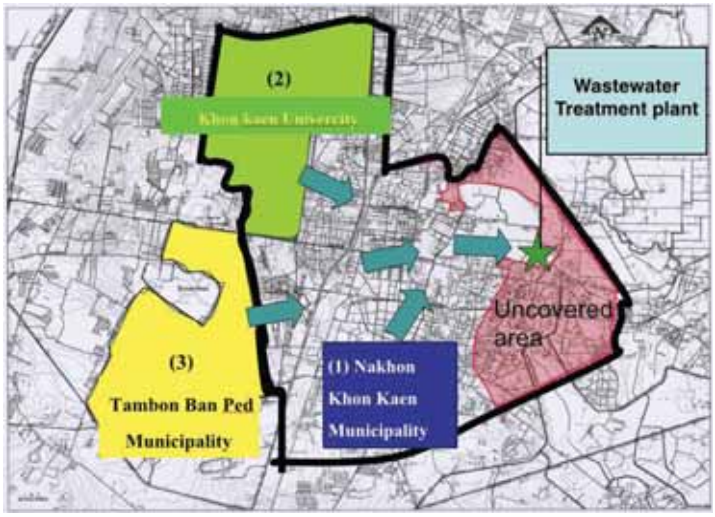


***Figure 12**: Wastewater treatment plant coverage and uncovered areas*[13]

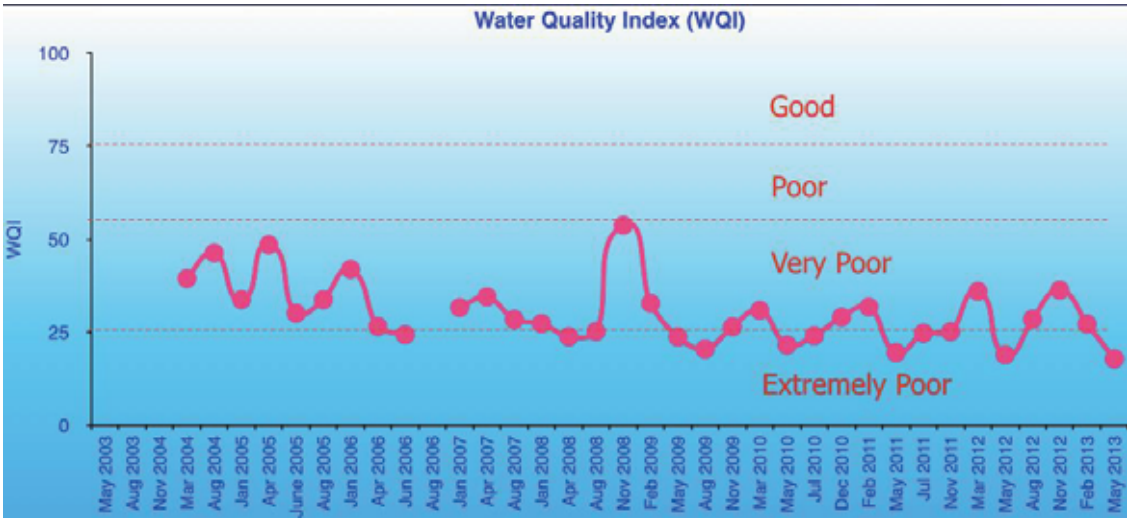


Figure 13: Water Quality Index of Pra Kue stream from 2003 to 2013 [14]

Insufficient water governance

Despite several initiatives of the RID, the water governance in KKc to mitigate flooding in Pralab is still insufficient (Interview #B and #G). The up to five meters high wall along Chi River with small pumps and the wall along the western side of Pra Keu stream as well as the recently established D8 gate with a water pump at the mouth of Pra Keu stream into Chi River are the current water management measures to tackle flooding in Pralab (Interview #G).

The flood walls were additional to the canal an effective flood prevention and mitigation tool in 2011 (Interview #G). The in 2016 established D8 gate and pump in Pra Keu stream could reduce 20 days of heavy flood (Interview #G). It is unclear at the moment, if the pump could have a significant impact

[13] Source: Data provided in interview with NKK municipality in June 2017.
[14] Source: Data provided in interview with Khon Kaen Regional Environmental Office in June 2017.

on flood mitigation as it was planned based on flood damage data before the 2011 flood (Interview #G). In July 2017, the pump had been used for the first time, however, electricity (100,000 THB/hour) and maintenance fees are high (Interview #G). It is unclear if the fees will be shared among other municipalities and with the provincial offices (Interview #G). The establishment of a wall along Phong River would be less efficient and only move the flood issue to the other side of the river (Interview #G). The RID is rather suggesting to establish a new gate upstream of Pra Keu stream which could reduce the extent of flood in Pralab significantly in future (Interview #G). Residents who live in that area, however, are opposing the project as it would shift again the flood problem to them (Interview #G).

4.1.2 Vulnerability Assessment of Livelihoods

The research found that the overall vulnerability or LVI of Pralab's livelihoods to the impact of flood and climate variability was found to be moderately vulnerable with 0.385 (Annex II, Table 3) while the LVI ranges from 0 (least vulnerable) to 1 (most vulnerable). Table 3 and 4 (Annex II) present the summary of the LVI results for all 46 sub-components, 11 major components, and 5 capitals, based on the evaluation of the household survey. It was found that the physical vulnerability (0.503) and financial vulnerability (0.485) are the highest, followed by the natural vulnerability (0.359), human vulnerability (0.357) and social vulnerability (0.257) as the lowest. Figure 14 illustrates the comparative vulnerability levels of the five types of capital and Figure 15 provides a vulnerability diagram of the major components of the LVI for Pralab. The results of the vulnerability assessment for all five capitals and components respectively are analyzed below while for the former is 0 the least vulnerable and 0.5 most vulnerable, and for the latter is 0 the least vulnerable and 1 most vulnerable, respectively.

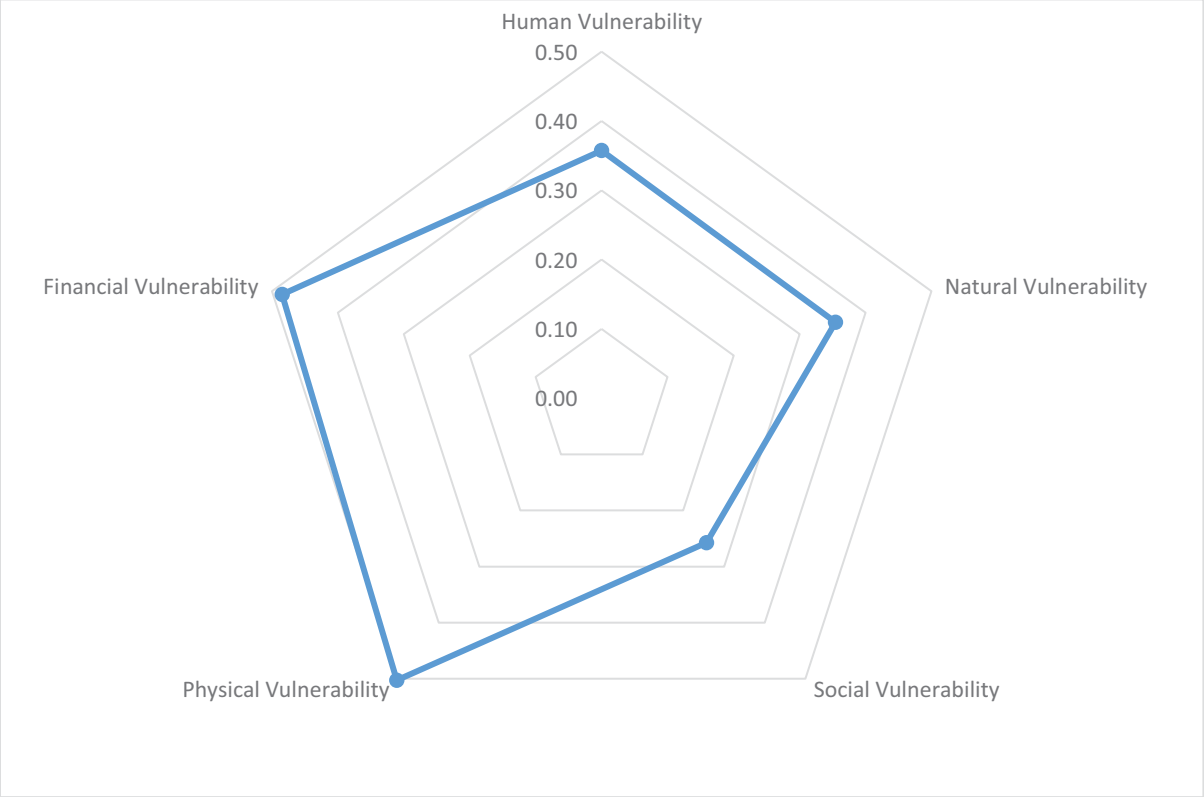


Figure 14: *Comparative vulnerability of five types of capital for Pralab*

4.1.2.1 Vulnerability of Human Capital

Pralab's vulnerability in terms of human capital is with 0.357 rather moderate to high compared to the other four capitals. The health component index showed, however, a rather low vulnerability with 0.223 wherein almost half of the surveyed households (46.8%) indicated to have at least one family member suffering from a chronic or severe illness but only 20.3% stated that at least one family member got ill due to severe flooding. In contrast to a previous study (Promphakping *et al.*, 2015) that investigated the impact of flood on health in Pralab that indicated higher numbers of diarrhea, pneumonia, dengue incidents, stress and in particular skin infections during and/or after flood, in this research only 17.7% of the surveyed households stated that they have had one of the four diseases.

Skin infections were caused mostly by contaminated water due to wastewater discharge from the inundated Pra Keu stream, pesticides from rice fields and solid waste (Interview #1, #3, #6, #7, #8 and #9). The long-lasting standing flood water attracted also a large number of mosquitos (Interview #1) and entailed a strong odor that led to respiration difficulties (Interview #1, #8 and #9). Stress was another major health impact caused by floods. This involved concerns on ways of coping with the flood water, financial damage and debts (Interview #1, #2 and #7). Further research on the interconnection of climate risks, wastewater and health impact would be required.

The other two component indexes, livelihood strategies and education, showed a more moderate vulnerability with 0.407 and 0.442 respectively. It was found that half of the surveyed households depend on agricultural farming as major source of income (0.506) and more than half of them

indicated that they use more than 50% of the harvest for their own consumption (0.640) while two third stated that their agricultural and fish farming was affected by the flood (0.704). The self-sufficiency in agriculture was considered a strength in the SLD stakeholders' self-assessment but at the same time a weakness due to the high flood risk in Pralab (SLD#1 and #2).

Rice farmers had a high crop damage because up to two meters deep floodwater remained for one to three months (for the lowest land areas) in the fields (Interview #2, #3, #5, #6, #7 and #8); some lost all rice harvest and investment (Interview #6 and #8). The golden apple snail outbreak contributed in some cases to crop loss (Interview #3 and #7). Fish farmers also reported a high loss of fish stock due to floodwater remaining in ponds for up to four months as well as stolen fish (Interview #1). Moreover, livestock farmers also experienced significant income decreases; for instance a swine farmer reported an 85% income deficit due to floods in 2011 (Interview #4).

As Pralab is a mixed rural-urban area, a large proportion of its residents is still pursuing farming activities to secure their livelihood although already almost half of the households have at least one family member working outside of Pralab (0.458). This was significant for some farmers to prevent higher livelihood loss during floods (Interview #3, #4, #5, #6, #7, #8 and #9). Permanent or temporary employment in sales assistance (Interview #3 and #7) or construction (Interview #4) for instance (Interview #7) are considered a more secure way to sustain a household than farming. KKc's urban growth provides also further employment opportunities for Pralab's residents who target a stable income (SLD#1 and #2).

The livelihood of those farmers who rely on their own rice farming for major food intake and who pursue no additional employment are most affected by severe flooding (Interview #1 and #4). The adaptive capacity to secure their income and food consumption are highly reduced.

The index for household heads who have only primary school education is relatively high (0.873) which is another significant indicator that makes the community more vulnerable to adapt to severe floods. Agricultural production with increasing climate uncertainty lead farmers to sell their land and invest into their children's education to provide them a more secured future (Interview #1). This had been accompanied by an increasing trend with a change from a modest rural to a cost-extensive urban lifestyle (SLD#2). Many may already be dependent on their children's or relatives' financial support in order to sustain their livelihood.

4.1.2.2 Vulnerability of Natural Capital

The index of Pralab's natural capital shows with 0.359 rather moderate high vulnerability. Pralab has a relatively low landless household index (0.131) but a high number (70%) of households with small land ownerships (less than 10 rai) which makes the land component index moderately high with 0.357. Out of nine interviewed households, all owned their house but only five their farmland (Interview 3, #5, #6, #7 and #8) while two were renting farmland (Interview #1 and #4).

However, it is anticipated that with further urbanization, the demand for a more luxury lifestyle and need to finance a good education for the children as well as land speculation and higher climate

uncertainty, more farmers will sell their land to developers. The low land price in Pralab was also stated as a strength in the self-assessment of SLD stakeholders (SLD#1). Most interviewed households emphasized the lack of interest into farming among the young generations due to low financial stability (Interview #1, #4, #5, #6, #7 and #8).

The natural capital index is also largely shaped by the fact that 95.8% of the surveyed households can only cultivate the 1st or 2nd rice crop. This also adds to the vulnerability of the index for the natural resources component which is relatively high with 0.501. Although the majority of the farmers receive irrigation water from the canals provided by the RID and do not rely only on rainwater, almost half of the surveyed households (46.6%) claimed that their farming activities (rice, vegetables and fish) were affected by the low water surface quality in Pra Keu stream, particularly. This was also emphasized in the SLD stakeholders' self-assessment (SLD#1 and #2) and interviews wherein one household claimed that her family had to stop vegetable farming along Pra Keu stream due to the heavy wastewater contamination (Interview #2).

The overall index for the natural disasters and climate variability component remained rather low with 0.217. It must be noted that the drought impact had not been included into the index to keep the focus on the flood issue. In the past 15 years, an average number of 2.3 of severe floods had been indicated by the surveyed households. However, many households explained that they face yearly 'light' flooding that comes with the monsoon (Interview #6, #8 and #9).

The low flood warning index (0.260) is a rather good indicator for the disaster warning system in Pralab and reflects the average satisfaction of the surveyed households with the municipality's disaster prevention and mitigation action in the past. However, in the self-assessment of the SLD stakeholders it was emphasized that the early warning system still requires improvement (SLD#2).

4.1.2.3 Vulnerability of Social Capital

The index of the social capital vulnerability was found to be low with 0.257 which is mostly attributed to the low socio-demography vulnerability (0.193). The dependency ratio index shows low-moderate vulnerability (0.329) as the proportion of people between the age of 15 and 65 was twice as high as the proportion of those below 15 and above 65 years among the surveyed households. The percentage of female household heads is however rather low with 26.7%. However, in the SLD stakeholder's self-assessment, it was emphasized that the proportion of household members who work in agricultural production reached already middle to high age (SLD#1).

The social networks vulnerability was moderately high with 0.322 due to the high number of households that received help during flood. The solidarity among the surveyed households in Pralab was found to be relatively good with a low index of 0.114, although one third of them indicated not to be engaged in a neighborhood-support-network for floods (0.338). In the SLD stakeholders' self-assessment, the strong community solidarity in Pralab was highlighted as a crucial strength (SLD#1 and #2). With further urbanization and expected lifestyle change, new residents may also bring more crime and drug abuse to the area (SLD#1).

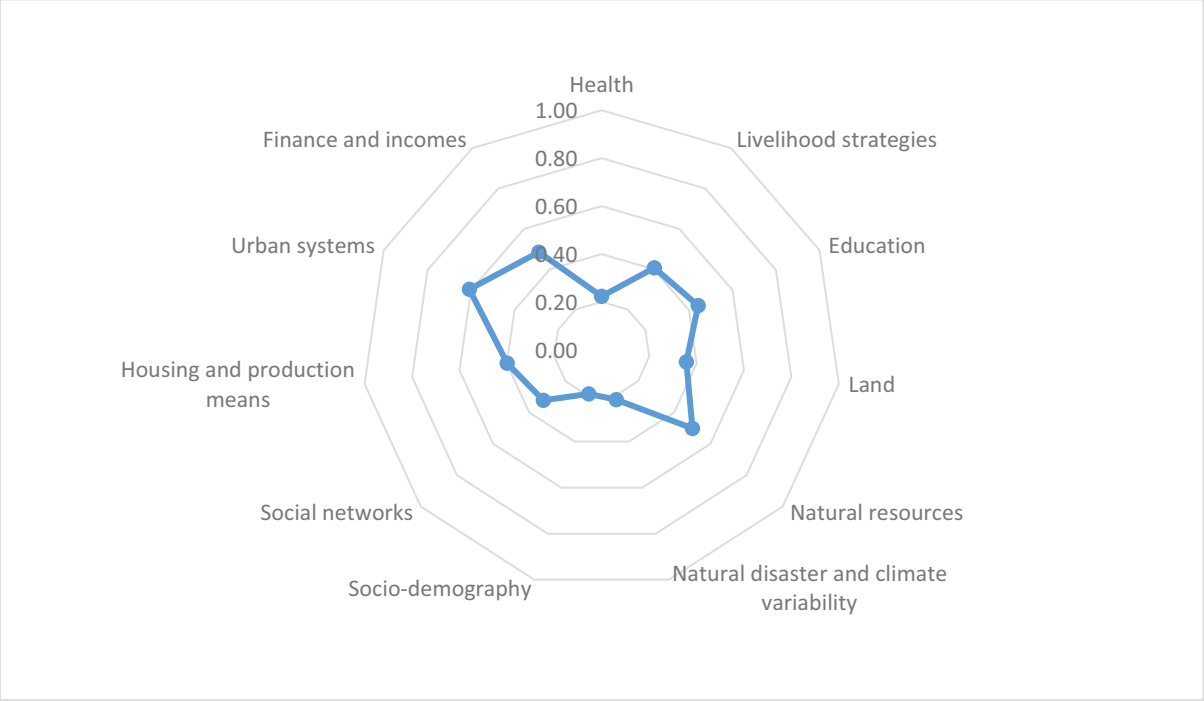


***Figure 15**: Vulnerability diagram of the major components of LVI for Pralab*

4.1.2.4 Vulnerability of Physical Capital

Pralab's physical capital index shows highest vulnerability with 0.503. This is largely due to the moderately high urban systems component index (0.607) with a lack of an adequate wastewater treatment system (0.920) and inadequate access to roads and streets during flood (0.589). The housing and production means index component was found moderately vulnerable with 0.398 which was mostly attributed due to the long duration of floodwater (more than 7 days) in the area (0.768) and houses (0.814). This is the most recent severe flood experience of Pralab from 2011. It was pointed out that floodwater reached up to two meters depth in the fields (Interview #1, #4 and #5) and an average of 30 centimeters for more than 7 days in the house (Interview #2, #5 and #9).

The damage to houses (partially to totally submerged) was indicated by the survey households rather low with an index of 0.186 while they have good housing quality (0.013) with a full-construction. One interviewee claimed that her house totally collapsed as it was built on an on-eroded stream bank (Interview #9), and others had to move temporarily to another house (Interview #5 and #9).

4.1.2.5 Vulnerability of Financial Capital

The index of the financial vulnerability (same as the finance and incomes component index) was found to be second highest after the physical capital vulnerability with 0.485. This capital refers largely to how people in Pralab cope with severe flooding. About two-third of the surveyed households (77.3%) reported a significant income reduction or no income due to flood damages with respect to their farming practices. More than half of the surveyed households also indicated to have large financial debts (52.3%; Interview #1, #4, #7 and #9), have no insurance or did not receive compensation

(Interview #8 and #9) that was not sufficient to recover the losses due to the severe flood (53.2%) and have a household net income that is lower than 100,000 Thai Baht per year (59.1%).

The financial damage ranged between 50,000 (Interview #3 and #4) and 300,000 Thai Baht (Interview #1). In general, several farmers emphasized in the interviews that the government compensation was not sufficient to recover from flood losses (Interview #1, #2, #3, #4, #5 and #6). The self-assessment of SLD stakeholders found that many households have already debts from agricultural activities which makes them more sensitive to financial losses (SLD#1 and #2).

The vulnerability index of households that borrowed up to 120,000 Thai Baht, from the bank (Interview #1) or the Village Fund (Interview #2), after the severe flood is relatively low with 0.169 but moderate for the index of households that reported not to have enough savings to recover from flood damages (0.321).

The high financial capital vulnerability is significant for the adaptive capacities of the community in Pralab. If the municipality will be hit again by a severe flood, the financial capital vulnerability will be even higher and as in the analysis of the natural capital vulnerability was already found, more community members will be forced to sell their land.

4.1.2.6 Livelihood Vulnerability Index-Intergovernmental Panel on Climate Change of Pralab

In the LVI-IPCC analysis it was found that the vulnerability index was with -0.069 relatively low as the scale of the LVI-IPPC ranges from -1 (least vulnerable) to 1 (most vulnerable). Figure 16 illustrates a vulnerability triangle that employs the contributing factor scores for the LVI-IPCC, including exposure, adaptive capacity and sensitivity (LVI-IPCC = (exposure - adaptive capacity)*sensitivity). Table 6 (annex II) describes the major components for the respective contributing factors of the LVI-IPCC for Pralab. The contributing factor of exposure that is based on the natural disaster and climate variability component was found to be relatively low (0.217).

The adaptive capacity of Pralab was scored moderately high (0.387), based on the major components, including livelihood strategies, education, socio-demography, social networks, finances and incomes and housing and production means. However, the sensitivity of Pralab's vulnerability was found to be significantly high (0.407), taking into account the components, health, land, natural resources and urban systems. This could conclude that if Pralab experience more frequent and severe floods in future and will develop more new infrastructure with a poor drainage piping system, and not improve the land and water governance, more people will sell their land and farmers might not even be able to cultivate their 2nd crop.

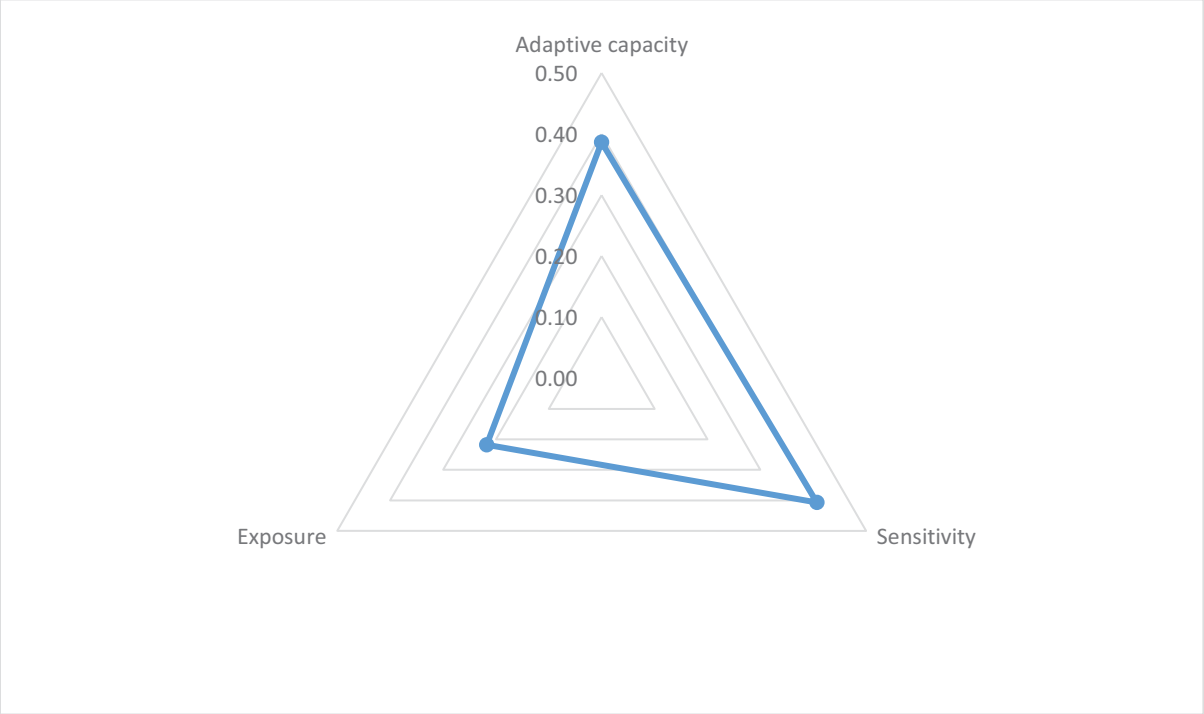


Figure 16: *Vulnerability triangle of LVI-IPCC factors for Pralab*

Although the exposure factor was found to be relatively low in the LVI-IPCC, it must be noted that Pralab experiences - in comparison to other municipalities in KKc - higher exposure to floods due to the water runoff from higher situated areas with larger water volume and duration of floodwater.

A self-assessment of SLD stakeholders of the three contributing factors for the LVI-IPCC emphasized that the location of the land in the low areas of KKc (SLD#1 and #2) and high financial insecurity in the event of flood (SLD#1)[15] due to agricultural loss are central for the high sensitivity of Pralab to flood (SLD#1 and #2). Moreover, the ineffective flood prevention and mitigation by the government as well as inefficient governance between government and communities were stated as contributing factors (SLD#2).

The relatively high scored adaptive capacity of Pralab was attributed in the self-assessment to the strong community solidarity and networks that provide help during and after flooding (SLD#1 and #2) as well as alternative income earning (SLD#1). In addition, the given support by the government which refers to the setting-up of pumping stations (SLD#2) and governmental fixed compensation for flood damage (SLD#1) were also mentioned as contributing factors.

[15] Community members considered the high financial insecurity as part of the sensitivity factor of the LVI-IPCC and not – as defined in this research - part of the adaptive capacity.

4.2 Responses to Flood

Current urbanization trends and changes in rainfall patterns indicate the need for a change of thinking from a short-term "predict and prevent" to a long-term adaptive approach to reduce the vulnerability of the livelihoods in the flood-prone Pralab and strengthen climate resilience. In the self-assessments of the SLD stakeholders and interviews (SLD#1 and #2), it was found that flooding in Pralab could not be completely prevented due to the situation in the low-lands but more efficient ways need to be found to reduce the impact of flooding and to cope and adapt to flooding (SLD#1 and #2). Households in Pralab are required to move out of self-sufficient agriculture in the long-run to increase their adaptive capacity to further floods (SLD#1 and #2). This includes taking up of alternative employment that guarantees a stable income and a change in agricultural production to more water-resistant crops (SLD#1 and #2). The elevation of land and houses and selling or renting out of agricultural land would lower their sensitivity to future floods (SLD#1 and #2).

At the same time, government agencies ought to improve the urban governance with respect to (i) disaster prevention and mitigation planning, (ii) land use planning, (iii) water governance, (iv) infrastructure development, (v) wastewater treatment, and (vi) solid waste management (SLD #1 and #2). The development of an efficient disaster prevention, mitigation and relief plan, and flood risk management plan are essential to better prepare for and cope with flooding (SLD#2). It was emphasized that the early warning system is rather confusing and governance between different governmental authorities and the community still weak (SLD#2).

The enforcement of the new city land use plan that is currently in approval process is considered as crucial to prevent and mitigate flood impacts in Pralab (SLD#2). However, the plan will still take up to two years or more to become effective (Interview #I). The establishment of more permanent water pumps[16] along Chi River that would pump out water from high flood risk areas to Chi River was considered useful to reduce flooding (SLD#1 and #2). Yet, a timely discharge of existing rainwater out of the area before water runoff from central KKc areas reaches Pralab during rainy season would be more efficient in the understanding of policy makers and experts; concrete measures have yet to be formulated (SLD#2). The establishment of a new water gate upstream of Pra Keu stream represents another strategy to prevent and mitigate the flood risk in Pralab (SLD#1). Nevertheless this would cause flooding in the area between Pra Keu stream and Phong River (Interview #G).

The introduction of new criteria for major drainage pipes is necessary to support an efficient water runoff (Interview #A). This is currently in planning for major risk areas in NKK municipality but would be an important requirement for the whole city (Interview #A). The relevant regulation for land and house elevation also needs revision and stronger enforcement to ensure efficient house drainage system and larger water run-off areas (Interview #A and #B).

The installation of a decentralized wastewater treatment system with smaller plants in different municipalities is needed to tackle the water surface quality contamination of Pra Keu stream and prevent possible skin infections caused by polluted floodwater (Interview #D). This practice would be more efficient because a centralized system requires high investment and operation costs but the lack

[16] Currently, pumps at the D9 and D10 gate along Chi River are only provided in the event of heavy rainfall, however, this also depends on the municipality request and availability as these pumps are shared between different municipalities and provinces in Thailand (Interview #G).

of budget does not allow such installation at the moment (Interview #D). The improvement of the overall solid waste management would also be necessary to reduce water contamination during flooding and the blockage of grids (Interview #A).

Communities in Pralab apply a number of strategies to cope with and adapt to flooding. However, it was observed that most households rather start thinking about coping strategies in the actual event of flooding than considering long-term adaptive strategies. Policy makers and experts have a clearer understanding of how current strategies – at both household, community and government agency level - could be improved to mitigate the extent of flooding and vulnerability of Pralab's communities.

Table 1 and 2 present current and future coping strategies and adaptive strategies respectively, based on the interviews with communities, policy makers and experts, and self-assessments from SLD stakeholders.

Table 1 – Current and future coping strategies

	Coping Strategies
Households	Moving of valuable items placed on ground level to upper level temporarily (Interview #2, #3 and #6; SLD#1 and #2) Preparation of rice and dried or preserved food for the event of flooding prior to rainy season (SLD#1 and #2). Preparation of medicine kit (SLD#2). Preparation of light bulbs and torch lights prior to rainy season (SLD#1). Moving of animals to higher or elevated level in the event of heavy rainfall (SLD#1). Covering of fish pond with net to prevent fish from being carried away with flood water (Interview #1). Catching of fish for food intake during flood, when road access is limited (Interview #1 and #2). Preparation of boats, fuel and fishing gear (SLD#2). Taking up of temporary work in construction or service sector during flood season (Interview #3 and #4). Timely preparation for evacuation in the event of flood (Interview #6). Collective pumping out of water from flooded paddy fields (Interview #7). Collective harvesting to speed up harvesting during or before flooding (Interview #8). Treatment of wastewater with effective microorganism (EM ball) to reduce strong odor in floodwater (Interview #6). Development of cropping calendar needed that match with rain pattern changes needed (SLD#2).

Village/Community		Flood warning sent to households in high risk areas needed (SLD#1). Set-up of community guards to send out flood warning to community members and to provide protection from potential thieves during flooding needed (SLD#1). Provision of more mobile toilets and boats needed (Interview #B; SLD#1). Preparation of sand bags (SLD#1). Establish shared rice warehouse in safe areas with a moisture control system needed (SLD#2). Develop community emergency response plan needed (SLD#2). Provision of flood emergency information and training to community members with yearly rehearsals needed (SLD#2). Efficient flood warning system needs to be established in each community (SLD#2).
Government Agencies	**Water Governance**	Provision of permanent pumps at D9 and D10 gate along Chi River to remove water in highly flooded areas along Chi River (SLD#1 and #2). Discharge existing rainwater in the area out before runoff water from central KKc areas reaches Pralab area during rainy season (SLD#2). Slow down flow rate of rainwater runoff from central KKC areas in order to save time for flood preparedness and prevention (SLD#2). Build a new canal from highly flooded area to Pra Keu stream (SLD#1). Repairing of existing water gates D9 and D10 needed (SLD#1). Timely closing of dam gate if the water capacity of Phong and Chi River are too high and capacity of dam not yet reached (Interview #H). Development of regulation for rainwater storage in built urban environment needed (SLD#2).
	Disaster Prevention and Mitigation	Revision of disaster prevention and relief plan prior to flood needed (SLD#2). Development of flood risk management plan needed (SLD#2). Improve weather forecasting system to plan harvesting in a timely manner, before flooding needed (SLD#1).

	Improvement of early warning system with simple modeling for local authority needed (Interview #A and #B; SLD#2). Khon Kaen Water Management Committee meeting if dam water level is high of rivers exceed maximum level (Interview #D and #H). Provision of food packs (Interview #B; SLD#1). Provision of medicine kits to community as well as knowledge on disease risks during flood needed (Interview #B; SLD#1) Provision of flood damage compensation (Interview #B: SLD#1). Provision of boats and vehicles to communities during flood needed (SLD#2). Provision of solar cells to communities during flood needed (SLD#2). Strengthened security system during flood needed (SLD#2). Provision of mobile clinics (Interview #B and #E). Development of risk management funds to support affected community members needed (SLD#2). Provision of community flood disaster insurance needed (SLD#2).
Land Use Planning	Municipality land use plan regulation to bridge time until new city land use plan is approved to prevent further land use changes that would exacerbate flooding needed (Interview #A).
Wastewater management	Restriction of number of permitted fish farms along Phong River was an important strategy to reduce water pollution caused by dead fish from overfishing and fish food (Interview #D). Provision of simple water treatment (membrane process) to communities needed (SLD#2).
Solid Waste Management	Cleaning of drainage grids in the event of heavy rainfall in major risk areas needed (Interview #A).

Table 2 – Current and future adaptive strategies

Adaptive Strategies	
Households	Taking up of permanent job with a stable income needed (Interview #3; SLD#1). Change to more water-resistant crops to reduce harvest loss during flood needed (Interview #4; SLD#1 and #2).

		Moving of valuable items placed on ground level to upper level permanently (Interview #2 and #6). Elevation of house and land above average flood level (Interview #3; SLD#1). Moving of electricity meter to higher level (SLD#1). Renting out or selling of farmland permanently – needed (Interview #3).
Government Agencies	**Water Governance**	Building of a new water gate at upstream of Pra Keu stream needed (Interview #G; SLD#1). Pump at D8 gate at the downstream of Pra Keu stream to pump water from Pra Keu stream to Chi River (Interview #B and #G). Canal walls along Chi River and Pra Keu stream send water to farming and serve as flood walls to prevent inundating (Interview #G). Building of another flood wall along Phong River to prevent inundation into Pralab area needed (SLD#2). The criteria for the minimum and maximum water level (currently: 175M.MSL and 182 M.MSL respectively) had been adjusted after the 2011 flood; these criteria may need to be adjusted again in future (Interview #H).
	Disaster Prevention and Mitigation	Telemetering stations have been established in 2010 by Ubolratana Dam around Chi River Basin to monitor rainfall and water level; real time statistics are collected every 15 minutes and are online accessible (http://nehcc-inter.egat.co.th) with a warning system (Interview #H; SLD#2). Setting up of precipitation meter in Pralab for own monitoring neeed (SLD#2).
	Land Use Planning	New city land use regulation that is in approval process would prevent further infrastructure development in flood prone areas in the east-south of KKc (Interview #I).
	Infrastructure Development	New criteria for major drainage pipes needed; currently in planning for NKK municipality in major risk areas (Interview #A). Clearing up of drainage piping systems needed (SLD#1). Regulation for land and house elevation needs improvement to ensure efficient house drainage system and larger water run-off areas (Interview #A and #B). Provision of information on water drainage and natural floodway to communities (SLD#1).

	Elevate roads (as a flood wall as well) above average flood water level (SLD#2).
	Improvement of road conditions (SLD#1).
Wastewater management	The installation of a decentralized wastewater treatment system with smaller plants in different municipalities is needed because the centralized system requires high investment and operation costs (Interview #D).
	Stricter monitoring of fulfillment of requirements for general wastewater discharge from factories (Interview #D).
	Introduction of new carrying standards and restriction of number of permitted factories operating because amount of effluent discharged to water body is too high and affects the water quality (Interview #D).
Solid Waste Management	Improvement of solid waste management to prevent drainage grids from being blocked by waste in the event of heavy rainfall and prevent water contamination in the event of flood needed (Interview #A; SLD#1).

It must be noted that community members gave highest priority in their formulation of coping and adaptive strategies to the (i) setting-up of permanent pumping stations along Chi River, (ii) strengthening of municipality laws on land elevation, and (iii) searching for permanent employment to secure a stable income (SLD#1). Policy makers and experts, however, gave highest priority to the (i) discharge of existing rainwater out of the area before runoff water from central KKc areas reaches Pralab area during rainy season, (ii) establishment of a flood wall along Phong River, and (iii) development of a cropping calendar that considers rain pattern changes (SLD#2).

Although the new city land use plan regulation was mentioned in the SLD with policy makers and experts as an important institution to mitigate flood in Pralab, it had not been given any priority in the self-assessment. The focus on the improvement of water governance and the disaster prevention and mitigation plan may be considered a more effective strategy at the moment as the new land use plan regulation has yet to be approved. A municipality land use plan regulation in Pralab that considers flood risk areas, however, had not been given any attention in the self-assessments.

5. DISCUSSION AND RECOMMENDATIONS

The case study of Pralab is exemplifying for the challenges of a Thai community that is situated in the flood-prone fringe areas of a secondary city and placed in a transition process of livelihood strategies. More and more community members exit rural self-sufficient agricultural practices and enter an urban lifestyle, induced by increasing urbanization and climate uncertainty. Growing financial insecurity due to agricultural losses and resulting debts that have accumulated over time is a major reason for a livelihood change in Pralab. Although farmers in Pralab are connected to the royal irrigation system, agricultural farming became too risky as major source of living and alternative employment with a regular income presents a more secure option. Despite governmental compensation for flood damage caused by the most recent severe flood in 2011, many farmers still struggle to recover from the losses. If another severe flood strikes the area, some farmers might be forced to sell their land in order to square their debts.

Pralab's residents, however, have a good capacity to adapt to floods, given their balanced household dependency ratio and common house and land ownership. The community has a high solidarity and strong social networks that provide fundamental support in the event of flooding. These capabilities represent a starting position to formulate efficient adaptive strategies for Pralab's residents. Moreover, community members are aware of the necessary transitions in their livelihoods but due to their lifelong occupation in agriculture they may still have difficulties to accept the need to change their traditional practices. Health had also been a central concern among community members. The last severe flood in 2011 caused skin infections, food contamination and mental stress. Further research on the interconnection of wastewater in flood events and health impacts would be useful.

The 2011 century flood was crucial to enable policy makers to rethink current strategies that address severe flooding situations. However, local government stakeholders still have difficulties in defining and implementing relevant responses to flood. There is a common consensus among KKc's city leaders that urbanization is closely interdependent with climate change impacts, and careful and inclusive urban planning is required. It is also understood that floods are not merely a natural hazard but influenced by social and political processes, i.e. weak water governance, poor infrastructure development as well as unregulated land use changes.

The essential institutional mechanism to cope with flood is the provincial disaster prevention and mitigation plan. Although Pralab's communities showed satisfaction with the governmental flood management, the plan still appears to lack in an efficient action plan as well as good governance among different government offices and administrative levels. This refers mainly to an early flood warning system that needs to be improved and made practically for local authorities as well as timely and adequate provision of emergency boats, mobile toilets, medicine kits and food in the event of severe flooding. It was pointed out that the municipality had to borrow mobile toilets from Bangkok in 2011 as the provincial office was incapable to provide a sufficient amount.

The theft prevention system also requires improvement to guarantee security during flooding. Particularly, the flood damage compensation system needs to be strengthened. Complex procedures can increase the financial vulnerability of communities. Notwithstanding that the Thai Government had set up a National Catastrophe Insurance Fund in 2012, as of 2017, agricultural activities were not included (Singkran, 2017). Thus, the introduction of a community flood disaster insurance fund for

farmers who are unable to purchase flood insurances with high premiums is a useful suggestion. At the community level, a flood emergency response plan with yearly rehearsals would also be needed to raise awareness on flood risks and appropriate responses.

The lack of a coherent flood risk management and passive community participation had been significantly criticized by local stakeholders. The actual local needs of communities find limited reflected in relevant plans. The provincial plan rather adopts top-down policies from the national umbrella plan (Singkran, 2017) that leaves more confusion than clarity at the local level. Hence, a two-way communication between national, provincial and local administrative bodies and the communities themselves needs to be employed to enable good flood governance. Centralized systems tend to reduce the local capacities to prepare, respond and recover from flood disasters (Lebel et al., 2010).

The key institutions to foster climate resilience and improve urban governance that determines the extent of flooding on the long run in Pralab are recommended as following:

(i) The new 2015 land use plan regulation that is currently in approval process. The Provincial Office of Public Works and Town and Country Planning is urged to request a fast-tracking of the regulation's approval process in order to prevent further improper land use changes and more severe flooding in Pralab. This plan will turn half of Pralab into a conservation area and limit the development of new infrastructure – both roads and buildings – that could exacerbate flooding in the event of heavy rainfall.

(ii) Governance with respect to flood disaster prevention and mitigation between relevant governmental offices and local residents needs to be strengthened through the coordinating institution, the Provincial Disaster Prevention and Mitigation Office, by initiating planning meetings that involve also community leaders in order to deliver timely and efficient services to communities.

(iii) The establishment of a new water gate upstream of Pra Keu stream would reduce the flood risk in Pralab significantly but may be difficult to implement as the communities living in the targeted area would face flooding. The RID would need to reassess the situation and develop the relevant project proposal in accordance with the local communities. Efficient water governance is a difficult and sensitive topic in KKc because investment is high and the problem of flooding often only moved to another area by diverting the runoff water.

(iv) The revision of used drainage piping system criteria in relevant policy documents could decrease floods in central KKc and Pralab and divert the runoff water into different areas. This may also be an important measure to reduce and slow down the floodwater from NKK before it reaches Pralab. NKK municipality which is currently developing a new criteria set and plans to exchange major pipes in flood risk areas in NKK would need to coordinate with other municipalities in KKc, particularly Pralab, and share the newly developed criteria. Budgeting plans have to be established in coordination with the Provincial Office of Public Works and Town and Country Planning.

(v) Land, house and road elevation regulations require proper monitoring and enforcement by the local government offices, including Pralab municipality, in order to ensure efficient water runoff.

(vi) The establishment of decentralized wastewater treatment systems would reduce the health risk during flooding and contamination of fish farms. All five municipalities, including Pralab and NKK, are required to initiate consultative dialogues led by the Regional Environmental Office 10 and the RID and supported by academic experts to develop concrete and realistic plans for cost-effective decentralized wastewater treatment systems.

The land and water use as well as infrastructure management are in particular critical systems in KKc and Pralab. If the described institutions were strengthened, these systems would obtain the needed flexibility to absorb sudden and cumulative floods which are likely according to rainfall weather forecasts for the next 50 years. Resilient agents are elemental to achieve urban climate resilience. They need to be responsive, resourceful and have the capacity to learn. Thus, Pralab communities in particular require knowledge on the underlying factors that exacerbate flooding, including the implications of improper land and house elevations, as well as efficient emergency preparation for ad hoc measures in the event of flooding and long-term adaptive strategies (e.g., alternative employment). The participation of communities in the development of disaster prevention and mitigation plans is hereby important to suit their needs and vital to guarantee equitable urban governance.

The decentralization of the administrative system in Thailand aimed to simplify policy making processes but finally created overlapping mandates, ambiguity and implementation gaps (Lebel and Lebel, 2017). A top-down structure remained that neglects the lack of skillful local governments as well as supports the concentrations of resources and capacities for flood management at a single and often high level (*ibid.*). This forms a central obstacle for the local governments in KKc to develop a long-term resilient approach and to build the needed institutional structures in order to address floods effectively.

6. CONCLUSION

In this research, the vulnerability of livelihoods of flood-prone Pralab community in the fringe zones of KKc was analyzed to reveal the underlying challenges that determine the extent of floods and capacity to adapt to the changing environment. Livelihood changes with a transition from traditional self-sufficient livelihood practices towards employment with a stable income will be inevitable in view of increasing urbanization and changes of precipitation patterns with more frequent and intense floods. At the same time inclusive urban planning is required that mitigates flood hazards and allows active community participation. Local stakeholders need to push for the approval of a new and climate sensitive land use plan regulation, new criteria for the road drainage piping system and the establishment of a new water gate upstream of Pra Keu stream. Further studies are essential which provide suggestions on resolving the inefficient decentralized administrative system that impede a proper flood disaster prevention and mitigation governance.

7. REFERENCES

Adger, W.N., H. Eakin and A. Winkels (2009): Nested and Teleconnected Vulnerabilities to Environmental Change. *Frontiers in Ecology and Environment*, 7.3, 150-157.

Angelo, H. and D. Wachsmuth (2014): Urbanizing Urban Political Ecology: A Critique of Methodological Cityism. *International Journal of Urban and Regional Research*, 39:1, 16-27.

Chambers, R. and G.R. Conway (1992): *Sustainable Rural Livelihoods: Practical Concepts for the 21st Century*. International Development Studies Discussion Paper 296 [WWW document]. URL https://opendocs.ids.ac.uk/opendocs/bitstream/handle/123456789/775/Dp296.pdf?sequence=1 (accessed: 21 May 2017).

Can, N.D., S. Sophat, V. H. Tu, S. Khom and C.T. Hoanh (2014): Vulnerability of Livelihoods in Flood-prone Areas along the Cambodia-Vietnam Border. In: Lebel, L. C.T. Hoanh, C. Krittasudthacheewa and R. Daniel [Ed.]: Climate Risks, Regional Integration, and Sustainability in the Mekong Region. Petaling Jaya: Strategic Information and Research Development Centre, 97-122.

Can, N.D., V.H. Tu and C.T. Hoanh (2013): Application of Livelihood Vulnerability Index to Assess Risks from Flood Vulnerability and Climate Variability – A Case Study in the Mekong Delta of Vietnam. *Journal of Environmental Science and Engineering A 2,* 8, 476-486.

Delaware River Basin Commission (DRBC) (2007): Municipal Questionnaire for the Flood Mitigation Plan.

Department for International Development (DFID) (1999): *Sustainable Livelihoods Guidance Sheets* [WWW document]. URL http://www.ennonline.net/dfidsustainableliving (accessed 27 May 2017).

Demographic Health Survey (DHS) (2001): Measure DHS: Model "A" Questionnaire with Commentary for High Contraceptive Prevalence Countries. Basic Documentation, Number 1.

Etwire, P.M., R.M. Al-Hassan, J.K.M. Kuwornu and Y. Osei-Owusu (2013): Application of Livelihood Vulnerability Index in Assessing Vulnerability to Climate Change and Variability in Norther Ghana. *Research Journal of Environment and Earth Science*, 3:2, 157-170.

Farrington, J., T. Ramasut and J. Walker (2002): Sustainable Livelihoods Approaches in Urban Areas: General Lessons, with Illustrations from Indian Cases. Swedish International Development Cooperation Agency.

Flick, U. (2009): *An Introduction to Qualitative Research*. Fourth Edition. London: Sage.

Friend, R., Choosuk, C., Hutanuwatr, K., Inmuong, Y., Kittikornkool, J., Lambregts, B., Promphakping, B., Roachanakanan, T., Thiengburanathum, P., Thinphanga, P., and Siriwattanaphaiboon, S. (2016). Urbanizing Thailand. Implications for climate vulnerability assessments. Asian Cities Climate Resilience Working Paper Series 30.2016 [WWW document]. URL http://pubs.iied.org/pdfs/10770IIED.pdf. (accessed: 11 August 2016).

Hahn, M.B., A.M. Riederer and S.O. Foster (2009): The Livelihood Vulnerability Index: A Pragmatic Approach to Assessing Risks from Climate Variability and Change. A Case Study in Mozambique. *Global Environmental Change*, 19:1, 74-88.

International Joint Commission Red River Basin Task Force (1997): Assessment of the Social Impact of Flooding for Use in Flood Management in the Red River Basin.

Isvilanonda, S. (2010): Thailand Agriculture: The Country's Profile and Current Status. Agri Benchmark Cash Crop Conference, Knowledge Network Institute of Thailand [WWW document]. URL http://www.agribenchmark.org/fileadmin/Dateiablage/B-Cash-Crop/Conferences/2010/Presentations/Thailand_Isvilanonda.pdf (accessed: 28 May 2017).

Isvilanonda, S. and I. Bunyasiri (2009): Food Security in Thailand: Status, Rural Poor Vulnerability, Some Policy Options. Agricultural and Resource Economics Working Paper No. 2552/1: Department of Agricultural and Resource Economics.

Khajuria, A. and N.H. Ravindranath (2012): Climate Change Vulnerability Assessment Approaches DPSIR Framework and Vulnerability Index. *Earth Science and Climate Change*, 3:109, 1-6.

Lamichhane, K. (2010): *Sustainable Livelihood Approach in Assessment of Vulnerability to the Impacts of Climate Change: A Study of Chhekampar VDC, Gorkha District of Nepal*. Project Work submitted to the Kathmandu University, Center for Development Studies, National College, Baluwatar [WWW document]. URL http://www.forestrynepal.org/images/thesis/Thesis%20Final.pdf (accessed: 20 May 2017).

Lebel, L. and P. Lebel (2017): Policy narratives help maintain institutional traps in governance of floods in Thailand, *International Journal of Water Resources Development*. [WWW document]. DOI 10.1080/07900627.2017.1336989.

Lebel, L., J.B. Manuta and P. Garden (2010): Institutional traps and vulnerability to changes in climate and flood regimes in Thailand. *Regional Environmental Change*, 11, 45-58.

Leichenko, R. (2011): Climate change and urban resilience. *Current Opinion in Environmental Sustainability*, 3:3, 164-168.

Marks, D. (2015): The Urban Political Ecology of the 2011 Floods in Bangkok: The Creation of Uneven Vulnerabilities. *Pacific Affairs*, 88:3, 623-651.

Mayring, P. (2014): Qualitative content analysis: theoretical foundation, basic procedures and software solution. Klagenfurt. [WWW document]. URL http://www.ssoar.info/ssoar/bitstream/handle/document/39517/ssoar-2014-mayring-Qualitative_content_analysis_theoretical_foundation.pdf?sequence=1 (accessed 12 April 2017).

Mayring, P. (2000): Qualitative content analysis. *Forum Qualitative Social Research*, 1.2, Art. 20 [WWW document]. URL http://www.qualitative-research.net/index.php/fqs/article/view/1089/2385 (accessed 18 April 2017).

Moench, M., S. Tyler and J. Lage (eds.) (2011) *Catalyzing Urban Climate Resilience. Applying Concepts to Planning Practice in the ACCCRN Program (2009-2011)*. Institute for Social and Environmental Transition-International, Colorado.

Moser, C. (2011): *A Conceptual and Operational Framework for Pro-Poor Asset Adaptation to Urban Climate Change*. In: Hoornweg, D., M. Freire, M.J. Lee, P. Bhada-Tata and B. Yuen [Ed.]: Cities and Climate Change: Responding to an Urgent Agenda. World Bank [WWW document]. URL http://siteresources.worldbank.org/INTURBANDEVELOPMENT/Resources/336387-1256566800920/6505269-1268260567624/Moser.pdf (accessed: 21 May 2017).

Northeastern Meteorological Center (n.d.): (in Thai) [WWW document]. URL http://www.khonkaen.tmd.go.th/home.php (accessed 20 March 2017).

Pollution Control Department (n.d.): Ministry of Natural Resources and Environment (in Thai) [WWW document]. URL http://www.pcd.go.th/info_serv/reg_std_water05.html (accessed: 1 July 2017)

Promphakping, B., Y. Inmuong, W. Photaworn, M. Phongsiri and K. Phatchanay (2015) Climate Change and Urban Health Vulnerability. Asian Cities Climate Resilience Working Paper Series 31.2016 [WWW document]. URL http://pubs.iied.org/pdfs/10774IIED.pdf (accessed 20 March 2017).

Reed, S.O., R. Friend, V.U. Toan, P. Thinphanga, R. Sutarto and D. Singh (2013) "Shared learning" for building urban climate resilience – experiences from Asian cities. *Environment and Urbanization*, 25.2, 393-412.

Ricepedia (2013): Thailand [WWW document]. URL http://ricepedia.org/thailand (accessed: 22 May 2017).

Singkran, N. (2017): Flood Risk Management in Thailand: Shifting from a passive to a progressive paradigm. *International Journal of Disaster Risk Reduction*. URL https://doi.org/10.1016/j.ijdrr.2017.08.003 (accessed 28 September 2017).

Sullivan, C. (2002): Calculating the Water Poverty Index. *World Development*, 30:7, 1195-1210.

Swyngedouw, E., M. Kaika and E. Castro (2002): Urban Water: A Political-Ecology Perspective. *Built Environment*, 28:2, 124-137.

Thaiwater (2015): *Drought Record for 2014 and 2015* (in Thai) [WWW document]. URL http://www.thaiwater.net/current/drought58/drought58.html (accessed 15 January 2017).

Thaiwater (2011): *The Great Flood Year* (in Thai) [WWW document]. URL http://www.thaiwater.net/current/flood54.html (accessed 15 January 2017).

United Nations Development Programme (UNDP) (2015): Training Material for Producing National Human Development Reports [WWW document]. URL http://hdr.undp.org/sites/default/files/hdi_training.pdf (accessed: 28 May 2017).

United Nations General Assembly (2016): Policy Paper 4: Urban governance, capacity and institutional development. Preparatory Committee for the United Nations Conference on Housing and Sustainable Urban Development (Habitat III). Third Session. Surabaya, Indonesia, 25-27 July 2016 [WWW document]. URL http://habitat3.org/wp-content/uploads/Policy-Paper-4-English.pdf (accessed 2 November 2017).

United Nations Habitat (2016): 6 – Urban Governance. Habitat III Issue Papers. New York, 31 May 2015 [WWW document]. URL http://habitat3.org/wp-content/uploads/Habitat-III-Issue-Paper-6_Urban-Governance-2.0.pdf (accessed 2 November 2017).

United Nations (2004): The Kingdom of Thailand. Public Administration Country Profile [WWW document]. URL http://unpan1.un.org/intradoc/groups/public/documents/un/unpan023244.pdf (accessed 30 June 2017).

Urothody, A.A. and H.O. Larsen (2010): Measuring Climate Change Vulnerability: A Comparison of Two Indexes. *Bangko Janakari,* 20:1, 9-16.

Witzel, A. and H. Reiter (2012): *The Problem-Centred Interview*. London: SAGE Publications.

World Bank (1997): Survey of Living Conditions: Uttar Pradesh and Bihar. Household Questionnaire, December 1997 – 1998.

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8. ANNEX I: PLAN OF IMPLEMENTATION

	ACTIVITY	Output	TIMEFRAME								
			January	February	March	April	May	June	July	August	September
1	Collection of socio-economic secondary data	Compiled data	x	x	x						
2	Collection of historical secondary data on urbanization and climate variability	Compiled data	x	x	x						
3	Identify and meet key stakeholders of relevant government agencies	Meeting reports			x						
4	Analyze collected secondary data	Analyzed data, including plans, diagrams, maps and photographs			x	x					
5	Develop conceptual and analytical framework	Document on frameworks			x	x					
6	Write-up desktop review	Review document				x					
7	Write-up 1st progress report	Progress report				x					
8	Development of household survey and interview questionnaires	Questionnaires					x				
9	Conduction of household survey and interviews	Field visit report						x	x		
10	Write-up 2nd progress	Progress report						x	x		
11	Analyze survey and interview data	Analyzed data						x	x		
12	Conduction of two SLDs	2 meeting reports									x
13	Analyze SLD outcomes	Policy brief									x
14	Write-up final report	Final report									x
15	Write-up journal article	Article									x

9. ANNEX II: LIVELIHOOD VULNERABILITY INDEX

Table 1 - Livelihood Vulnerability Index – Types of Capitals, Major and Sub-Components

Capital	Major component		Sub-component/Indicator	Survey Question/Source of Data	Reference
Human					
H1	*Health*	H1	HH with family member with illness (%)	Is anyone in your family chronically ill or gets sick very often?	Adapted from DHS (2001) Adapted from Hahn, Riederer and Foster (2009)
		H2	HH with family member ill due to floods (%)	Did anyone in your family get chronically ill or got sick very often due to the flood?	Adapted from Can et al. (2014) Adapted from DRBC (2007)
		H3	HH with family members with diarrhea, dengue incident, pneumonia, or skin infection (during/after flood) (%)	Did anyone in your family suffer from diarrhea, dengue incident, pneumonia, or skin infection during or after a severe flood?	Developed for the purposes of this questionnaire.
		H4	HH with no medical insurance to cover health services and treatment expenses (during or after flood) (%)	Do you have a medical insurance to cover health service and treatment expenses during and after flood?	Developed for the purposes of this questionnaire.
H2	*Livelihood strategy*	LS1	Average agricultural livelihood diversification [1/ (number of agricultural livelihood activities + 1)] (1/#crops) (range: 0.20-1)[17]	Do you or someone in your household raise animals? Do you or someone else in your household grow crops? Do you or someone else in your household farm fish?	Adapted from World Bank (1997)
		LS2	HHs dependent on agriculture as major source of income (%)	Does your household depend on agricultural farming as a major source of income?	Developed for the purposes of this questionnaire.
		LS3	HHs dependent on fish farming as major source of income (%)	Does your household depend on fish farming as a major source of income?	Developed for the purposes of this questionnaire.
		LS4	HHs with agricultural/fish farming that was affected by flood (%)	Does your farming (agricultural/fish) get affected by flood?	Developed for the purposes of this questionnaire.
		LS5	HHs that use more than 50% of harvest for own food consumption (%)	Does your household use more than 50% of your harvest for own food consumption?	Developed for the purposes of this questionnaire.
		LS6	HH with family members employed outside of Pralab (at least one) (%)	Do you or someone else in your household work outside of the community (at least one; other municipalities, cities)?	Adapted from World Bank (1997)

[17] Some indicators such as the Livelihood Diversity Index were created because an increase in the crude indicator, in this case, the number of livelihood activities undertaken by a household, decreases vulnerability (e.g., a household who farms and raises animals is less vulnerable than a household who only farms) so by taking the inverse of the crude indicator, we create a number that reflects this line of reasoning and assigns higher values to households with a lower number of livelihood activities.

		LS7	HH with family member unemployed (during flood season) (%)	Are you or someone else in your household jobless/unemployed during/after flood?	Adapted from International Joint Commission Red River Basin Task Force (1997)
H3	*Education*	E1	HHs: head illiterate (%)	Did you or someone else in your household never go to school?	Adapted from DHS (2001)
		E2	HHs: head with only primary school education (%)	Did you or someone else in your household visit school only until 6/9th grade?	Developed for the purposes of this questionnaire.
		E3	HHs: head not trained to cope with flood (%)	Did you or someone else in your family not receive training on how to cope with flood?	Developed for the purposes of this questionnaire.
Natural					
N1	*Land*	L1	Landless HHs (%)	Does your household not own land?	Adapted from International Joint Commission Red River Basin Task Force (1997)
		L2	HHs with land leasing (%)	Did you own land before and sell it?	Developed for the purposes of this questionnaire.
		L3	HHs with small land (10 rai) (%)	Is the land you own/lease/farm smaller than 10 rai?	Developed for the purposes of this questionnaire. Reference for 10 rai: Isvilanonda, S. and I. Bunyasiri (2009)
N2	*Natural resources*	NR1	HHs that did not cultivate 3rd crop (%)	How many crops did you cultivate?	Developed for the purposes of this questionnaire. Reference (for 3rd crop): Ricepedia (2013)
		NR2	HHs that depend on rainwater for rice farming (%)	If your household is doing agricultural farming, do you depend only on rainwater for rice farming?	Developed for the purposes of this questionnaire.
		NR3	HHs that are affected by wastewater through stream/rivers for farming (%)	Do you feel affected by wastewater contamination of the natural water bodies (like the Pra Keu stream/Chi river) in your area?	Developed for the purposes of this questionnaire.
N3	*Natural disasters & climate variability*	ND-CV1	Average number of severe floods in the past 15 years (No) (range: 0-6)	How many times has this area been affected by severe flood in the past 15 years?	Adapted from DRBC (2007)
		ND-CV2	HHs did not receive flood warning (%)	Did your household receive an adequate flood warning from the government in past 15 years before the flood happened?	Adapted from International Joint Commission Red River Basin Task Force (1997)
		ND-CV3	Mean standard deviation of average precipitation by month (average 10-15 years)	2002-2017: provincial data	Meteorological Department Khon Kaen Radar Inspection Station
Social					
S1	*Socio-Demography*	SD1	Dependency ratio (< 15 and > 65 years) – (((number of people aged < 15) + (number of people aged > 65))/ (number of people aged 15-64)) * 100 (%)	Could you please list the ages and sexes of every person who eats and sleeps in this house on a regular basis?	Adapted from DHS (2001)

		SD2	Female HHs head (male away from home > 6 months per year) (%)	Are you the head of the family? Does he/she live in your household?	Adapted from DHS (2001)
		SD3	Average family members in HHs (%)	How many family members do you have in your households?	Adapted from DHS (2001)
		SD4	HHs moved into area despite knowing that it is a flood prone area (%)	Did you move to Pralab area from other area? If yes, when did you move to Pralab? Did you know that Pralab is a flood-prone area when you moved there?	Developed for the purposes of this questionnaire.
S2	*Social Networks*	SN1	HHs received help because of flood (%)	Did relatives or friends help you because of flood? Did you receive support from the government during or after heavy flood?	Adapted from DHS (2001)
		SN2	HHs not engaged in neighborhood helping network during flood (%)	Does your community have collaborative neighborhood network for flood relief (during and after flood) and if yes, do you participate in this network?	Developed for the purposes of this questionnaire.
		SN3	HHs experience no solidarity in area (%)	Do you experience strong collaboration or solidarity in your neighborhood during and after flood?	Developed for the purposes of this questionnaire.
Physical					
P1	*Housing and production means*	HP1	HHs with poor quality housing (semi-constructed house/thatched roof) (%)	Is your house semi-constructed or has a thatched roof?	Developed for the purposes of this questionnaire.
		HP2	HHs with housing affected by flood (partially to totally submerged) (%)	Is your house usually affected by the flood (partially, to totally submerged)?	Developed for the purposes of this questionnaire.
		HP3	HHs experience floodwater in area for more than 7 days (%)	What was the longest time period of floodwater staying in your area before?	Developed for the purposes of this questionnaire.
		HP4	HHs experience floodwater in house for more than 7 days (%)	What was the longest time period of floodwater staying in your house before?	Developed for the purposes of this questionnaire.
		HP5	HHs that report no access to production means (%)	Does your household have access to production means?	Adapted from Can et al. (2014)
		HP6	HHs that have no or only motorbike as private means of transportation (%)	Do you have any private means of transportation?	Adapted from DRBC (2007)
P2	*Urban systems*	US1	HHs that report no access to wastewater treatment plant (%)	Is your household connected to the wastewater treatment plant?	Developed for the purposes of this questionnaire.
		US2	HHs that report no consistent water supply and/or electricity during flood (%)	Does your household have no consistent water supply and/or electricity during flood?	Developed for the purposes of this questionnaire.
		US3	HHs that report no adequate access to roads and streets during flood (%)	Do you have no adequate access to roads and streets during flood?	Adapted from International Joint Commission Red River Basin Task Force (1997)

Financial					
F	*Finance and incomes*	FI1	HHs borrowed money (more frequently after severe flooding) (%)	Did you borrow any money from relatives or friends frequently after a flood?	Adapted from World Bank (1997)
		FI2	HHs that report to obtain not enough savings to recover from flood damages (%)	Were you savings enough to recover from the damages you incurred from the flood?	Developed for the purposes of this questionnaire.
		FI3	HHs that report large financial debts (%)	Do you or anyone in your household have any large financial debts?	Developed for the purposes of this questionnaire.
		FI4	HHs that report significant income reduction or no income due to flood damage in agricultural/fish farming (%)	Did you experience significant income reduction or no income due to flood and harvest loss in agricultural/fish farming?	Adapted from International Joint Commission Red River Basin Task Force (1997)
		FI5	HHs that did not have insurance or received compensation to recover from losses (%)	Did you have any insurance or receive compensation that helped you recover your losses?	Adapted from International Joint Commission Red River Basin Task Force (1997)
		FI6	HHs with net HHs income lower than 100,000 THB/year (%)	What is your average household income?	Developed for the purposes of this questionnaire. Reference for 100,000 THB benchmark: Isvilando, S. (2010)

Table 2 – Categorization of major components into contributing factors from the IPCC vulnerability definition for calculating the LVI-IPCC

IPCC contributing factors to vulnerability	Major components
Exposure	Natural Disasters and Climate Variability
Adaptive Capacity	Livelihood Strategies Education Socio-Demography Social Networks Finance and Income Housing and Production Means
Sensitivity	Health Land Natural Resources Urban Systems

Table 3 – Summary LVI results for all types of capital and components for Pralab I

Capital	Major Component		Sub-component/Indicator	Unit	Observed Value	Vulnerability Index
Human						
H1	*Health*	H1	HH with family member with illness	%	46.8	0.468
		H2	HH with family member ill due to floods	%	20.3	0.203
		H3	HH with family members with diarrhea, dengue incident, pneumonia, or skin infection (during/after flood)	%	17.7	0.177
		H4	HH with no medical insurance to cover health services and treatment expenses (during or after flood)	%	4.2	0.042
	Health vulnerability (H1)					**0.223**
H2	*Livelihood strategy*	LS1	Average agricultural livelihood diversification [1/ (number of agricultural livelihood activities + 1)] (1/#crops) (range: 0.20-1)[18]	1/# crops	0.5	0.342
		LS2	HHs dependent on agriculture as major source of income	%	50.6	0.506
		LS3	HHs dependent on fish farming as major source of income	%	7.2	0.072
		LS4	HHs with agricultural/fish farming that was affected by flood	%	70.4	0.704
		LS5	HHs that use more than 50% of harvest for own food consumption	%	64.0	0.640
		LS6	HH with family members employed outside of Pralab (at least one)	%	45.8	0.458
		LS7	HH with family member unemployed (during flood season)	%	12.7	0.127
	Livelihood strategy vulnerability (H2)					**0.407**
H3	*Education*	E1	HHs: head illiterate	%	8.4	0.084

[18] Some indicators such as the Livelihood Diversity Index were created because an increase in the crude indicator, in this case, the number of livelihood activities undertaken by a household, decreases vulnerability (e.g., a household who farms and raises animals is less vulnerable than a household who only farms) so by taking the inverse of the crude indicator, we create a number that reflects this line of reasoning and assigns higher values to households with a lower number of livelihood activities.

		E2	HHs: head with only primary school education	%	87.3	0.873
		E3	HHs: head not trained to cope with flood	%	37.0	0.370
	Education vulnerability (H3)					**0.442**
Natural						
N1	*Land*	L1	Landless HHs	%	13.1	0.131
		L2	HHs with land leasing	%	24.1	0.241
		L3	HHs with small land (10 rai)	%	70.0	0.700
	Land vulnerability (N1)					**0.357**
N2	*Natural resources*	NR1	HHs that did not cultivate 3rd crop	%	95.8	0.958
		NR2	HHs that depend on rainwater for rice farming	%	7.9	0.079
		NR3	HHs that are affected by wastewater through stream/rivers for farming	%	46.6	0.466
	Natural resources vulnerability (N2)					**0.501**
N3	*Natural disasters & climate variability*	ND-CV1	Average number of severe floods in the past 15 years (No) (range: 0-6)	No	2.3	0.152
		ND-CV2	HHs did not receive flood warning	%	26.0	0.260
		ND-CV3	Mean standard deviation of average precipitation by month (average 10-15 years)	mm	98.6	0.241
	Natural disasters & climate variability vulnerability (N3)					**0.217**
Social						
S1	*Socio-Demography*	SD1	Dependency ratio (< 15 and > 65 years) – (((number of people aged < 15) + (number of people aged > 65))/ (number of people aged 15-64)) * 100	Ratio	32.9	0.329
		SD2	Female HHs head (male away from home > 6 months per year)	%	26.7	0.267
		SD3	Average family members in HHs	Persons	4.4	0.044

		SD4	HHs moved into area despite knowing that it is a flood prone area	%	13.1	0.131
	Socio-demography vulnerability (S1)					**0.193**
S2	*Social Networks*	SN1	HHs received help because of flood	%	51.5	0.515
		SN2	HHs not engaged in neighborhood helping network during flood	%	33.8	0.338
		SN3	HHs experience no solidarity in area	%	11.4	0.114
	Social networks vulnerability (S2)					**0.322**
Physical						
P1	*Housing and production means*	HP1	HHs with poor quality housing (semi-constructed house/thatched roof)	%	1.3	0.013
		HP2	HHs with housing affected by flood (partially to totally submerged)	%	18.6	0.186
		HP3	HHs experience floodwater in area for more than 7 days	%	76.8	0.768
		HP4	HHs experience floodwater in house for more than 7 days	%	81.4	0.814
		HP5	HHs that report no access to production means	%	25.0	0.250
		HP6	HHs that have no or only motorbike as private means of transportation	%	35.9	0.359
	Housing and production means vulnerability (P1)					**0.398**
P2	*Urban systems*	US1	HHs that report no access to wastewater treatment plant	%	92.0	0.920
		US2	HHs that report no consistent water supply and/or electricity during flood	%	30.4	0.304
		US3	HHs that report no adequate access to roads and streets during flood	%	59.8	0.598
	Urban system (P2)					**0.607**
Financial						
F	*Finance and incomes*	FI1	HHs borrowed money (more frequently after severe flooding)	%	16.9	0.169

FI2	HHs that report to obtain not enough savings to recover from flood damages	%	32.1	0.321
FI3	HHs that report large financial debts	%	52.3	0.523
FI4	HHs that report significant income reduction or no income due to flood damage in agricultural/fish farming	%	77.3	0.773
FI5	HHs that did not have insurance or received compensation to recover from losses	%	53.2	0.532
FI6	HHs with net HHs income lower than 100,000 THB/year	%	59.1	0.591
Finance and incomes vulnerability (F)				**0.485**
Livelihood Vulnerability Index (Weighted average of H, N, S, P, F)				**0.385**

Note: Index values were interpreted as relative values to be compared within the research sample only. The LVI is on a scale from 0 (least vulnerable) to 1 (most vulnerable).

Table 4 – Summary LVI results for all types of capital and components for Pralab II

Capitals	Major Component	Observed Value
Human		**0.357**
	Health	0.223
	Livelihood strategies	0.407
	Education	0.442
Natural		**0.359**
	Land	0.357
	Natural resources	0.501
	Natural disaster and climate variability	0.217
Social		**0.257**
	Socio-democracy	0.193
	Social networks	0.322

Physical		**0.503**
	Housing and production means	0.398
	Urban Systems	0.607
Financial		**0.485**
	Finance and incomes	0.485

Table 5 – Factors contributing to LVI-IPCC for Pralab

Contributing factors	Major components	Major component values	Contributing factor values
Adaptive Capacity			**0.387**
	Livelihood Strategies	0.407	
	Education	0.442	
	Socio-demography	0.193	
	Social networks	0.322	
	Finance and incomes	0.485	
	Housing and production means	0.398	
Sensitivity			**0.407**
	Health	0.223	
	Land	0.357	
	Natural resources	0.501	
	Urban systems	0.607	
Exposure			**0.217**
	Natural Disaster and climate variability	0.217	
LVI-IPCC = (Exposure – Adaptive Capacity)*Sensitivity			**-0.069**

Note: LVI-IPPC ranges from -1 (least vulnerable) to 1 (most vulnerable).

10. ANNEX III: SURVEY QUESTIONNAIRE (ENGLISH/THAI)

CONSENT FORM (English)

I understand, that as a participant in this study I will be asked semi-structured questions in a survey questionnaire about the impact of urban flood to the vulnerability of Pralab community in Khon Kaen City. I understand that I may refuse to answer any questions or withdraw from the study at any time. I understand that my specific answers and comments will be kept anonymous. I understand that the answers I give in this survey will be used to inform a study about the impact of urban flood to the vulnerability of Pralab community in Khon Kaen City and that this is a part of a larger research project called the Urban Climate Change Resilience in Southeast Asia (UCRSEA) Partnership, funded by the Government of Canada. I understand what this study involves and agree to participate.

Signed by on June 2017.

( )

ใบยินยอมด้วยความสมัครใจ

ข้าพเจ้ายอมรับว่า จากการเข้าร่วมเป็นผู้ให้สัมภาษณ์ในครั้งนี้ ข้าพเจ้าอาจจะได้รับการติดต่อให้สัมภาษณ์เชิงลึกในภายหลังเกี่ยวกับผลกระทบที่ได้รับจากปัญหาน้ำท่วมใน ต.พระลับ ข้าพเจ้าเข้าใจว่าข้าพเจ้าสามารถปฏิเสธการให้สัมภาษณ์ และถอนตัวจากการให้ข้อมูลในงานวิจัยนี้ได้ ณ ช่วงเวลาใดก็ได้ ข้าพเจ้าเข้าใจว่าจะไม่มีการเปิดเผยตัวตนของผู้ให้สัมภาษณ์ ข้าพเจ้าเข้าใจว่าข้อมูลที่ให้สัมภาษณ์ในครั้งนี้ใช้สำหรับการศึกษาผลกระทบของน้ำท่วมต่อพื้นที่ ต.พระลับ ซึ่งเป็นส่วนหนึ่งของโครงการ Urban Climate Change Resilience in Southeast Asia (UCRSEA) Partnership ซึ่งได้รับเงินสนับสนุนจากรัฐบาลแคนนาดา และข้าพเจ้ายินยอมที่จะให้ข้อมูลสำหรับการศึกษาวิจัยนี้

ลายเซ็น _____ วันที่ มิถุนายน 2560

( ) เวลา _____

Survey Questionnaire (English)

Personal Data

1. Name: _____
2. Age: ____
3. Present Address: _____
4. Contact Number (in case you are willing to give an interview): _____
5. Gender: Female □ Male □
6. Years of residence in present address: _____
7. Originally from (province): _____

Health

8. Is anyone in your family chronically ill or gets sick very often?
   Yes □ No □

9. Did anyone in your family get chronically ill or got sick very often due to the flood?
   Yes □ No □

10. Did anyone in your family suffer from diarrhea, pneumonia, dengue, or skin infection during or after a severe flood?
    Yes □ No □

11. Do you have a medical insurance to cover health service and treatment expenses during and after flood?
    Yes □ No □ If yes, which type? _____

Livelihood Strategy

12. Do you or someone in your household raise animals?
    Yes □ No □

13. Do you or someone else in your household grow crops?
    Yes □ No □

14. Do you or someone else in your household farm fish?
    Yes □ No □

15. Does your household depend on agricultural farming as a major source of income?
    Yes □ No □

16. Does your household depend on fish farming as a major source of income?
    Yes □ No □

17. Does your farming (agricultural/fish) get affected by flood?
    Yes □ No □ If yes, how? _____

18. Does your household use more than 50% of your harvest for own food consumption?
    Yes □ No □ If yes, how much percent? _____

19. Do you or someone else in your household work outside of the community (at least one; other municipalities, cities)?
    Yes □ No □

20. Are you or someone else in your household jobless/unemployed (during/after flood)?
    Yes □ No □ If yes, how many? ____

Education

21. Did you or someone else in your household never go to school?
Yes □ No □ If yes, how many? ____

22. Did you or someone else in your household visit school only until 6/9th grade?
Yes □ No □ If yes, how many? ____

23. Did you or someone else in your family not receive training on how to cope with flood?
Yes □ No □ If yes, how many did not receive training? ____

Land

24. Does your household not own land?
Yes □ No □

25. Did you own land before and sell it?
Yes □ No □ If yes, why did you sell your land? _____

26. Is the land you own/lease/farm smaller than 10 rai?
Yes □ No □

Natural Resources

27. How many crops did you cultivate?
1st □ 2nd □ 3rd □

28. If your household is doing agricultural farming, do you depend only on rainwater for rice farming?
Yes □ No □
If no, what are your alternative water sources? _____

29. Do you feel in agricultural/fish farming affected by wastewater contamination of the natural water bodies (like Pra Keu stream/ Chi River) in your area?
Yes □ No □
If yes, how do you feel affected? _____

Natural Disasters and Climate Variability

30. How many times has this area been affected by severe flood in the past 15 years?
_____

31. Was anyone injured or even die during flood in the past 15 years?
Yes □ No □

32. Did your household receive an adequate flood warning from the government in past 15 years before the flood happened?
Yes □ No □

33. In your opinion, what causes the flood in Pralab?
Urbanization □ Weak land-use planning □
Low land-elevation □ Weak governance □
Heavy rainfall/climate variation □ Poor watershed management □
Others_____

Socio-Demography

34. How many family members do you have in your households?
_____

35. Could you please list the ages and sexes of every person who eats and sleeps in this house on a regular basis?
Age _____ Sex _____ Age _____ Sex _____
Age _____ Sex _____ Age _____ Sex _____
Age _____ Sex _____ Age _____ Sex _____

36. What is your relationship in this household?
□ Father □ Mother □ Son/daughter □ relative □ others
Are you the head of the family?
Yes □ No □
If not, who is the head? _____

Does he/she live in your household or is usually away for longer than 6 months?
Yes □ No □

37. Did you move to Pralab area from other area?
Yes □ No □
If yes, when did you move to Pralab?
Before 1987 □ 1989-1992 □ 1993-1997 □
1998-2002 □ 2003-2007 □ 2008-2012 □
2013-2016 □

38. Did you know that Pralab is a flood-prone area when you moved there?
Yes □ No □

Social Networks

39. Did relatives or friends help you because of flood?
Yes □ No □

40. Did you receive support from the government during or after heavy flood?
Yes □ No □
If yes, what kind of support received _____

41. Does your community have collaborative neighborhood network for flood relief (during and after flood) and if yes, do you participate in this network?
Yes □ No □

42. Do you experience strong collaboration or solidarity in your neighborhood during and after flood?
Yes □ No □

Housing and Production Means

43. Is your house semi-constructed or has a thatched roof?
Yes □ No □

44. Is your house usually affected by the flood (partially to totally submerged)?
Yes □ No □ If yes, how was/is your house affected? _____

45. What was the longest time period of floodwater staying in your area before?
_____

46. What was the longest time period of floodwater staying in your house before?
_____

47. Does your household have access to production means?
Yes □ No □

48. Do you have any private means of transportation?
Yes □ No □
If yes, what kind(s)? Motorbike □
Car □

Urban Systems

49. Is your household connected to the wastewater treatment plan?
Yes □ No □

50. Does your household have no consistent water supply and/or no electricity during flood?
Yes □ No □

51. Do you have no adequate access to roads and streets during flood?
Yes □ No □

Finance and incomes

52. Did you borrow any money from relatives or friends frequently after a flood?
Yes □ No □

53. Were you savings enough to recover from the damages you incurred from the flood?
Yes □ No □

54. Do you or any one in your household have any large financial debts?
Yes □ No □

55. Did you experience significant income reduction or no income due to flood and harvest loss in agricultural/fish farming?
Yes □ No □

56. Did you have any insurance or receive compensation that helped you recover your losses?
Yes □ No □
If yes, what type of insurance/compensation_____ and how much did they give you? _____
And, how did you spend it? _____

57. What is your average annual household income?

□ < 16,000 THB	□ 16,001-19,000 THB	□ 19,001-50,000 THB
□ 50,001-100,000 THB	□ 100,001-200,000 THB	□ 200,001-300,000 THB
□ 300,001-400,000 THB	□ 400,001-500,000 THB	□ > 500,000 THB

แบบสอบถาม

ข้อมูลส่วนตัว

1. **ชื่อ-นามสกุล**: _____
2. อายุ: ____ ปี
3. ที่อยู่ปัจจุบัน: _____
4. เบอร์โทรศัพท์ (ในกรณีที่ต้องการให้สัมภาษณ์เชิงลึก): _____
5. เพศ: ☐ หญิง ☐ ชาย
6. ระยะเวลาที่อยู่อาศัยในครัวเรือน: _____
7. สถานที่อยู่อาศัยเดิม (จังหวัด): _____

ข้อมูลเกี่ยวกับสุขภาพ

8. มีสมาชิกในครัวเรือนเจ็บป่วยด้วยโรคเรื้อรังหรือเจ็บป่วยเป็นประจำหรือไม่
   ☐ มี ☐ ไม่มี
9. มีสมาชิกในครัวเรือนเจ็บป่วยด้วยโรคเรื้อรังหรือเจ็บป่วยเป็นประจำ ที่เป็นผลกระทบจากเหตุการณ์น้ำท่วมหรือไม่
   ☐ มี ☐ ไม่มี
10. มีสมาชิกในครัวเรือนเป็นโรคท้องร่วงหรือท้องเสีย โรคทางเดินหายใจ โรคไข้เลือดออก หรือโรคผิวหนัง ในช่วงเวลาหรือหลังเหตุการณ์น้ำท่วมใหญ่หรือไม่
    ☐ มี ☐ ไม่มี
11. มีสมาชิกในครัวเรือนมีประกันสุขภาพหรือสวัสดิการจากรัฐด้านการรักษาพยาบาลในช่วงเวลาที่เกิดเหตุการณ์น้ำท่วมหรือไม่
    ☐ มี ประเภทใด_____ ☐ ไม่มี

สภาพความเป็นอยู่

12. ครัวเรือนของท่านมีสัตว์เลี้ยงหรือทำปศุสัตว์หรือไม่
    ☐ มี ☐ ไม่มี
13. ครัวเรือนของท่านมีการปลูกพืช หรือทำการเกษตรหรือไม่
    ☐ มี ☐ ไม่มี
14. ครัวเรือนของท่านทำการประมงหรือไม่

□ ใช่ □ ไม่ใช่

15. รายได้หลักของครัวเรือนท่านมาจากการทำการเกษตรใช่หรือไม่

□ ใช่ □ ไม่ใช่

16. รายได้หลักของครัวเรือนท่านมาจากการทำการประมงหรือไม่

□ ใช่ □ ไม่ใช่

17. การทำการเกษตรหรือเลี้ยงสัตว์ของท่านประสบปัญหาจากน้ำท่วมหรือไม่

□ ใช่ □ ไม่ใช่

18. ครัวเรือนของท่านบริโภคผลผลิตทางการเกษตรของตนเองมากกว่า 50% หรือไม่

□ มี กี่เปอร์เซ็นต์ ____ ไม่มี □

19. มีสมาชิกในครัวเรือนของท่านทำงานนอกพื้นที่ ต.พระลับ เพื่อหาเงินมาใช้จ่ายในครอบครัวหรือไม่

□ มี จำนวนกี่ท่าน ____ ไม่มี □

20. มีสมาชิกในครัวเรือนของท่านไม่มีงานทำหรือตกงานจากเหตุการณ์น้ำท่วมหรือไม่

□ มี □ ไม่มี

การศึกษา

21. มีสมาชิกในครัวเรือนของท่านที่ไม่ได้รับการศึกษาหรือไม่

□ มี จำนวนกี่คน ____ ไม่มี □

22. มีสมาชิกในครัวเรือนของท่านจบการศึกษาขั้นพื้นฐานหรือไม่ (ป.4/ป.6/ม.3)

□ มี จำนวนกี่คน ____ ไม่มี □

23. มีสมาชิกในครัวเรือนของท่านที่ไม่ได้รับการฝึกอบรมหรือข้อมูลเกี่ยวกับการปฏิบัติตัวเพื่อรับมือกับเหตุการณ์น้ำท่วม

□ มี จำนวนกี่คน ____ ไม่มี □

ที่อยู่อาศัย

24. ครัวเรือนของท่านไม่ถือครองกรรมสิทธิ์ที่ดินใช่หรือไม่

□ ใช่ □ ไม่ใช่

25. ครัวเรือนของท่านเคยขายที่ดินให้ผู้อื่นหรือไม่

□ ใช่ เหตุผล _____ □ ไม่เคย

26. ที่ดินที่ถือกรรมสิทธิ์ หรือเช่า อยู่เพื่อทำการเกษตรมีขนาดน้อยกว่า 10 ไร่หรือไม่

☐ ใช่ ☐ ไม่ใช่

ทรัพยากรธรรมชาติ

27. ครัวเรือนของท่านทำการเกษตรหรือไม่ ประเภทใด และทำการเพาะปลูกกี่ครั้งต่อปี

☐ ไม่ทำการเกษตร ☐ 1 ครั้ง ☐ 2 ครั้ง ☐ 3 ครั้ง

28. ถ้าครัวเรือนของท่านทำนา ท่านพึ่งพิงน้ำฝนเพียงอย่างเดียวใช่หรือไม่

☐ ใช่ ☐ ไม่ใช่ โปรดระบุ แหล่งน้ำอื่นๆ _____

29. ท่านได้รับผลกระทบจากการจับปลาไม่ได้ หรือทำนาข้าวได้ผลผลิตลดลง จากน้ำเสียที่ปนเปื้อนในแม่น้ำลำคลอง หรือน้ำเสียที่ปล่อยลงสู่ที่นาหรือไม่

☐ ใช่ ท่านมีความรู้สึกอย่างไร _____

☐ ไม่ใช่

ภัยธรรมชาติ และความอ่อนไหวต่อการเปลี่ยนแปลงสภาพภูมิอากาศ

30. ครัวเรือนของท่านได้รับผลกระทบต่อน้ำท่วมใหญ่จำนวนกี่ครั้งในช่วงเวลา 15 ปีที่ผ่านมา

_____ ครั้ง

31. มีสมาชิกในครัวเรือนของท่านเจ็บป่วยหรือเสียชีวิตจากเหตุการณ์น้ำท่วมหรือไม่ ในช่วงเวลา 15 ปีที่ผ่านมา

☐ มี ☐ ไม่มี

32. ครัวเรือนของท่านได้รับรู้ข่าวสารการเตือนภัยน้ำท่วมจากภาครัฐอย่างเพียงพอ ในช่วงเวลา 15 ปีที่ผ่านมาหรือไม่

☐ ใช่ ☐ ไม่ใช่

33. ท่านคิดเห็นอย่างไรเกี่ยวกับเหตุการณ์น้ำท่วมใน ต.พระลับ (ตอบได้มากกว่า 1 ข้อ)

☐ การขยายตัว ☐ ไม่มีการวางผังเมืองที่ดีพอ

☐ พระลับเป็นพื้นที่ต่ำ ☐ การบริหารจัดการที่ไม่มีของภาครัฐ

☐ ฝนตกหนัก หรือฝนไม่ตกต้องตามฤดูกาล ☐ การบริหารจัดการลุ่มน้ำไม่ดีพอ

อื่นๆ _____

สภาพเศรษฐกิจและสังคม

34. จำนวนสมาชิกในครัวเรือนของท่านมีกี่คน

_____ คน

35. กรุณาระบุ อายุ และเพศ ของผู้ที่อยู่อาศัยในครัวเรือนของท่าน

อายุ _____ เพศ _____ อายุ _____ เพศ _____

อายุ _____ เพศ _____ อายุ _____ เพศ _____

อายุ _____ เพศ _____ อายุ _____ เพศ _____

36. ท่านมีความสัมพันธ์อย่างไรกับสมาชิกในครัวเรือน

☐ พ่อ ☐ แม่ ☐ ลูก ☐ ญาติ ☐ อื่นๆ โปรดระบุ _____

ท่านเป็นหัวหน้าครอบครัวใช่หรือไม่ (คนรับผิดชอบหลักในบ้าน และมีอำนาจในการตัดสินใจ)

☐ ใช่ ☐ ไม่ใช่ โปรดระบุบุคคลที่เป็นหัวหน้าครอบครัว _____

หัวหน้าครอบครัวอาศัยอยู่ในครัวเรือนเดียวกัน หรือใน 1 ปี อาศัยอยู่ในครัวเรือเป็นระยะเวลาอย่างน้อย 6 เดือน หรือไม่

☐ ใช่ ☐ ไม่ใช่

37. ครัวเรือนของท่านย้ายถิ่นมาอยู่ ต. พระลับใช่หรือไม่

☐ ใช่ ☐ ไม่ใช่

ถ้าใช่ ย้ายมาในช่วงปีใด

☐ ก่อนปี 2530 ☐ 2531-2535 ☐ 2536-2540

☐ 2541-2545 ☐ 2546-2550 ☐ 2551-2555

☐ 2556-2560

38. หากท่านย้ายถิ่นมาอยู่ ต.พระลับ ก่อนที่จะย้ายมาท่านทราบหรือไม่ว่าพื้นที่ ต.พระลับเป็นพื้นที่น้ำท่วมถึง

☐ ใช่ ☐ ไม่ใช่

สภาพสังคม

39. ครัวเรือนของท่านได้รับการช่วยเหลือจากญาติหรือเพื่อนตอนเกิดเหตุการณ์น้ำท่วมหรือไม่

☐ ใช่ ☐ ไม่ใช่

40. ท่านได้รับการช่วยเหลือจากภาครัฐในระหว่างหรือหลังเหตุการณ์น้ำท่วมใหญ่หรือไม่

☐ ใช่ การช่วยเหลือด้านใด_____ ☐ ไม่ใช่

41. ในชุมชนของท่านมีการช่วยเหลือด้านน้ำท่วมหรือไม่ และครอบครัวของท่านมีส่วนร่วมหรือไม่

☐ มี ☐ ไม่มี

42. จากการช่วยเหลือซึ่งกันและกันในระหว่างและหลักการเกิดน้ำท่วม ชุมชนของท่านเข้มแข็งขึ้นหรือไม่

☐ ใช่ ☐ ไม่ใช่

ครัวเรือนและการเข้าถึงการบริการ

43. สภาพบ้านของท่านเป็นสิ่งก่อสร้างถาวรหรือไม่

☐ ใช่ ☐ ไม่ใช่

44. บ้านของท่านถูกน้ำท่วมเป็นประจำใช่หรือไม่ (ทั้งกรณีท่วมบางส่วนและท่วมมิดหลังคาเรือน)

☐ ใช่ ได้รับผลกระทบอย่างไร _____ ☐ ไม่ใช่

45. น้ำท่วมในบ้านท่านนานที่สุดเท่าใด

_____ วัน

46. น้ำท่วมบริเวณบ้านท่านนานที่สุดเท่าใด

_____ วัน

47. ครัวเรือนของท่านมีกำลังจ่ายสำหรับค่าซ่อมบ้าน ในกรณีได้รับความเสียหายจากน้ำท่วม

☐ ใช่ ☐ ไม่ใช่

48. ท่านมียานพาหนะส่วนบุคคลหรือไม่

☐ มี ประเภทใด ☐ รถมอเตอร์ไซค์ ☐ รถยนต์

☐ ไม่มี

ระบบสาธารณูปโภค

49. ครัวเรือนของท่านได้รับบริการด้านการบำบัดน้ำเสียหรือไม่

☐ ใช่ ☐ ไม่ใช่

50. ครัวเรือนของท่านไม่มีน้ำประปา และไฟฟ้าใช้อย่างสม่ำเสมอในช่วงเวลาที่น้ำท่วมหรือไม่

☐ ใช่ ☐ ไม่ใช่

51. ท่านสามารถสรรจรทางถนนในช่วงเวลาที่น้ำท่วมได้ไม่สะดวกใช่หรือไม่

☐ ใช่ ☐ ไม่ใช่

สถานะทางการเงิน

52. ครัวเรือนของท่านได้ยืมเงินจากญาติหรือเพื่อนมาใช้เพื่อเยียวยาผลกระทบจากน้ำท่วมหรือไม่

☐ ใช่ ☐ ไม่ใช่

53. ครัวเรือนของท่านมีเงินเก็บสะสมเพียงพอสำหรับเยียวยาผลกระทบจากน้ำท่วมหรือไม่

☐ ใช่ ☐ ไม่ใช่

54. ครัวเรือนของท่านมีหนี้หรือไม่

☐ ใช่ เท่าไหร่ _____บาท ☐ ไม่ใช่

55. ครัวเรือนของท่านหารายได้ได้น้อยลง หรือหาไม่ได้เลย ทั้งจากการทำเกษตรกรรม การประมง และอาชีพอื่นๆ ในช่วงน้ำท่วมหรือไม่

☐ ใช่ กี่เปอร์เซ็นต์_____ ☐ ไม่ใช่

56. ครัวเรือนของท่านมีการทำประกันความเสียหายหรือได้เงินชดเชยจากภาครัฐในกรณีน้ำท่วมที่ดินทำกินหรือไม่

☐ ใช่ ประกัน/เงินชดเชยประเภทไหน_____ ได้รับเงินเท่าไหร่ _____ นำเงินไปทำอะไร _____

☐ ไม่ใช่

57. ครัวเรือนของท่านมีรายได้เฉลี่ยต่อปีเท่าใด

☐ น้อยกว่า 16,000 บาท ☐ 16,001-19,000 บาท ☐ 19,001-50,000 บาท

☐ 50,001-100,000 บาท ☐ 100,001-200,000 บาท ☐ 200,001-300,000 บาท

☐ 300,001-400,000 บาท ☐ 400,001-500,000 บาท ☐ มากกว่า 500,000 บาท

11. ANNEX IV: IN-DEPTH INTERVIEW QUESTIONNAIRES

Questionnaire I (Municipality)

1. Did flooding in your municipality become increasingly worse in the past 15 years? How?
2. Do you have any documents on flood damage and flood compensations that you could share with us?
3. How do you think does poor land use contribute to flooding in KKC?
4. How did land speculation and real estate market contribute to flooding?
5. How did water management policy create exposure to flood, and in particular in Pralab? What are examples, such as in terms of dams and flood protection infrastructure?
6. Do you think wastewater overspill has a severe impact on the environment and livelihood of people in Pralab, in particular in the event of flood in Pralab?
7. What about warning, did people receive them in time?
8. What did you do or are doing to help people to cope with flood?
9. Will efforts such as the newly established pump in Pralab be a long-term solution to improve flood protection and to mitigate flood? What are the problems?
10. What are other approaches that could help to mitigate flood in KKC, particularly in NKK and Pralab?
11. Do you think that the residents in Pralab are more vulnerable to flood than residents in NKK who are exposed to flash flood in certain areas? Why do you think so?
12. How relevant do you think is stronger cooperation of other municipalities for tackling the flood problem in KKC?
13. Are there policies within your institution that deal directly with flooding? Do you have a disaster preparedness and prevention plan?
14. What are the goals of such policies?
15. What are the main problems to be solved by those policies? Why?
16. Are those policies sufficient to tackle the problem of flood in Pralab?
17. Do you think improved land use planning and water management in NKK could mitigate the flood risk in KKC?

Questionnaire II (Public Works and Town Authority)

1. Did flooding in your municipality become increasingly worse in the past 15 years? How?
2. How relevant do you consider your work in town planning and urban development to prevent flood?
3. Why did has the land use plan(s) not been implemented?
4. How do you think does land use planning contribute to flooding in KKC?
5. How important do you consider land use planning as a flood mitigation tool for KKC?
6. Why are drainage systems in certain areas not efficient enough in the event of heavy rainfall?
7. How did land speculation and real estate market contribute to flooding?
8. Do you think wastewater overspill has a severe impact on the environment and livelihood of people in Pralab, in particular in the event of flood in Pralab?
9. Will efforts such as the newly established pump in Pralab be a long-term solution to improve flood protection and to mitigate flood? What are the problems?
10. What are other approaches that could help to mitigate flood in KKC, particularly in NKK and Pralab?

11. Do you think that the residents in Pralab are more vulnerable to flood than residents in NKK who are exposed to flash flood in certain areas? Why do you think so?
12. How relevant do you think is cooperation of other municipalities for tackling the flood problem in KKC?
13. Are there policies within your institution that deal directly with flooding? Do you have a disaster preparedness and prevention plan?
14. What are the goals of such policies?
15. What are the main problems to be solved by those policies? Why?

Questionnaire III (Pollution Control Authority)

1. Did you recognize any significant water quality changes in the past 15 years? If yes, what kind?
2. Why is the surface water quality deteriorating?
3. Do you think the wastewater treatment plant in KKC is efficiently treating the water?
4. Do you think flooding has an impact on surface water quality deterioration? Why?
5. Why is wastewater in Pralab not covered by the treatment plant?
6. Do you think wastewater overspill and discharge has a severe impact on the environment and livelihood of people in KKC, in particular in the event of flood in Pralab?
7. Will efforts such as the newly established pump in Pralab be a long-term solution to improve flood protection and to mitigate flood? What are the problems?
8. How relevant do you think is stronger cooperation of other municipalities for tackling the wastewater problem in Pralab?
9. Are there policies within your institution that deal directly with flooding? Do you have a disaster preparedness and prevention plan?
10. What are the goals of such policies?
11. What are the main problems to be solved by those policies? Why?

Questionnaire IV (Community Member)

1. Name:
2. Age:
3. Present Address:

4. Gender:
5. Years of residence in present address:
6. Originally from (Province):
7. Ownership of house: owner, rented, rented by other family member:
8. Type of house: built up concrete structure, semi constructed, thatched roof:

9. Level of education: illiterate, literate, primary, middle, high, college, others:
10. Occupation of bread winner/s:
11. Type of employment: permanent, temporary, seasonal, daily:
12. Other sources of employment:
13. Do you think that your employment provides you enough income for daily life?

Before flood

14. What is your understanding of flood? How do you distinguish regular floods and severe floods such as in 2008 and 2011?
15. Have you experienced any severe floods before in this community? If so, how many times? What knowledge did you learn about floods from your past experience?
16. When did you feel did the impact of flooding become more precarious or severe? Why?
17. Were you worried about floods before the severe flood in 2008 and 2011? Did you think about moving away due to the flood problem?
18. How would you characterize this community? Is there much collaboration and cooperation within the community? Are there many conflicts?
19. Have there been any significant changes to the community since you lived here? (Income level, change of job, land prices, solidarity/conflict, leadership, infrastructure, migration)
20. Did you or any family members have any pre-existing health problems or disabilities?
21. Would you say that you have a good network of friends and/or family who would help during times of trouble?
22. Do you and your family members have health insurance? If yes, which one?

Flood

23. What did and do you usually prepare for the floods before they came/come?
24. When did the floodwater come to your house? How long did it stay and how high did it get?
25. Where did the water come from in your community?
26. How quickly did the water come in? What was the quality of the water?
27. If you do farming, how long did it stay in the field? When did/does flood water start affecting your crop/harvest?
28. Were you and other members of your household affected? How?
29. Did you evacuate? If so, for how long and why? If not, why not?
30. Do you think there is wastewater contamination in the flood water? If yes, why?
31. Did you know that the wastewater treatment plant is affecting natural water bodies?
32. Did you receive an adequate warning from the government about the floods?
33. In your opinion, what caused the floods?
34. Is there someone to blame for the floods or were the floods due to heavy rain and the low land elevation? If so, who? Why?
35. Do you know other people in the neighborhood who were badly affected (such as death, illness, etc.)? Why do you think these people were affected more than others?
36. Do you think it's fair/just that your community was or is more affected by flood but those in the inner city where the flood water comes from are not? Why or why not?
37. Do you think your village/community was flooded more than those nearby? If so, why or why not?
38. Was the level of water equal throughout the community? If not, why?
39. Were you surprised by how much water there was and for how long it stayed?

Flood Loss & Response

40. What types of direct losses did floods usually incur? How different are losses due to heavy foods?

41. How was your house affected? How was your land/business affected?
42. What types of indirect losses from floods? Such as, absence at work place, school, difficult to get daily wage jobs, difficulty to reach work place, health disorders, loss of convenience as shops and convenience stores, closed medical stores?
43. Did the floods cause you stress?
44. What did you do to respond to the floods in terms protecting your house and health? Making sure you had enough food to eat? Did you do anything to try keep water out of your house?
45. What did you do to respond to the floods in terms of protecting your agricultural production?
46. If you do fish farming, did the flood affect your farming? If yes, how? If no, why not?
47. How did you learn to cope/respond with the floods? Was it from previous knowledge, community support, government advice, etc.?
48. What did the government do to help you respond to the floods? Was it adequate?
49. Do you think the government does enough to improve the flood situation in your area?
50. Do you know about any current solution approaches to tackle the flood problem?
51. Did any other groups help you, such as NGOs, companies during flood?
52. Do you think your community has a high capacity to cope with floods compared to other communities in Thailand?
53. What is your assessment of:
    a. Municipality's role in the flooding?
    b. Public Work's and Town Authority's role in the flooding?

Recovery/Aftermath

54. After the floodwater left, what did you do?
55. Did you receive any compensation? Was it enough compared to the total damage?
56. Did you have any insurance which helped you recover your losses? If so, what type of insurance and how much did they give you? If not, why did you not have any? Did you buy new insurance afterwards?
57. Did you receive assistance from any other groups such as NGOs and private companies afterwards?
58. Were you savings enough to recover from the damages you incurred from the flood?
59. What impacts do you think the flood had on your life? Did it lead to any major changes? What about on the community?

Afterwards

60. What has the municipality done since the floods?
61. Are their actions/activities adequate? Why?
62. Did your trust in authority change at all after severe flood? Did your view of the government change?
63. What has your community done since the floods to prepare for futures?
64. What you have personally done to prepare for future floods?
65. What do you recommend should be done?
66. Do you think your community will be badly flooded again? If so, do you feel prepared?