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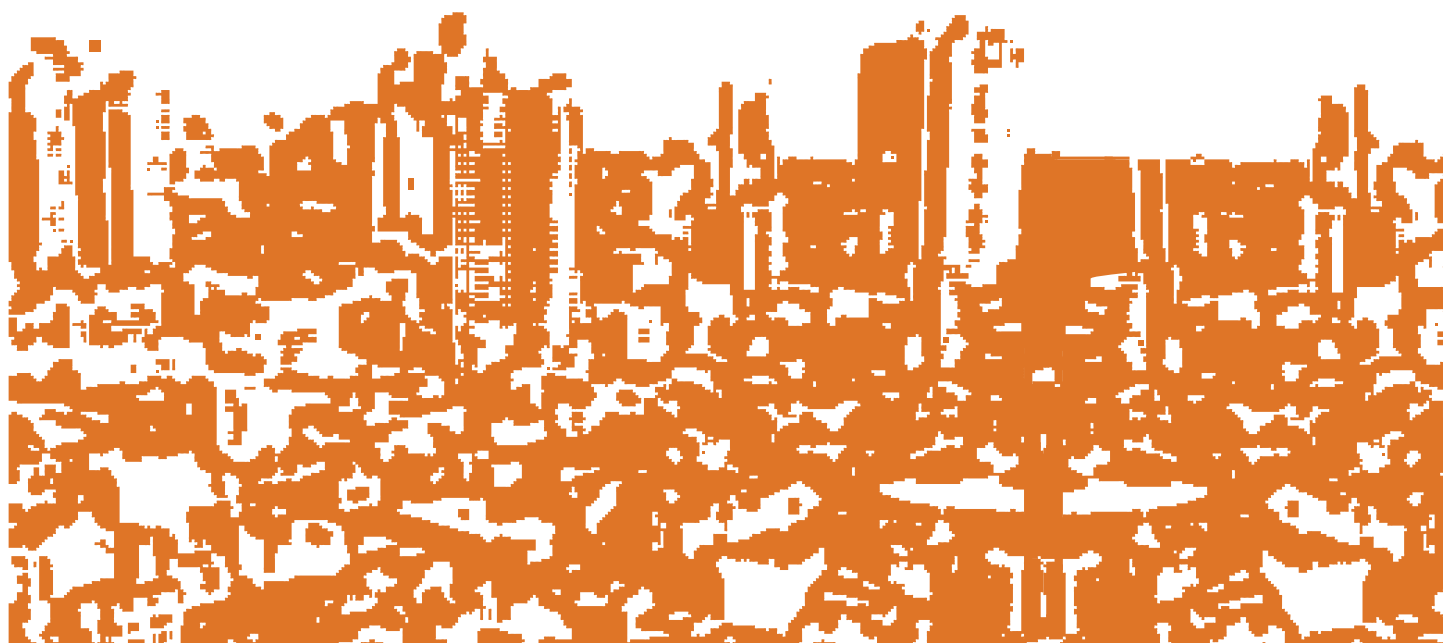
# Asian Cities Climate Resilience

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## **Climate change and urban health vulnerability**

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# Abstract

There is increasing awareness of the impacts of climate change on the health of urban residents. Although Thailand has seen relatively low rates of urbanisation compared to its ASEAN counterparts, cities across the country are growing. This study examines the climate change and urban health vulnerability of suburban Pralab, Khon Kaen City, in the northeast of Thailand. Empirical data is drawn from a field study using focus groups and in-depth interviews, and statistics recorded by local government agencies, as well as previous recent research on the study site. This study found that the urbanisation of Khon Kaen has led to profound physical and socio-economic changes in Pralab. Infrastructure development, such as roads, often acts as dykes, preventing or slowing water drainage, leading to longer periods of flooding. The effect of the floods on the health of the residents is intensified by wastewater discharged from the city drainage system into the suburban area of Pralab. The study examines the increased health vulnerability of suburban areas, which can be attributed to urban growth and climate change, and puts forwards recommendations to deal with the impacts of increasing climate variability.

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# Acronyms

ASEAN	Association of Southeast Asian Nations
IIED	International Institute for Environment and Development
KKU	Khon Kaen University
SEARO	World Health Organization Regional Office for Southeast Asia
UN-Habitat	United Nations Human Settlements Programme
UNISDR	United Nations Office for Disaster Risk Reduction
WESD	Research Group on Well-being and Sustainable Development
WHO	World Health Organization

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# 1 Introduction

Urban centres accommodate more than half of the world’s population and are projected to house 60 per cent of the population by 2030, with cities providing invaluable resources and opportunities for driving GDP growth for every country (Hallegatte and Morlot 2011; IPCC 2014a). Cities concentrate many socioeconomic development activities within a limited space, putting them at risk from the potential impacts of climate change (Hallegatte *et al.* 2011). Urban centres also generate a high proportion of global greenhouse gas emissions. The IPCC (2014b) notes that most Asian cities with rapid socioeconomic growth are widely affected by climate pressures, while extreme events such as heavy floods and drought, lead to adverse impacts on human health, social security, livelihoods, and poverty.

Over the last few decades, urbanisation has been rapid in Asia (Ooi 2009), with Southeast Asia as the fastest growing region, and by 2025, it is predicted that urban residents will represent 53.2 per cent of the population (Table 1). Most cities in the region are now facing a range of socioeconomic problems due to rapid development. Social divides between rural-urban and rich-poor are widely recognised in many Asian cities – and climate change impacts are putting increasing pressure on the urban poor, widening the divides within cities and towns. The urban poor are sensitive to changes in the social and environmental determinants of health caused by climate change (Munslow and O’Dempsey 2010). Additionally, children and the elderly are vulnerable to the impacts of climate change, and among the urban poor they have even greater vulnerability due to pre-existing social and economic disparities (Sheffield and Landrigan 2011).

Table 1: Urban and rural population growth rates, 1950–2030

Regional Asia	Urban population (%)				Average annual rate of change (%)			
	1950	1975	2000	2025	Urban		Rural	
					2000–2005	2025–2030	2000–2005	2025–2030
Asia	17.4	24.7	36.7	50.6	1.31	1.10	–0.80	–1.19
Eastern Asia	18.0	25.2	38.5	51.8	1.20	1.06	–0.79	–1.20
Southcentral Asia	16.6	22.2	30.6	44.7	1.36	1.37	–0.63	–1.18
Southeastern Asia	14.8	22.3	37.2	53.2	1.85	1.00	–1.18	–1.20
Western Asia	26.7	48.5	70.2	77.0	0.71	0.26	–1.77	–0.97
World total	29.7	37.9	47.0	58.0	0.83	0.77	–0.86	–1.12

Source: Ooi (2009)

The World Health Assembly adopted a Resolution of Climate Change and Health in 2008 and the World Health Organization Regional Office for Southeast Asia (SEARO) issued the 'New Delhi Declaration on the Impacts of Climate Change on Human Health' in 2008. However, the impacts of climate change on health are largely poorly understood, while minimal studies have been carried out in tropical countries (Kjellstrom and McMichael 2013). There have been some efforts made by international agencies to try to develop frameworks on health and climate change. More recently, SEARO developed a regional strategy for protecting health from climate change (WHO 2012), a guide aimed at fostering the member countries to: (i) assess health impacts and vulnerability from climate change; (ii) explore any health adaptation options to the climate impacts; and (iii) health and climate research, review, monitoring and evaluation. Many countries in Southeast Asia, such as the Philippines, Vietnam, and Cambodia, have begun to formulate frameworks on health and climate change, with support from international organisations. There are still a number of countries in the region currently at the early stages of developing national climate change and health frameworks, including Lao PDR, Myanmar and Thailand. Studies on vulnerability and impacts from climate change in Thailand and other Mekong countries have only recently been initiated. Most studies focus on impacts of the climate change on hydro-geography, agriculture, forestry and biodiversity, while few relate to human population and livelihoods.

The suburb of Pralab is located approximately 5 km from downtown Khon Kaen and suffers seasonally from the impact of floods. In 2013, Khon Kaen University (KKU) researchers found, during a small research project carried out on 'city vulnerability to the impacts of climate change' (supported by Thailand Environment Institute and IIED), that greater climate impacts are likely to occur at the urban fringe areas of Khon Kaen. Most infrastructure settings for public services in this suburb are critically vulnerable to flash floods; these include roads, the health centre, schools, the Buddhist temple, and the community meeting house. In 2011, when the suburb experienced a very heavy flood, more than half of its population was evacuated and moved to live temporarily along the highway roadside for almost two months.

The KKU research team revisited Pralab again in early August 2014. Local residents complained that the town's infrastructure and institutions did not function effectively. Residents further briefed the team on their worries; in particular the safety of their children on the journey to and from school; elderly and chronically ill patients struggling to go regularly to the health centre for medicine; elderly people not being able to walk easily to attend regular rituals at the Buddhist temple; and poisonous animals becoming widespread. They felt that those living close to the city centre of Khon Kaen seemed to have more choices in adapting to the monsoon climate and thereby minimising impacts, compared to those on the fringes.

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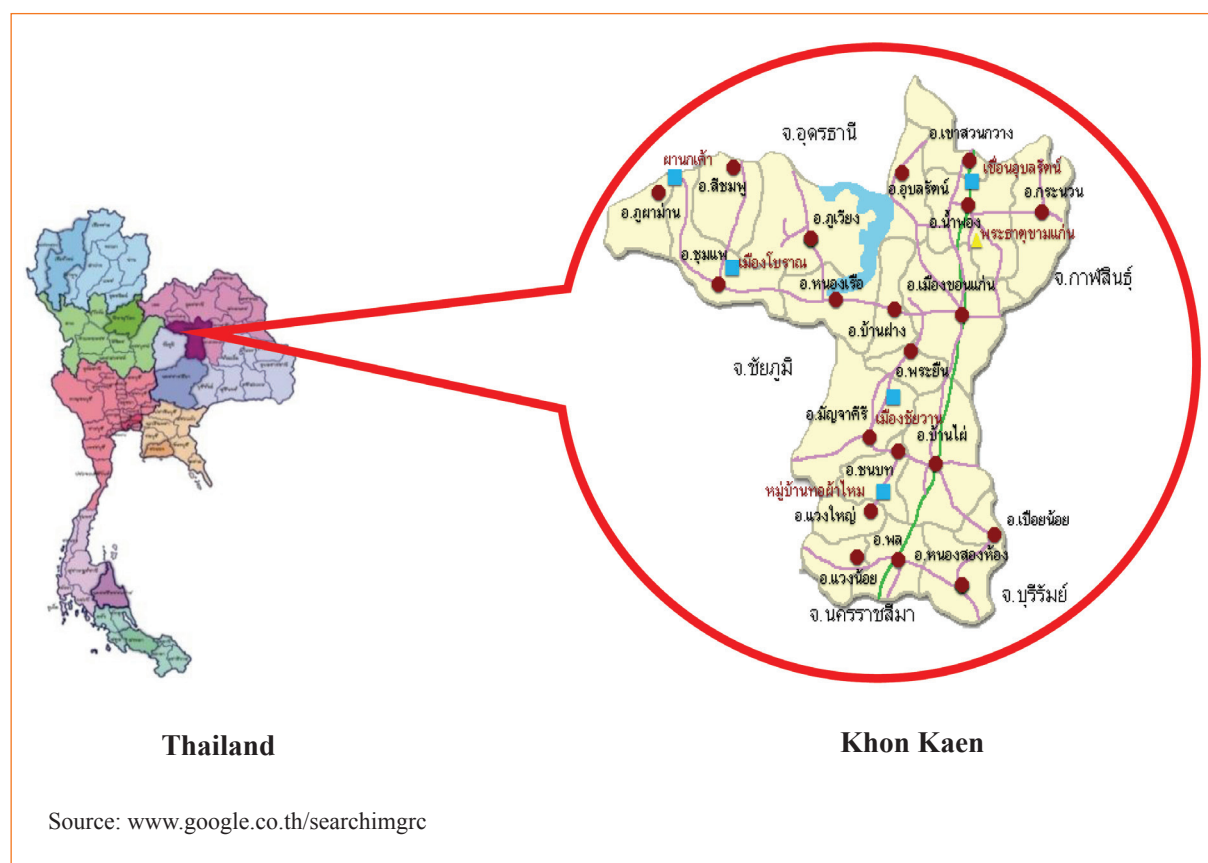


## 2 Objectives of the research

The overall objective of this study is to communicate the findings to policymakers, particular to those working on public health policy and planning initiatives. The specific aims of the study are to:

- 1) identify key climate-sensitive diseases, at-risk population groups, and the impacts of climate on social and environmental determinants of health;
- 2) identify gaps in public services and the necessary public health actions to meet the need of the health-climate burden;
- 3) explore ways that individuals, families and communities can build resilience to climate impacts on health; and
- 4) develop guidance for public health policy and strategies that should be adopted in response to the impacts of climate change.

Figure 1: Khon Kaen province



## 3 Methodology

The study applied mixed methods to collect and analyse public health-related climate data. These include a series of data collections as follows:

- 1) Compiling community health profile data which is recorded and archived at the Pralab Health Centre, aiming to identify variations of key diseases emerging seasonally (wet-dry comparison) for the last ten years. The health data profile of the health centre was also collected and analysed for key disease outbreaks during flooding.
- 2) Identifying key disease outbreaks related to floods in the Pralab community as well as reviewing institutional actions during, before, between and after the inundations.
- 3) Carrying out focus group discussion with related government staff and community leaders to identify: (i) epidemics of key diseases in association with changes in social and environmental determinants during the flooding/monsoon season in Pralab community; (ii) gaps in public services and public health actions to meet the need of the health-climate burden; and (iii) expected public health policy and health authority actions to be initiated.
- 4) Carrying out in-depth interviews about climate-related impacts on individual and family health and diseases in Pralab to gain more insights into: (i) underlying root factors (within and outside households) that could directly and indirectly cause the emergence of diseases; (ii) how these impacted individual and families to cope or manage such threats; (iii) suggestions on ways to build family and community resilience to the impact of climate on health; and (iv) recommendations for public health policy and strategies which need to be adopted.

Details of focus group discussions and in-depth interviews used to obtain data is summarised in Table 2 below.

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## Table 2: Details of focus group discussions and in-depth interviews

Types of data	Types or group of people	No.	Selection methods
Focus group discussions			
Epidemics of key diseases in association with changes in social and environmental determinants during flooding, gaps in public services and public health actions, policy recommendation.	Government staffs from following government agencies: - Pralab Municipal Authority, Department of Public Work and Town, Royal Irrigation Department, Provincial Hospital, Provincial Natural Resource and Environment Authority, Pralab Health Centre staff	10	Purposive
	Pralab residents	10	
	-Community leaders	6	
	-Chronic illness persons	10	
	-Community health volunteers	12	
In-depth interviews			
Impacts of flood on health and adaptation	Food venders/sellers	2	Purposive
	Affected residents in Pralab	27 (household-heads)	Snowball
	Public health authorities of Pralab	2	Purposive
Disaster management plan	Provincial Disaster Prevention and Mitigation Authority	1	Purposive
	Pralab Disaster Prevention and Mitigation Authority	1	
	Pralab Public Work and Town Authority	1	
	Pralab Public Health Authority	1	
	Provincial meteorologist	1	
	Pralab Health Centre Authority	1	

The data obtained from both primary and secondary sources was analysed using content analysis techniques and policy recommendations were formulated. The initial findings and policy recommendations were verified through meetings with stakeholders. The final workshop with local policymakers was organised to refine and finalise the policy recommendations that are applicable and feasible to local contexts.

## 4 Urban growth, climate change, health hazards and urban resilience: a brief literature review

According to UN-Habitat, since 2008, over half of the global population inhabits urban areas. Asia currently has the highest rates of urbanisation. In 1990, it was estimated that 31.5 per cent of the population resided in Asian cities, increasing to 42.2 per cent in 2010, or a rate of 10.7 per cent annually (UN-Habitat 2012). The urban population of Asian countries is projected to reach 64 per cent by 2050 (UN 2014). The rate of urbanisation of Thailand, although considerably lower than ASEAN counterparts (Lambrechts 2015), is following the Asian trend. Urban growth has been evident over the past two decades, and the rate of growth has a great potential to increase. However, urbanisation is also subject to debate, especially where to draw the line between rural and urban. Statistics of urban populations could be misleading, depending on where populations are registered as residents<sup>1</sup> and where the boundaries are drawn between urban and rural. It is appropriate to say that the urban or modern style of living is ubiquitous in areas surrounding towns and cities, while rural lifestyles, in the sense of being 'traditional' life-styles in Thailand, are declining.

Many studies of urban areas have been related to aspects of economic growth. Cities are seen as spaces created to accommodate investments that will lead to an increase in capital. However, studies of urban areas in developing countries have traditionally been a lower priority compared to rural development. In the context of many Asian countries, including Thailand, where agriculture only represents 12 per cent of GDP, the industrial sector 42 per cent, and the service sector 46 per cent of GDP (World Bank 2014), it is clear that urban growth is important. Consequently, it is important to study the implications of likely climate change impacts on urban areas, including the impacts on public health, which can affect urban livelihoods and economic performance. Although recently there have been growing concerns about climate change and urban growth, the relationships between climate variability and human health in urban settings remain poorly understood ([www.uhcr.org](http://www.uhcr.org)).

In recent years, there has been a growing awareness of a direct consequence of climate change on health (Barrett *et al.* 2015). The potential impacts of climate change on health problems can be outlined as below (McMichael *et al.* 2001):

- Heatwaves increase the risk of mortality and morbidity, particularly for aging groups and the urban poor.
- Climate extremes (eg storms, floods, cyclones, droughts) cause deaths and casualties, displacement, disrupt food production and affect clean or fresh water availability and quality. All these increase risks of infectious diseases.

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<sup>1</sup> For instance, tourists are not registered as residents. The registered population of Bangkok Metropolitan Area is said to be lower than the actual number of residents.

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- In certain locations or settings, climate change causes social disruption (such as following sea level rises, long and severe droughts), economic decline and displacement of populations. Health impacts of these disruptions are substantial.
- Climate change represents an additional pressure on the world's food supply system. Yield decline at lower latitudes of the low-income countries could result in undernourishment, particularly of poor and marginalised groups.
- Exposure to polluted air can cause a number of health problems and increases morbidity and mortality.

There is growing evidence of the association between climate change and specific diseases. The United State Global Change Research Program (USGCRP 2009), for instance, found that the increased frequency and severity of heatwaves led to more heart-related illnesses and deaths. Increasing temperatures and poor air quality can affect and worsen cardiovascular disease, and flooding can contaminate water with harmful viruses, bacteria and chemicals leading to food- and water-borne diseases.

Faced with climate variability such as heatwaves, floods, etc., pre-existing health problems can be intensified. For example, obesity arising from insufficient physical activity is more common among urban women than rural women, and both are common causes of other non-communicable diseases such as heart disease and strokes, (Prasad *et al.* 2014), which can be triggered by heatwaves or other extreme events.

One approach to understanding urban health impacts arising from climate change has centred around the concepts of vulnerability and resilience. In sociology, vulnerability refers to the low capacity of individuals or groups to cope with pressures caused by shocks. Vulnerability therefore connotes the relationships between humans and environments, which include natural environments, social institutions, social forces, social values and cultures that underpin both human society and environment (Bankoff *et al.* 2004). Satterthwaite (2008) outlines the factors underpinning urban vulnerability to climate change, including: 1) the adequacy, reach and quality of infrastructure provision; 2) preparedness with regard to likely climate change impacts; 3) planning and coordination among related agencies; 4) the ability of low-income groups to live in secure housing in non-hazardous areas; and 5) the ability of local governments to provide a conducive atmosphere for building the capacity of civil society organisations to participate in confronting climate change. In assessing vulnerability, various indices have been developed, one of which includes social considerations, sources of livelihoods, health, social networks, food security, water security, and exposure to natural disasters (Hahn *et al.* 2009).

The concept of resilience is closely associated to vulnerability, and refers to the ability of a system, community, or society exposed to hazards to resist, absorb, accommodate, and recover from the effects of a hazard in a timely and efficient manner (UNISDR definition). According to ISET (2012), urban resilience in particular comprises the interaction between urban agents, institutions, and infrastructure systems. The *100 Resilient Cities* initiative (100RC) pioneered by the Rockefeller Foundation defines urban resilience as ‘the capacity of individuals, communities, institutions, businesses and the system within a city to survive, adapt and grow no matter the chronic stresses and acute shocks they experience’.<sup>2</sup> This group proposes the City Resilience Framework (CRF) that comprises four essential dimensions; including health and well-being, society and economy, infrastructure and environment, and leadership and strategies. This paradigm is promoted by international institutions, such as the World Bank, to enhance the understanding of the complex system of urban planning and manage urban hazards (Jha *et al.* 2013). In a simplified form, vulnerability and resilience can be considered as two sides of a coin. Vulnerability refers to the susceptibility of agents, institutions and infrastructures to climate variability. An understanding of the drivers of vulnerability will enable a more effective approach to building resilience by building the capacity of individuals, institutions, and systems to withstand and adapt to climate variability.

Studies on urbanisation in Thailand have highlighted the ‘institutional trap’ (Lebel *et al.* 2011), related to urban governance. The trap includes overlapping bureaucracies, fragmentation, overemphasis on control, overly narrow concentration of resources on a single level, elite capture (deploying resources and opportunities to serve their own interests), and a focus on responding to hierarchies or political pressures rather than the demand of the clients (Berquist *et al.* 2014). The institutional gap for emerging rapidly urbanised cities in provincial areas such as Udon Thani is particularly evident (Promphakping *et al.* 2013).

2 [www.100resilientcities.org](http://www.100resilientcities.org)

An infrastructure deficit will exaggerate the vulnerability of local populations to climate change, and can cause urban health problems. For example, flooding can be worsened by the blockage of drains and inappropriate waste management, resulting in diseases. In Thailand, investment in infrastructure has generally rested with central government, especially state enterprises. From 1997, infrastructure plans and construction were significantly decentralised, through the enforcement of the new Constitution. However, Thai decentralisation is focused on expenditure, not revenue. Central government continues to collect revenues and then transfers these to local government. Under this type of decentralisation, municipalities (urban) have benefited less than the lowest level of the Tambol administrative organisation (rural) (TAOs) and the provincial level of provincial administrative authorities (PAAs) (Webster and Theeratham 2004). Local governments usually received insufficient finances for infrastructure from central government, and funding greatly varied according to political environments and connections. Local governments, TAOs (a number of which have now been upgraded to Tambol municipalities), PAAs and municipalities are therefore competing for budgets from the central government. Lack of coordination within local governments is therefore common, especially in developing and maintaining infrastructure such as roads, drainage, energy, and other services.

Connected to the lack of, or insufficient, infrastructure is the limitation or failure of urban planning. Scott *et al.* (2001) argue that the urban growth of cities in the developing world can be characterised by ‘global city-region’ development, whereby firms seeking low costs for production have fed the urban growth of the city peripheries. This pattern of growth does not follow the American model of sprawling suburbs of rampant consumerism and blighted inner cities (Marcuse and Kempen 2000). For example, Shatkin (2008) argues that the growth of Metro Manila was shaped by intense fiscal and external pressures on government to concede influence over urban development to private sector actors, and by a local political economy that has fostered the political power of elite families.

In Thailand, urban planning has been proclaimed as Royal Decree (Town and Country Planning Act BE 2518) since 1975. According to this law, the city must have a ‘city master plan’ – which is primarily for land use planning, and the plan must be made by royal decree and must be recorded in the government gazette. However, urban planning under this law has proven inefficient. In the case of Khon Kaen, the first city master plan expired over a decade ago, and the second city master plan has been suspended for many years, due to a residents’ petition to the court, as a consequence of which a court order has halted the law. With the absence of urban planning, Khon Kaen’s urban growth is in a vacuum.

Urban growth, as briefly discussed above, is both susceptible to, and further galvanizes, climate change. The activities associated with the burning of fossil fuels for energy and other human activities are mostly and directly associated with industrialisation and urbanisation, such as construction and transportation. Studies on climate change have been traditionally focused on its implication on environments and ecosystems, and thus the implications of their collapse on the fate of humans have been well-established. However, the direct link between climate change and the health or well-being of people is still being explored. This is partly because climate change is a global or macro phenomenon encompassing a number of factors, and it is therefore difficult to justify a causation of specific health problems at micro scales.

To sum up, urbanisation can be defined in line with David Harvey, as “social, cultural and physical landscape that built to accommodate new investment, for a further capital accumulation” (Harvey 2002). In the developing worlds, urbanisation is new and rapid, and urban governance becomes a salient issue. This includes insufficient and uneven urban infrastructures, such as roads, housing, drainage, energy and social cultural infrastructure (eg a sense of belonging, social space, etc.). Faced with growing variability and extreme climates, the new urbanised zones are susceptible and vulnerable, and climate change has a potential to cause negative impacts on the health of urban residents.

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# 5 Contexts of the study areas – Khon Kaen City and Pralab suburban area

## 5.1 Khon Kaen: urban growth

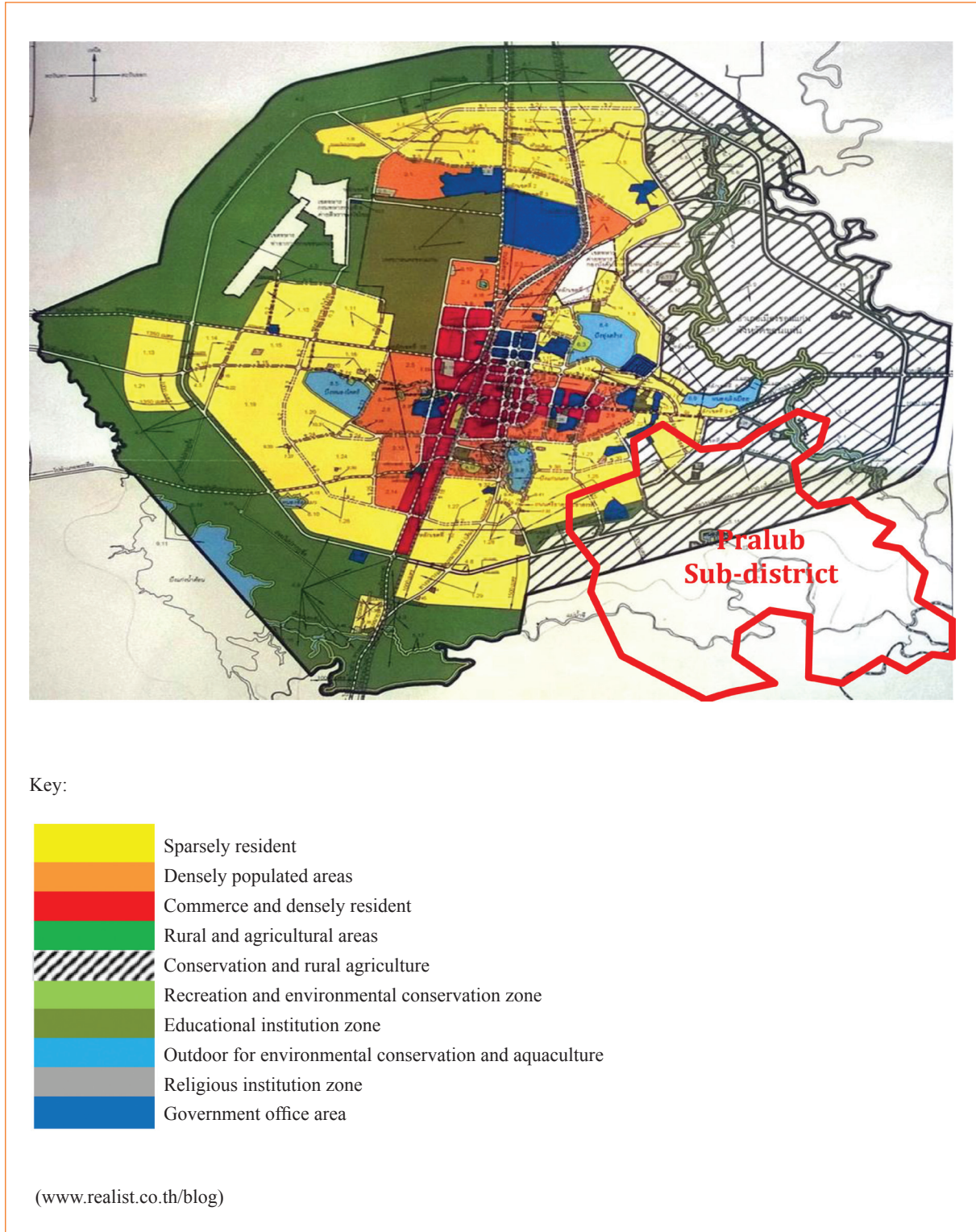
Khon Kaen is a province with a total area of 10,885 square kilometres. The province is home to 1.75 million people (in 2009), most of whom reside in rural areas. There are 25 district towns within Khon Kaen Province: these towns are the links to central government, and also the units of local government, usually town municipality (**เทศบาลเมือง**, tesabanmuang) or sub-district municipality (**เทศบาลตำบล**, tesabantambol). Khon Kaen is the capital city of the province, designated the regional capital city of the northeast Thailand since the first National Economic Development Plan (1961–1965).

The city houses a number of important regional as well as central government agencies, such as the northeast branch of the Bank of Thailand and the regional police headquarters. Since the early 1960s, the city has grown steadily, from a centre of upland crop trading and a regional government centre, to a centre of diversified businesses and government services. In the past few years, Khon Kaen City, in government plans, has been assigned as the transportation and logistics hub of the Mekong sub-region. This plan has been one of the driving forces of Khon Kaen's urban growth.

Currently, Khon Kaen municipality extends over 46 square kilometres and is home to 112,329 people (2013). Over the last ten years, the municipal population statistics have shown a steady decline; in 2002, the population was 130,528. The decline of population is partly due to shifts in location of house registrations, with those who were previously registered within Khon Kaen municipality increasingly buying and registering their houses in the suburbs. This is combined with new migrants expanding the urban zone of Khon Kaen beyond the administrative area of Khon Kaen municipality. The urban zones of Khon Kaen, therefore, have expanded to cover adjacent areas that are administered by separate local governments (Figure 2). These local government administrative units raise governance challenges for urban Khon Kaen. Moreover, vast areas within these urban zones are under the management of specific government agencies, such as military bases and public universities. These government agencies have their own plans and budgets for investment in infrastructure (eg roads and buildings) within their compounds.



Figure 2: The new Khon Kaen City plan (approved by the provincial committees in January 2015)





## 5.2 Pralab suburb

Pralab was previously classified as a Tambon administrative organisation (TAO) and was elevated to Tambon municipality in 2008. It is an area of 40 square kilometres, most of which is agricultural land. It includes 19 villages with a total population of 21,991 (Pralab Tambon Municipality 2015). Over the last few years, the population of Pralab has increased steadily, by 1.61 per cent annually. The increase of population is partly due to the growth of Khon Kaen, resulting in the spread of real estate development to surrounding areas.

As Khon Kaen's urban areas have steadily grown, people have moved to the city and its periphery for livelihood and investment opportunities. These newcomers have also caused Pralab to expand, but to a lesser extent compared to other neighbouring areas of Khon Kaen municipality. This is because Pralab is a low-lying area more suited to agriculture. Nevertheless some new housing development projects have been built in Pralab area. Some migrants working in the city seeking low cost rented houses have not registered their residence officially, but also contribute to the increase of population in Pralab.

## 5.3 Pralab: social and demographic characteristics

A recent survey, covering 100 households in Pralab, has shown that 82 per cent of the population residing in Pralab completed primary education. Thirty one per cent of the population were reported to engage in agriculture as their main occupation, followed by small enterprises or trading and casual jobs (19 and 16 per cent respectively) (Inmuong *et al.* 2014). These patterns of livelihoods are common to rural areas where many people have received a lower level of education, and agriculture is the main source of their livelihoods. Almost all of Pralab's household incomes are derived from working and trading in Khon Kaen City, with a large proportion of the population providing services in Khon Kaen City centre and returning home daily. Another source of family income is trading vegetables in Khon Kaen fresh markets.

Table 3: Livelihoods in Pralab

Occupation	No. of respondents	Percentage
Agriculture	31	31%
Government officers	4	4%
Private enterprise	1	1%
Company employee	3	3%
Casual wage earning	16	16%
Small scale business	19	19%
Student	1	1%
University employee	1	1%
Housewife	2	2%
Hairdresser	1	1%
No occupation	21	21%
<b>Total</b>	<b>100</b>	<b>100%</b>

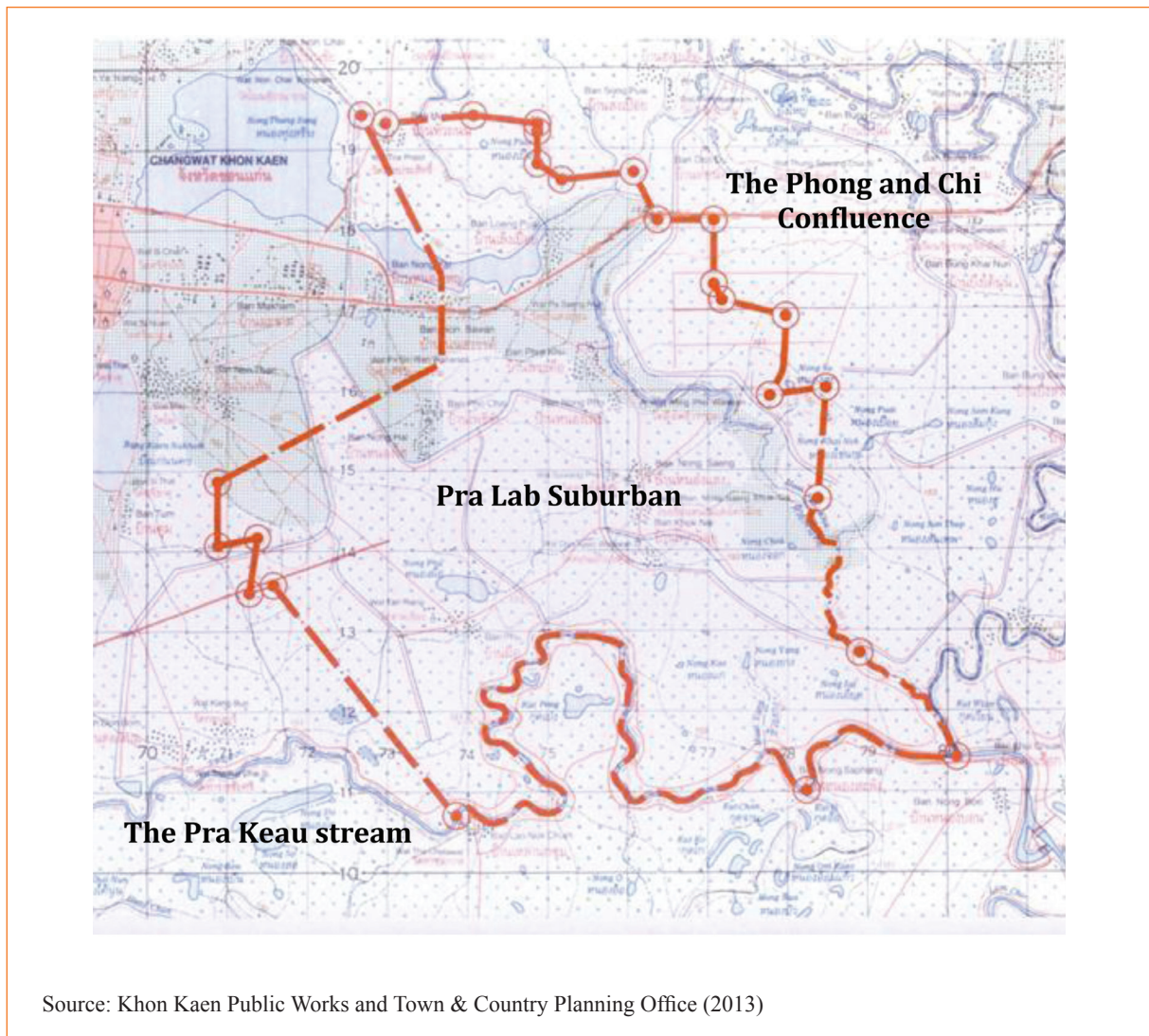
Source: Inmuong *et al.* (2014)

Pralab also houses more than 1,000 non-permanent residents who migrated from other provinces. These population groups earn a living by providing odd-jobs in Khon Kaen City centre. Living costs, such as house rentals, are relatively cheaper in Pralab suburb than in Khon Kaen City.

In addition, the same survey cited above reported a significant number of Pralab residents with ‘no occupation’, which accounts to 21 per cent of the total population (Inmuong *et al.* 2014). This indicates that unemployment is high (see Table 3). Employment in suburban areas like Pralab is highly dynamic. As agricultural lands shrink in favour of urban growth, people become dependent on new urban jobs, especially in the service industries. However, urban jobs require specific skills and often a higher education level than primary, which means that most suburban residents are engaged in non-skilled casual labour. This type of work is temporary by nature and its availability is unpredictable. This could explain the high unemployment rates among Pralab residents.

The latest Pralab Health and Environment Division Report (2014) shows that Pralab has 2,218 elderly persons, 402 persons with chronic health problems, 1,207 children under 5 years old, and 142 disabled persons. These groups can be considered to be vulnerable to floods that are the consequence of climate change. Pralab has two community health service centres with 357 village health volunteers, one secondary school and six primary schools.

Figure 3: Pralab suburban area



Source: Khon Kaen Public Works and Town & Country Planning Office (2013)

Pralab suburb is situated at the confluence of the two rivers, the Phong and the Chi, and the Pra Keau stream, a tributary of the Phong River (see Figure 3). Wastewater discharged from the Khon Kaen sewerage treatment plant flows into the Pra Keau stream. Pralab, at the further end, is vulnerable to floods from the two large rivers while upstream, adjacent to Khon Kaen City, it is at risk from the impact of wastewater flow. During heavy monsoonal years, Pralab suburb has often experienced intermittent floods, while the peak record occurred in 2011, when Pralab was inundated for almost three months. During the heaviest flood of 2011, Pralab's infrastructure and service systems (eg roads, sewerage, public health services, and schools) collapsed, while the flood waters blocked the connection between Pralab and the outside world. The recent assessment of vulnerability to floods of Pralab's residents reveals that Pralab's population is very vulnerable to climate change impacts, particularly with regard to health, natural disasters (flood), social demography, food, and water security (Figure 4).

The 2011 flood caused infrastructure destruction, transportation failure, blocked access to schools and health service centres, and a decline in family incomes. Pralab is recognised by many government agencies and the Khon Kaen general public as the most vulnerable place to the impact of floods in upper northeast Thailand, and this is much intensified due to the increasing degrees of climate change and variability.

Figure 4: Vulnerability analysis of Pralab suburban area

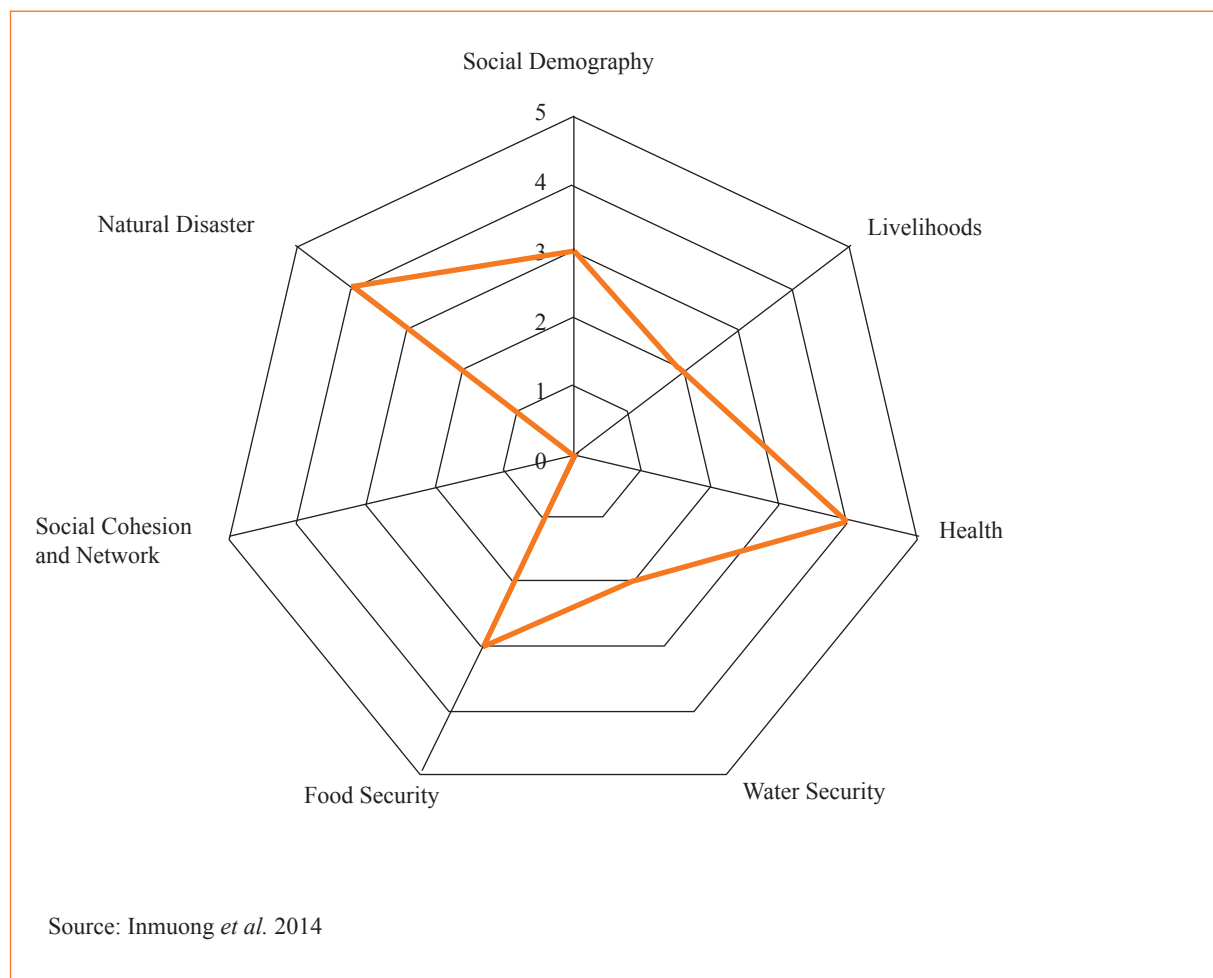


Figure 5: Floods in Pralab and temporary shelters on the roadside



## 5.4 Climate variability

The northeast of Thailand is notorious for droughts which, together with poor quality soil, have contributed to high levels of poverty. Although overall, rainfall in this region is low, floods can occur in some places, particularly in the lowlands during the monsoon season. For Khon Kaen, the statistics of average precipitation show great variation over the past decade (2003–2013). The highest precipitation recorded by the meteorological station of Khon Kaen was in 2003, 2008 and 2011. The high precipitation coincided with floods in Pralab area, especially in 2008 and 2011 (see Figure 4). However, while the 2008 flood peaked relatively high, the water levels fell quickly in a few days with the run-off flowing steadily into the main river channels; whereas in 2011, the water remained stagnant in Pralab for almost three months. This was due to a higher number of rainy days, peaking at 131 days (see Figure 5) as well as the surrounding areas, including the main river channels, being filled up with run-off water. The severe and long-lasting flood in 2011 had an enormous effect on Pralab community. It is appropriate to say that climate extremes, in the case of Pralab, are characterised by the number of rainy days in a year.

## 5.5 Health profile of Khon Kaen and Pralab

Pre-existing health problems can be intensified when facing climate variability extremes such as floods (Prasad *et al.* 2014). For instance, floods can prevent access to health services and food sources, or lead to a decrease in physical activities that could intensify some of those who already have health problems such as obesity, heart diseases, etc. Illness or chronic illness of individuals may result from their ability to cope with climate extreme, whereas health infrastructures can reflect the ability of institutions to respond to the consequences of climate change. In this respect, it is useful to look at the general health profile of the studied area, as summarised below.

Figure 6: Average annual rainfall in Khon Kaen (2001–2013)

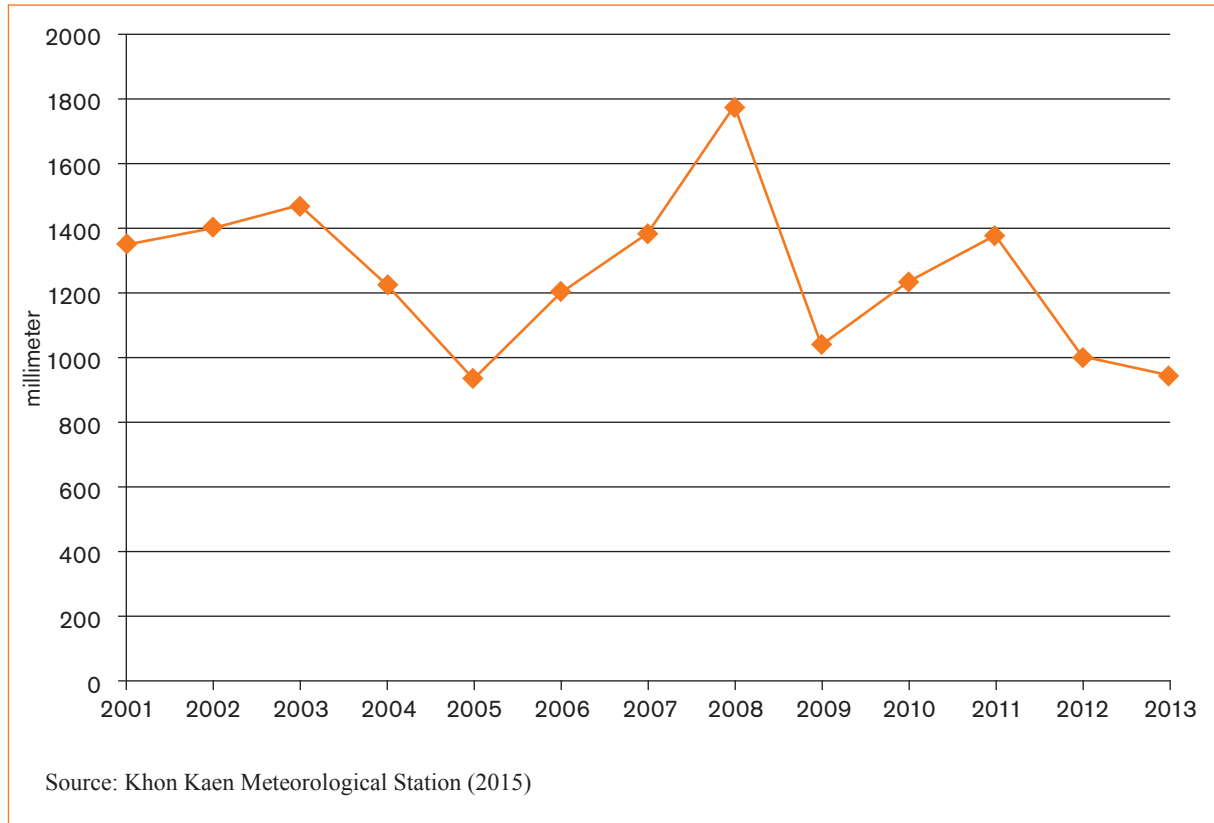
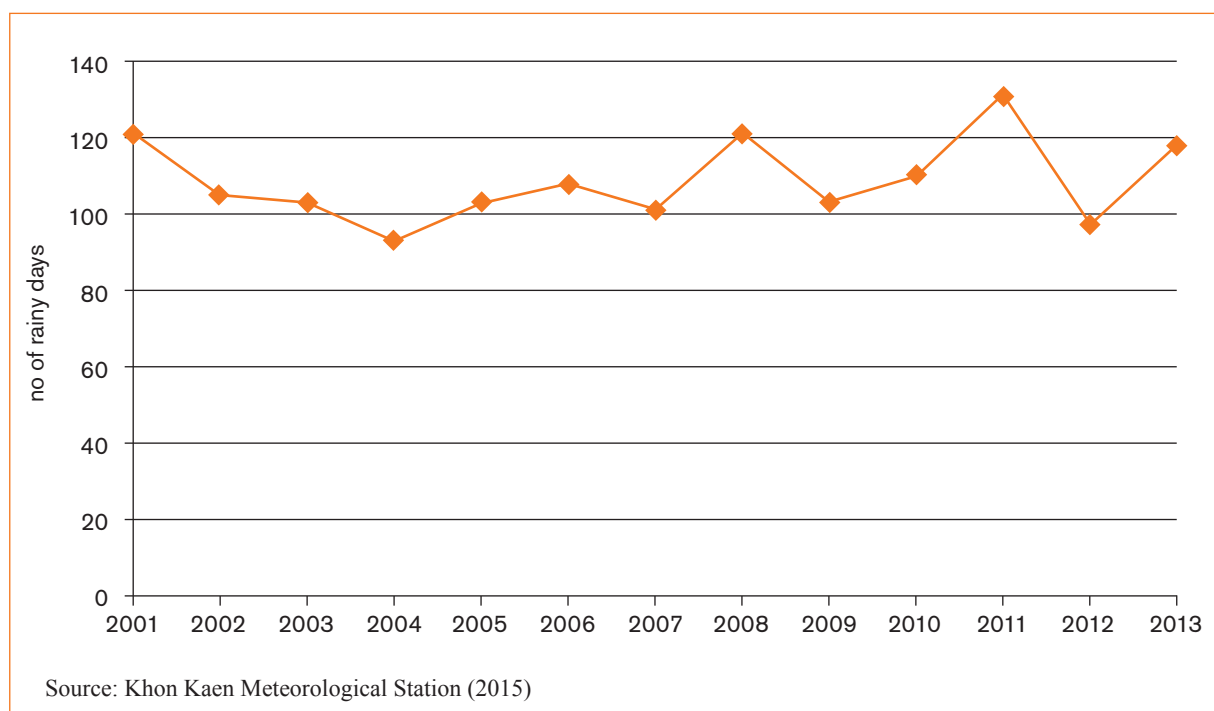


Figure 7: Number of rainy days in Khon Kaen (2001–2013)





In general, health services and health facilities, such as hospitals, dental clinics, pharmacies, and private clinics are concentrated in urban areas. This is also the case for Khon Kaen. Within the province with the total population of 1.776 million (2011), there are 32 hospitals, of which 27 are government hospitals. There are 888 physician doctors (1:1985 population), 209 dentists (1:8,432 population), and 3,489 nurses (1:505 population) (Office of the Permanent Secretary of Ministry of Public Health 2012). Most of the health facilities are located within the urban area of Khon Kaen municipality. These include one government hospital with 867 patient beds, Khon Kaen University Hospital, with 1,220 patient beds, and three private hospitals. Given the proximity of Pralab to Khon Kaen City, these health facilities and health personnel benefit the population of Pralab. In addition, in the last decade, the government has extended universal health insurance to cover those who are not under any existing types of health insurance. This government programme helps to ease the problem of access to health services that was previously obstructed to the poor due to the expense.

The health status of the population can be best described through the prevalence of diseases which cause illnesses. A report on the top five causes of illness of in- and out-patients admitted to government hospitals in Khon Kaen Province in 2011 is outlined as in Table 4.

**Table 4: Disease incidences from in- and out- patient records in Khon Kaen Province in 2011 (rate per 100,000 of the population)**

<b>In-patients</b>	
Endocrine, nutritional and metabolic disorders	2908.10
Disease of blood / blood forming in organs and other disorders	1426.39
Hypertension diseases	1274.64
Diabetes mellitus	1230.19
Complication of pregnancy, labour, delivery, puerperium and other obstetric conditions, not classified elsewhere	971.99
<b>Out-patients</b>	
Respiratory system	35324.5
Digestive system	31689.30
Endocrine, nutritional and metabolic disease	27324.23
Diseases of the musculoskeletal system and connective tissue	23320.28
Diseases of the circulatory system	23075.58

Source: Office of the Permanent Secretary of Public Health (2011)

As shown in Table 4, endocrine, nutritional and metabolic disorders and diseases of the blood and blood-forming organs and other disorders are the major illnesses and these take a long time to cure, while respiratory and digestive system disorders are the main causes of short-term illnesses. These two prevalent communicable diseases are to a certain extent related to local environmental factors where air quality, housing, and food sanitation are considerably poor.

## 6 Climate change impacts on health

It is well-documented elsewhere that the consequences of climate change can directly or indirectly affect population health, particular with communicable disease incidents in the upper respiratory or intestinal tract, skin infections, as well as vector-borne illness.

As discussed in the previous section, the main climactic impact which Pralab has been witnessing is prolonged flooding, due in part to a high number of rainy days. The health records from the community health centres show that the population of Pralab is facing health burdens from both non-communicable and infectious diseases (Table 5). The results of analyses of health reports from the two community health centres over the past five years indicate that the residents of Pralab have relatively high rates of diabetes and hypertension. The prevalence of diabetes ranged relatively high from 1,755–2,265 per 100,000 of the population. Likewise, the hypertension rates are also increasing from 1,109–1,434 in the period of 2010–2014. Most of those with diabetes and hypertension are aged 50 years old or over. For the communicable diseases, the top four high incidences are diarrhoea, pneumonia and dengue fever.

The diarrhoea rate per 100,000 of the population remains relatively high when compared with dermatitis and dengue fever. During the heavy floods of 2011, these four infectious diseases (diarrhoea, pneumonia, dermatitis, and dengue) showed a higher prevalence when compared to the previous and subsequent years, with the exception of dengue.

Table 5: Incident rates of prevalent diseases per 100,000 of the population in Pralal surburban area

Year	Diabetes	Hypertension	Diarrhoea	Pneumonia	Dermatitis	Dengue
2010	1755	1109	1736	273	32	178
2011	1804	1185	2106	408	157	152
2012	1993	1245	1518	363	27	132
2013	2215	1356	1852	358	48	265
2014	2265	1434	1313	291	110	21

Source: Pralab and Ban Phue Tambol (sub-district) Health Promoting Hospital (2014)

The result of focus group discussions where Pralab community representatives participated showed that the community leaders perceived that the community has an underlying health burden with diabetes and hypertension. They also observed that during flooding periods, the community had high infection rates with intestinal, respiratory tract, and skin diseases (Table 4). When the discussion focused on the impact of climate change and urbanisation on the social and environmental determinants of health, the participants elaborated that they felt the key issues were polluted water sources, limited access to safe food sources, difficulty in disposing waste, lack of public health plans related to climate change and disaster preparedness, drainage and transportation failure, and impacts on family livelihoods (Table 6).

**Table 6: Health consequences from the combined effects of climate change and urbanisation**

Drivers	Impacts on social and environmental determinants of health	Health outcomes
<ul style="list-style-type: none"> <li>■ Climate change</li> <li>■ Urbanisation</li> </ul>	<ul style="list-style-type: none"> <li>■ Polluted water with limited availability of safe and clean drinking water</li> <li>■ Limited food supply and access to food sources</li> <li>■ Difficulty of disposing and managing solid waste during floods</li> <li>■ Lack of public health plans and strategy related to climate change impacts</li> <li>■ Disruption to drainage and transportation</li> <li>■ No income and threatened family livelihoods</li> </ul>	<p>Baseline health burdens:</p> <ul style="list-style-type: none"> <li>■ Diabetes</li> <li>■ Hypertension</li> </ul> <p>Health outcomes due to floods:</p> <ul style="list-style-type: none"> <li>■ Diarrhoea</li> <li>■ Pneumonia</li> <li>■ Dermatitis</li> </ul>



## 7 Building resilience

One, and perhaps the most salient response to flooding in individual households in Pralab suburb, is the elevation of houses. This method has been widely used in Thailand, not only to cope with floods, but also for renovating houses in rural areas. With this approach, without deconstructing the house, the pillars of the house are elevated by hydraulic jacks and restabilised at a higher level. The civil engineer officer of Pralab district municipality revealed that this method has been widely used by house owners, especially for old houses in Pralab suburb. The cost of elevating a house ranges between 8,500–30,000 Baht per house. This cost represents a considerable investment for poorer households, and therefore some households have borrowed money to elevate their houses to avoid flooding. However, since the elevation of old houses does not require official approval, there are no reliable records available. For new houses or commercial buildings, all projects use landfilling to elevate the earth above flood levels. This method requires official approval. Since the big flood of 2011, 456 units (houses) and 33 commercial buildings have been approved for construction and all of these have used landfilling to raise the earth, at least to the same level as the top of the nearby road (Civil Engineer Office 2015).

The same civil engineer officer also expressed his concern regarding building long-term resilience. He noted that dyke construction along the Pra Keau natural waterway is necessary to prevent the overflow of polluted water drained from Khon Kaen urban zone into the Pralab area. Water pumps should be installed in flood-prone areas to drain water, and, for this, local government must support the cost of the electricity or gas to pump the water.

From in-depth interviews with flood-affected households, the residents of Pralab apply a range of coping mechanisms when faced with floods. Individuals prepare necessities, such as medicine for household members with chronic illness, clothes and gumboots. Households have to move their belongings and appliances to higher levels to avoid water damage. If necessary, households build temporary shelters on roadsides or on public land that has escaped flooding (see Figure 5). There were two public spaces used for temporary shelters during the 2011 flood – ring roads and the village primary school. The number of households who built shelters on the roadside was 221, representing 50 per cent of the population of Ban Pra Keau, one of the villages of Pralab Tambon municipality. In the same year, 75 households used primary school buildings for their temporary shelters (Public Health Officer, interviews). During the floods, networks of kin or mutual support are essential for all kinds of help for households. Households who own boats prepare them to use as transportation during the floods. Some of the households earn an income from fishing during the floods. Apart from assistance in terms of food, clean drinking water and some necessities that affected people receive from government agencies, they also receive help from philanthropic organisations from Khon Kaen, particularly in the form of canned food and bottled drinking water.

In-depth interviews were carried out with the Khon Kaen provincial health authority, the district health chief and two community health officers. They all reflected that Thailand has not yet put in place a national public plan and strategy to cope with climate change. The Thai Cabinet launched a resolution assigning the Ministry of Public Health (MOPH) to lead on the development of a public health plan and strategy for adaptation to climate impacts in December 2012. At this point, the MOPH has just finished the first draft of the plan and strategy document, and this still needs consultation with other government agencies and the general public. The draft national public health and climate change adaptation plan and strategy focuses on establishing a public health surveillance system, information and communication network, developing climate and health training courses, and formulating a rapid response system to tackle health problems during extreme climatic events.

Interviews with the two heads of the community health centres in Pralab revealed that there were no resources from the provincial and district health authorities, particularly for the preparedness of the centres in handling the health impacts from climatic change. During the severe flood in 2011, the two health centres did their best by cooperating with village health volunteers to deliver health services at home for those residents who could not physically access the health centres. Most services provided at home were the supply of drugs and health advice for chronic patients and for any emergency cases. The centres had no environmental health resources to offer to affected residents, such as clean water, solid waste management systems, insect and rodent control, or even mobile latrines. Those displaced residents who stayed in the temporary shelter (221 households) lived mostly on packaged food, clean water and other essentials provided by many charity organisations in Khon Kaen City centre.

The health officers also observed that many residents who remained at home during the floods were suffering from skin problems arising from contact with polluted waters, insufficient fresh food and water, the threat of poisonous animals, difficulties in disposing of garbage and human excreta, and difficulties in cleaning clothes and other houseware. Chronic patients became more stressful, and most residents feared that some of their assets would be lost, and therefore they did not want to leave their houses for temporary shelters on roadsides and in the primary school during the flood. Most children could not go to school, and many families could not access their workplaces in Khon Kaen City centre.

The respondents from the health authorities at provincial, district, and community levels also revealed that they all expected the country to put in place a national public health plan and strategy in coping with climate change. They feel that once the plan and strategy had been established and approved by the Cabinet, then public health resources and other supporting measures would be available and eventually transferred to the level of the community health centres. The two community health centres also observed that the collapse of infrastructures; road, sewerage systems, public water supply systems, solid waste collection and transportation, were well-known as the social and environmental determinants of health. They were of the opinion that occurrences of diarrhoea and other communicable diseases in particular were more prevalent during the flooding period, and hence related to the floods.

The provincial health authorities added more observations on the collaborating efforts between government agencies; they remarked that even the provincial government had set up a disaster relief committee, but for the health sector there was little cooperation with other sectors. The aid provided by public health and other services to displaced residents and those staying at their home during the flood, was mainly from local government, but with limited capacity - and therefore surprisingly a large part came from private agencies, in particular local charity groups and the provincial chamber of commerce. It is worthy to note here that social cohesion and social networks, as illustrated in Figure 4, have become a proactive and reliable group to fulfil the mission of helping the diverse affected population. This active civic movement for helping those impacted by floods has been triggered and stimulated by the local mass media as they disclosed information about the severe conditions to the general public.

The results of the focus group discussions with the chronically ill patients revealed that they expected the health authorities to be better prepared to deal with extreme flood events. They reasoned that the elderly in Pralab with chronic hypertension and diabetes were struggling to get access to the health care services during flood events, while the health care providers could not do any physical check-ups at the health centre or do outreach home visits. They received some advice and drugs from village health volunteers instead, and this was not sufficient. These groups also experienced more stress during the floods. They suggested that provincial and district health providers should offer more healthcare services in the areas where floods were persistent, when the existing two to three health officers at the community centres could not handle the heavier load. Communication with the registered patients in the area was another area of concern when the patients sought to consult the healthcare providers.

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The results of the focus group discussions with Pralab residents reflected similar issues to the focus group with chronic patients, but they also felt that most family members were at high risk from communicable diseases. During the flooding period, they had limited safe drinking water and food at home, and the very poor sanitation of the surrounding environment put their households at high risk of infectious diseases. They felt that most of their family members were susceptible to diarrhoea and dermatitis. They suggested that the provincial and district health authorities should bring in sanitation services to the flooded areas to help the locals manage these environmental health risks.

The focus group with the village health volunteers (one person per ten households), revealed that they worked very hard to deliver health services to the flood-affected households. They had insufficient boats to bring them to those families with sick persons. What they could do best was to assign a volunteer household in the neighbourhood to stock basic medical first aid to supply to any households which may need it. They also stated that the only two ambulance boats provided for the emergency were insufficient for the needs of more than 4,000 flood-affected households.

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## 8 Proposed community strategies for coping with climate and health impacts

The community stakeholders suggested that there should be coping and adaptation strategies adopted locally to deal with the impacts climate and urbanisation. The local government - Pralab municipality - should be a leading agency in merging and including issues of climate-urbanisation-health consequences into its annual and rolling (three year) community development policy and planning process. Such an initiative by Pralab would also need support by provincial and district policy and planning authorities, both technically and financially.

The provincial and district policy and planning authorities should be the coordinating agencies for collaborative action across the provincial and district authorities, in particular to formulate the before- and after-flooding support programme and activities in Pralab municipality. The period prior to flooding should include a set of all essential preparedness activities and concerted actions to be carried out between the relevant provincial government authorities, Pralab municipality, and community leaders.

During past floods, Pralab municipality was not able to operate community services effectively and needed considerably support from provincial and district government agencies. In the future, the provincial and district disaster prevention and mitigation authority should take action on managing waste and supplying safe food and water to households affected by the floods. This agency should also relocate severely impacted households, the elderly and children to safe places as well as supplying shelter, food, drinking water, boats and other materials. Likewise, the provincial and district civil works and town planning authorities should help Pralab to build transportation infrastructure to reconnect the flooded communities with the outside world, as well as rebuild infrastructure such as roads, sewerage systems, health centres, and schools after the flooding period.

The provincial and district public health authorities should establish a policy and plan to support Pralab municipality, including a set of actions before and after periods of flooding. Prior to the flooding period, the public health preparedness activities should be focused on public health services, in particular on mobile chronic patient treatment, emergency medical care, household water and sanitation provision, public health counselling, communicable disease prevention and control, and drug stockpiles. As the public health evidence showed that upper respiratory infection, diarrhoea and dermatitis are much more prevalent during the flooding periods, provincial and district public health authorities should take specific measures to deal with these health threats. During the post-flooding period, these public health authorities should collaborate with other respective provincial and district authorities to jointly manage waste, provide safe food and drinking water, manage vector control, as well as mental health rehabilitation.

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More details of coping strategies suggested by Pralab communities are as follows:

### a. Waste management:

- a) Solid waste management system to be put in place during flooding events.
- b) Mobile latrines to be provided by local government and external agencies.
- c) Wastewater to be managed in collaboration with other agencies.

### b. Disaster management:

- a) Other neighbouring local governments to cooperate in assisting Pralab community when facing disaster impacts.
- b) A disaster preparedness plan to be established in collaboration with all relevant agencies and institutions.
- c) A community-based coping strategy for floods to be developed.
- d) Provision of essential facilities to the evacuated and relief areas to be put in a state of preparedness.

### c. Public health measures:

#### i. Vulnerable groups (elderly and children)

- a) Creation of a database inventory of vulnerable groups.
- b) Provision of information and capacity building of community groups, particularly on knowledge and practices in disaster handling.
- c) Support to individuals and families in preparing a stockpile of essential drugs, safe food and water and other essential items during the flooding period.
- d) Support to essential facilities enabling public health officers to take care of vulnerable groups.
- e) Development of a collaborative plan and action by public health agencies to handle emergency cases.
- f) Development of a special health service plan for vulnerable groups.

#### ii. General public:

- a) Establishment of a health surveillance system during flood period.
- b) Development of an integrated public health plan in collaboration with other agencies.
- c) Building capacity of village health volunteers to cope with health impacts during the floods.
- d) Preparation and provision of essential drugs.
- e) Informing and building knowledge and skills of the public on how to cope with the floods.
- f) Collaboration with other agencies to deliver mental health services before, between, and after the floods.

#### d. Transportation measures:

- a) Provision of boats, large vehicles, pedestrian stairways to connect the community and outside localities.
- b) Provision of a community map to inform community members and outsiders of travel options within the flooding area.
- c) Preparation of evacuation routes in advance with mock drills, particularly for vulnerable groups.
- d) Support the maintenance of community members' vehicles during and after flooding periods.

#### e. Infrastructure and social measures preparedness:

- a) Improvement of drainage and pump systems.
- b) Enforcement of law in land management.
- c) Fostering of social networks to manage the flood impacts.
- d) Installation of a water filtration system in the flooded area.
- e) Establishment of a public food supply centre within the community during the flood.
- f) Support to individuals and families to prepare and store food during the flood.

#### f. Early warning systems and access to information:

- a) Establishment of early warning systems.
  - b) Collaboration with other agencies to access climate information.
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## 9 Conclusion

The growth of Khon Kaen is a consequence of the ‘production of space’, the process whereby the capital seeks new places to invest in order to expand the accumulation of capital. The growth of the urban centre of Khon Kaen has contributed to the urbanisation of suburban Pralab, and this has profoundly shaped its vulnerability. The urban growth is primarily associated with the expansion of urban infrastructure, such as roads, drainage systems, energy, water pipes. In the instance of such rapid expansion, insufficient and improper maintenance of infrastructure is common, as well as deficits in the provision of infrastructure. This study has looked at the impacts of climate change on health, in particular in the increasing urbanisation of Pralab suburb.

The climatic changes that have created urban health vulnerability in Pralab manifests as floods, and severe or exceptional flooding occurs during a year with the highest number of rainy days. Floods are not unusual in Pralab, but local people were able to deal with them previously. In more recent years, floods have lasted for a longer time, with the floods in 2011 remaining for more than two months. In part due to unusual precipitation, these longer floods are exacerbated by improperly built infrastructure, such as roads and the development of new residential projects. Roads are normally raised higher than the ground to avoid being flooded, but they effectively become dykes preventing or slowing water from being drained from the area when floods occur. In addition, there is an expansion of residential projects from Khon Kaen urbanised area to Pralab suburb. This infrastructure slows or blocks water drainage, and thereby intensifies floods.

This study identified key climate-sensitive diseases which include both non-communicable and communicable diseases. The communicable diseases are diarrhoea, pneumonia, dermatitis and dengue fever. The prevalence of these diseases was higher in the year of exceptional flooding (except for dengue). The population living in the Pralab suburb zone, particularly the elderly, young and chronically ill, are vulnerable. The consequences of climate change, characterised by unusual flooding, on the health of Pralab residents are intensified due to polluted water drained from Khon Kaen urban zone which contaminates the existing flood water.

The study found that individuals and households adopt a range of methods to deal with flood. Individual households elevate their houses to escape flooding. When floods are predicted, households prepare food, water, transportation (boats), and medicine for those who are chronically ill. Temporary shelters are set up along the roadsides or on public land that is safe from being inundated. The village health volunteers play a key role in distributing services to households during flood when the community health centre is not easily accessible. In addition, the study found that related government agencies play a less active role in providing assistance, such as food, clean water and temporary shelters, to affected people. Most of the assistance comes from non-profit organisations. This finding indicates institutional weaknesses in building resilience to climate variability.

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Pralab residents and institutions are adopting several strategies to cope with the impacts of climate change, however improvements are needed. These include:

- Improvements in waste management, both during and after floods; in particular mobile latrines must be adequately provided during floods.
  - Better cooperation between local governments in managing disasters; preparedness plans must be put in place before future events, including planning for relief facilities.
  - In respect to public health, a preliminary database and inventory of vulnerable groups must be prepared, and training in handling disasters, in the form of both knowledge and practice, must be provided.
  - Community capacity building to cope with disasters, for example training for village health volunteers in managing disasters, must be supported.
  - Finally, infrastructure, both social and physical, must be improved. This includes improvement of drainage systems, installation of filtration systems, enforcement of law in land management and the fostering of social networks.
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# Climate change and urban health vulnerability

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