Cities and Climate Change Initiative

ABRIDGED REPORT

Hoi An, Viet Nam

Climate Change Vulnerability Assessment

UN-HABITAT
FOR A BETTER URBAN FUTURE

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Hoi An, Viet Nam – Climate Change Vulnerability Assessment

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DISCLAIMER

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Introduction

1.1 Cities and Climate Change

Climate change is already affecting millions of people worldwide. In urban areas, which are typically characterized by a significantly higher population density, climate change will exacerbate and compound existing vulnerabilities, especially for the urban poor. As a result of climate change, we expect that storm frequency and intensity will increase, flooding will become increasingly significant and droughts will affect food production in rural areas, which will result in damaging knock-on effects in urban areas. Coastal areas are threatened by inundation from sea-level rise, and other urban challenges, such as poor health and inadequate housing, to name two, will be substantially exacerbated by climate change impacts. As the main drivers of increased greenhouse gas emissions, cities must be the centre of actions both to mitigate the causes of climate change, and to adapt to their anticipated effects.

In Vietnamese cities, as in other cities globally, urban centres are often located in highly risk-prone areas, such as in the coastal zone, along rivers or among mountains. Major types of infrastructure, such as roads, hospitals and water supply networks, as well as basic services such as healthcare, are vulnerable to the negative effects of climate change. In coastal areas, storm surges and sea-level rise can affect food supply and settlements. In Viet Nam, it is projected that sea levels will rise by 57 to 73 millimetres by 2100. Without appropriate adaptation actions, this could result in the inundation of 39 per cent of the coastal land area in the Mekong Delta, 10 per cent of the Red River Delta and 2.5 per cent of the Central Coastal Region, causing severe impacts to infrastructure, economic activities and the population. Finally, the poorest are always the most vulnerable to the impacts of climate change, due to the fact that they have less access to infrastructure, basic services and social safety nets in the event of a disaster.

1.2 UN-Habitat's Cities and Climate Change Initiative

Cities and local authorities have the potential to influence the mitigation of climate change, and to understand how to protect themselves from its effects. The Cities and Climate Change Initiative promotes the mitigation of, and adaptation to, climate change in developing countries. More specifically, the initiative supports the development of pro-poor innovative approaches to climate change policies and strategies. It builds on UN-Habitat's rich experience of sustainable urban development (through the Environmental Planning and Management approach of the Sustainable Cities and Agenda 21 Programmes), as well as internationally recognized capacity building tools. The initiative develops, adapts and disseminates methodologies that put city managers and practitioners in a better position to support adaptation to climate change. The Cities and Climate Change Initiative also promotes collaboration by local authorities and their associations in global, regional and national networks, with the triple rationale of: 1) enhancing policy dialogue so that climate change is firmly established on the agenda; 2) supporting local authorities' efforts to bring about these changes; and 3) enhancing awareness, education and capacity-building in support of climate change strategies. A major outcome of the initiative will be the development of a set of tools for mitigation and adaptation. The Cities and Climate Change Initiative now works in over 30 cities in 15 countries in the Asia-Pacific region.

02

Overview of the City

2.1 Geography

Hoi An is located in central Viet Nam, around 25 kilometres south of Danang in Quang Nam Province. It is situated on a coastal plain, at the estuary of the Thu Bon river basin, where the Thu Bon, De Vong and Co Co rivers converge. The urbanized portion of the city is situated at an elevation of between 0 to 15 metres above sea level. The coastal areas and river basin are characterized by low-lying elevations, with unstable topographic foundations, meaning they are prone to erosion. The hydrological regime of the Thu Bon and De Vong rivers highly influence the hydrological landscape of the city. When tides are high, the river levels rise. At low tide, the rivers are able to empty water into the sea. There are, on average, two high tides per day with a maximum tidal height (above mean sea-level) of 1.4 metres. During the rainy season, wave height can reach three to four metres at a distance of 50 metres from the shore. Saline intrusion becomes an issue during the dry season due to low river levels.

2.2 Climate Profile, Natural Resources and Ecosystems

The average daily temperature in Hoi An is 25.6°C with a relatively high humidity of 82 per cent. On aver-

Figure 1: Map of the wards of Hoi An

Source: UN-Habitat

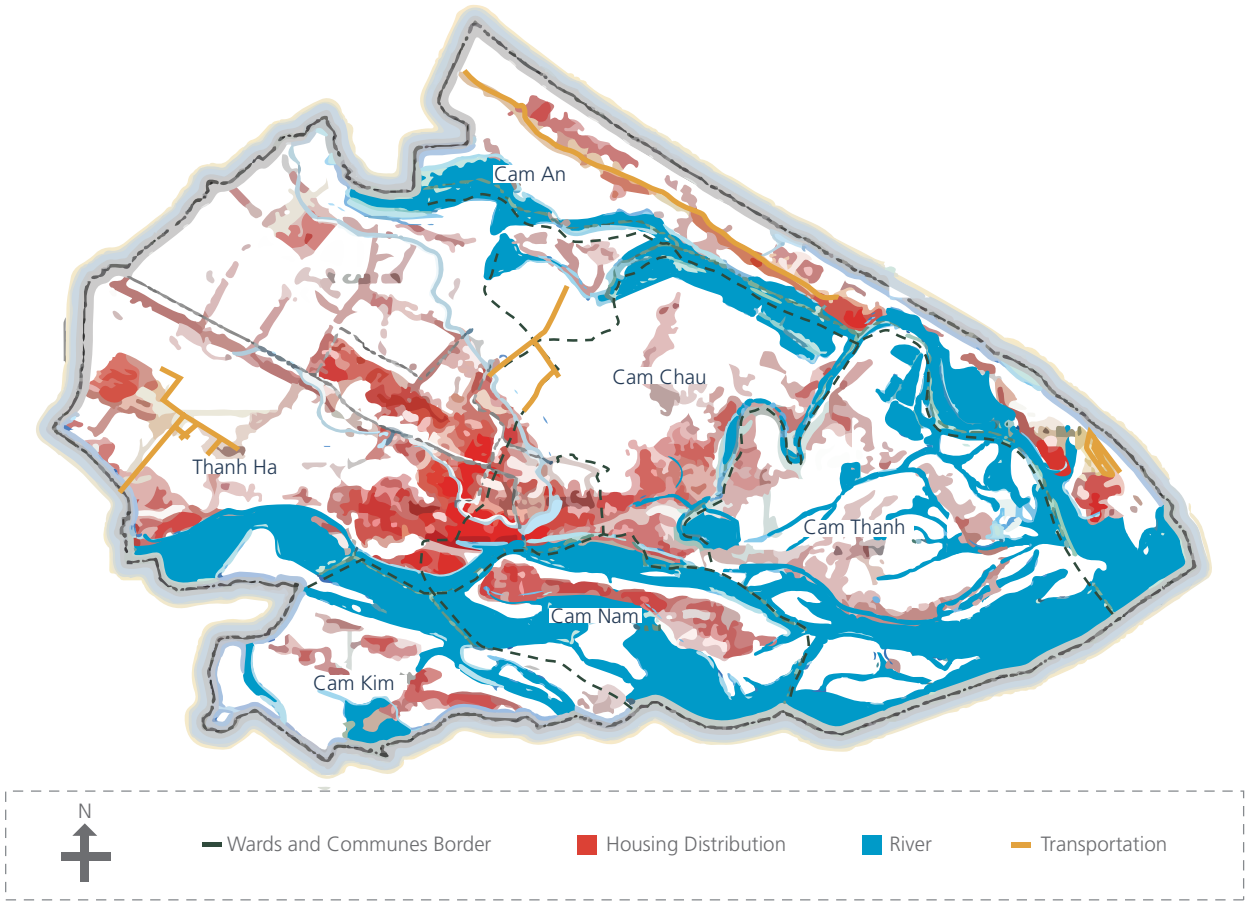
age, there are 147 rainy days per year with an annual rainfall of 2066 mm. Hoi An has two distinct seasons, a dry season, which runs from January to July, and a rainy season from August until December. The rainy season is characterized by the presence of typhoons and severe storms. These bring about localized flooding to all parts of the city, as well as storm surges to the coastal area. Approximately 25 per cent of all typhoons that reach Viet Nam affect Hoi An. In recent years, there were numerous floods (including the years 1998, 1999, 2007 and 2009) where the height of flood waters reached over 3 metres.

The city has abundant natural resources, including forests, surface and ground water, fisheries and minerals. Approximately 35 per cent of the city's land area is used for agriculture, forestry and fisheries. Surface water accounts for around 23 per cent of the total land area of the city. Surface water is important as it is used for agriculture and domestic use, as well as being extracted for industrial purposes. It also plays a vital role in supporting aquaculture and ecosystems in the city.

2.3 Population and Urbanization

Hoi An is a small city, with a population of 90,265[1] spread out over a land area of 6,171 hectares, which

Figure 2: Housing locations in the city



Source: UN-Habitat

[1] Quang Nam Provincial Department of Statistics, 2011

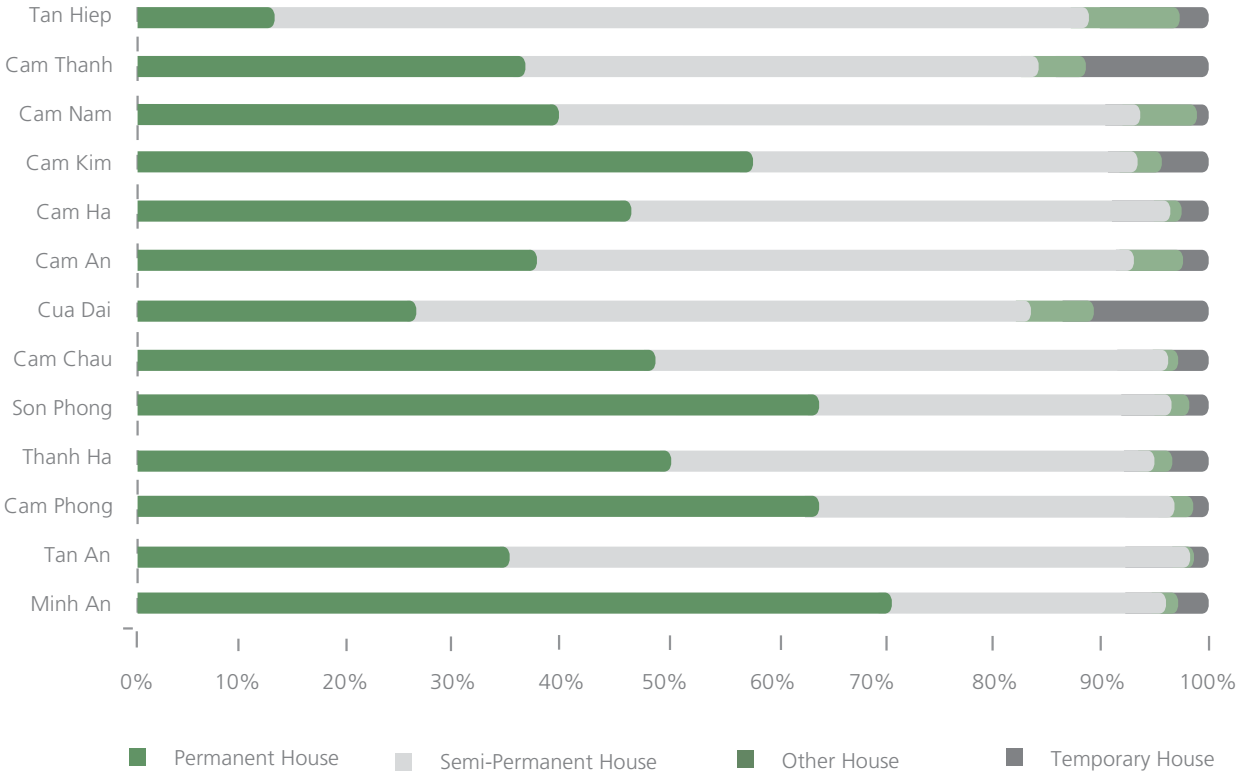
gives it a population density of 1,463 inhabitants/km^2. Population growth in Hoi An is relatively moderate with a growth rate of 1.36 per cent per year. There is a significant difference between this and the national picture, which has an urbanization rate of 29.6 per cent and an annual growth of around 3.4 per cent. In Hoi An, 77.16 per cent of the population lives in wards, however a significant difference between the population densities of the wards can be observed. Minh An Old town, in the centre of the city, has a population density of 10,154 persons per km^2, while Tan Hiep, on the Cham Islands located 15km from the coast of Hoi An, has a population density of 156 persons per km^2. The picture in Figure 2, housing locations in the city, shows that most residential areas in the city are clustered around rivers and in the coastal area. While 95 per cent of housing in the city is considered permanent or semi-permanent, the majority of housing is clustered around the river estuary in the Minh An and Tan An wards, with another population belt on the low-elevation coastal area in Cua Dai ward.

2.4 Economy and Livelihoods

Hoi An has experienced high economic growth in recent years, at a rate of around 11.5 per cent per capita per year for the period from 2004 to 2011. This rate compares very favourably with the national average GDP growth rate of 7.13 per cent over the same period[2] . Tourism, commerce and services represented 59.7 per cent of economic activity in 2010, compared to 11.8 per cent for fishery and aquaculture and 3 per cent for agriculture.

Tourism is a very important source of livelihood for the city and is a driver of the city's economy. In 1999, UNESCO recognized Hoi An as a World Heritage Site due to the city being home to over 800 preserved ancient houses from the 16th and 17th century. UNESCO recognition has resulted in a surge in tourism, with an average of 21 per cent annual increase in visitors for the period between 2003 and 2010.
Agriculture and fisheries are also important livelihood sectors for the city, though their share of total eco-

Figure 3: Housing types in Hoi An (%)



Source: UN-Habitat

[2] UNDESA (2010). LINK Global Outlook (United Nations publication, p.57)

nomic activity is declining. In certain wards, these sectors remain highly important; the proportion of households deriving their primary income from agriculture and fisheries is 25.5 per cent in Cam Kim Ward, 24.8 per cent in Cam Chau and 37.7 per cent in Cam Ha. These areas are low-lying, close to rivers, and are prone to river flooding and erosion.

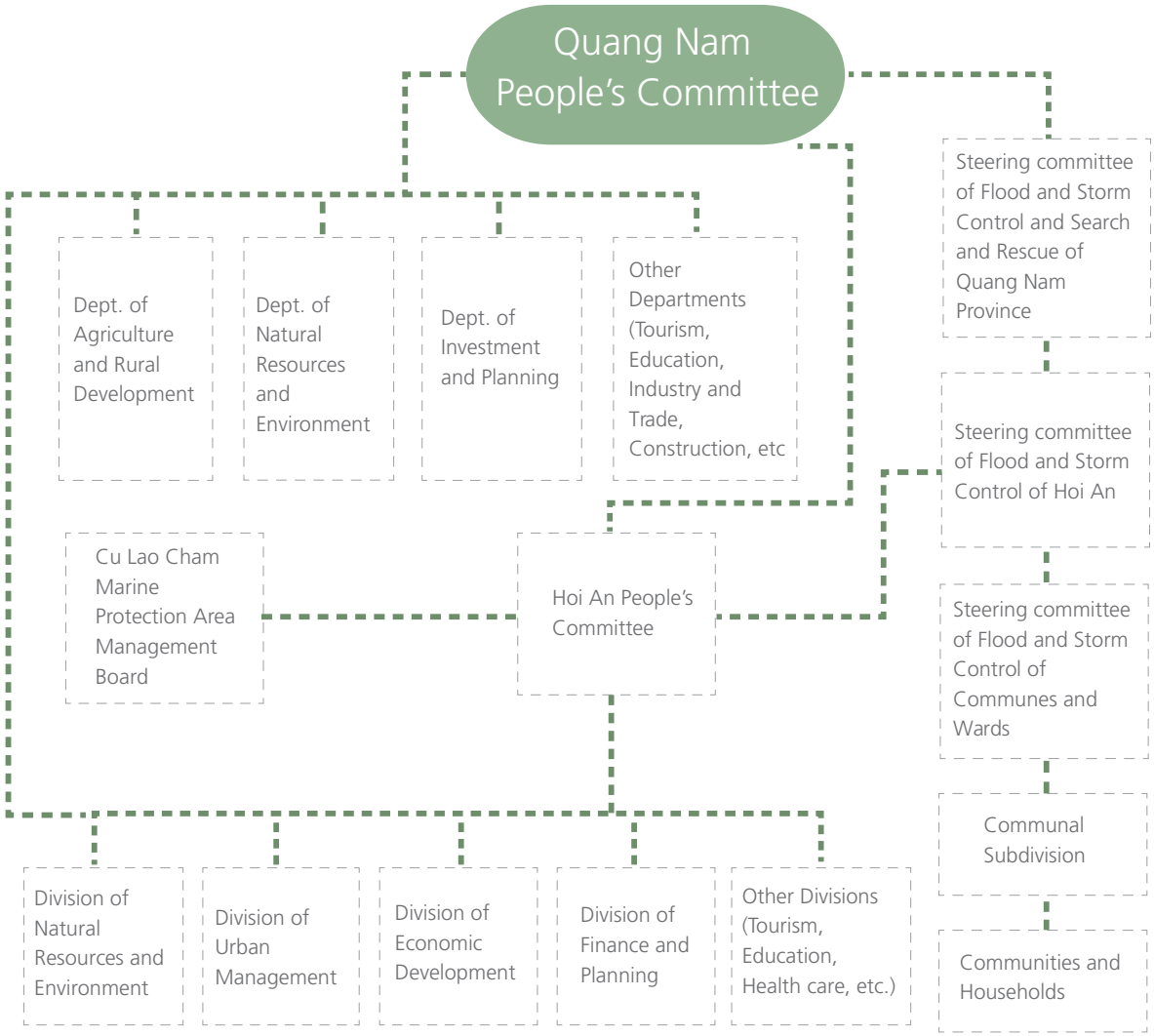
In 2010, 3.85 per cent of Hoi An's population lived below the poverty line, which is substantially lower than the national average of 14.5 per cent. However, the malnutrition rate in children under two years of age is 7.48 per cent, which is higher than the national average. There are substantial differences in socio-economic indicators between wards in the city. The less urbanised, more agricultural wards, such as Cam Kim, Cam Thanh, Cam Nam, Cam An and Cua Dai, have much higher instances of poverty and less access to basic services. This topic is analyzed further in the Adaptive Capacity section.

2.5 Governance Structure

Viet Nam's government structure is divided into four levels:

i) National;
ii) Provincial;
iii) City/district (under provincial authority); and
iv) Commune/ward[3] .

Figure 4: Governance Structure



Source: UN-Habitat

[3]The term commune is used in rural areas, whereas ward is used in urban areas.

This means that cities such as Hoi An have limited autonomy in Viet Nam, as they are under the leadership of the provincial government. For example, the city prepares plans and budgets and thereafter must send these to the provincial level for approval. The People's Committee is the central organ of the local government in Viet Nam, with line departments responsible for sector areas. The line divisions at the city level report upwards to both the line department at the provincial level (and ultimately to their line ministry) and to the People's Committee at the city level.

Sea Wall
Photo © Nguyen Thi Khang

03

City Vulnerability to Climate Change

3.1 Assessment Framework

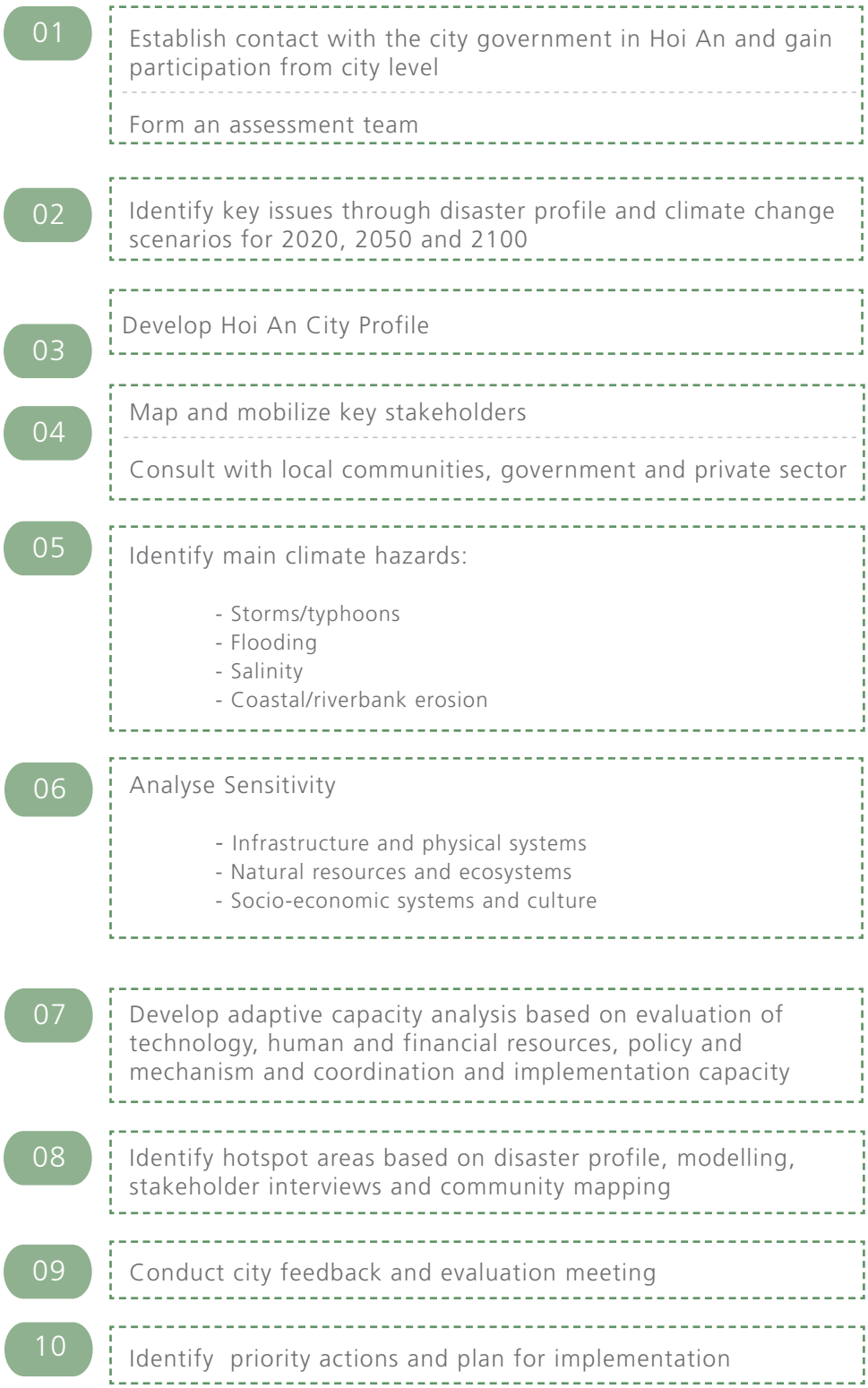
The Hoi An vulnerability assessment closely follows the framework utilized throughout UN-Habitat's Cities and Climate Change Initiative in Asia-Pacific. This follows the Intergovernmental Panel on Climate Change's framework of vulnerability as a function of exposure, sensitivity and adaptive capacity. For example, if exposure or sensitivity to climate hazards increases without a corresponding increase in adaptive capacity, vulnerability will increase. Exposure is defined as the magnitude of climate change impacts and the likelihood of these impacts happening. Sensitivity is defined as the degree to which a system will change in response to a given change in climate. Adaptive capacity is defined as the ability of people or systems to adjust in the face of climate impacts, to moderate or to offset the damage caused, and to take advantage of climatic changes.

In order to gather and analyze data, the assessment team used a mix of quantitative and qualitative methods, including climate models and scenarios, geographic information system data and mapping, community consultations through focus groups and key informant interviews with local government officials. The overall process flow of the assessment included the following steps:

Figure 5: Assessment Framework

Source: UN-Habitat

Figure 6: Process flow of the Hoi An Vulnerability Assessment



Source: UN-Habitat

3.2 Exposure

In consultation with the city, the assessment team identified five main climate hazards to which Hoi An is exposed: flooding, salinity, coastal erosion, river bank erosion and sea-level rise. An analysis of each hazard was conducted and is summarized in the paragraphs below.

3.2.1 Flooding

Hoi An suffers from extensive flooding during the rainy season, especially between the months of September and December. There are, on average, between three and five major floods every year, with an average inundation level of three metres. The drivers of flooding in the city are complex, but can be divided into flash/local flooding, which occurs as a result of heavy rainfall, river flooding, which occurs because of either tidal variations or due to the volume of water flowing from upstream (which may not be directly connected to the level of rainfall experienced within the city) and coastal flooding, which is a result of sea-level rise, high tides and storm surges.

Flash floods are an especially common occurrence throughout the city; between 1997 and 2004 there were 38 flash floods in the city, while in 2009 alone there were eleven flash floods. Generally, projections show that the city will be exposed to a moderate increase in rainfall between now and 2100 using a mid-level emissions scenario.

Table 1: Projected increases in rainfall[4]

	2020			2050			2100		
Scenario % increase in rainfall	B1	B2	A2	B1	B2	A2	B1	B2	A2
	0.7	0.7	0.7	1.6	1.7	1.7	2.2	3.2	4.1

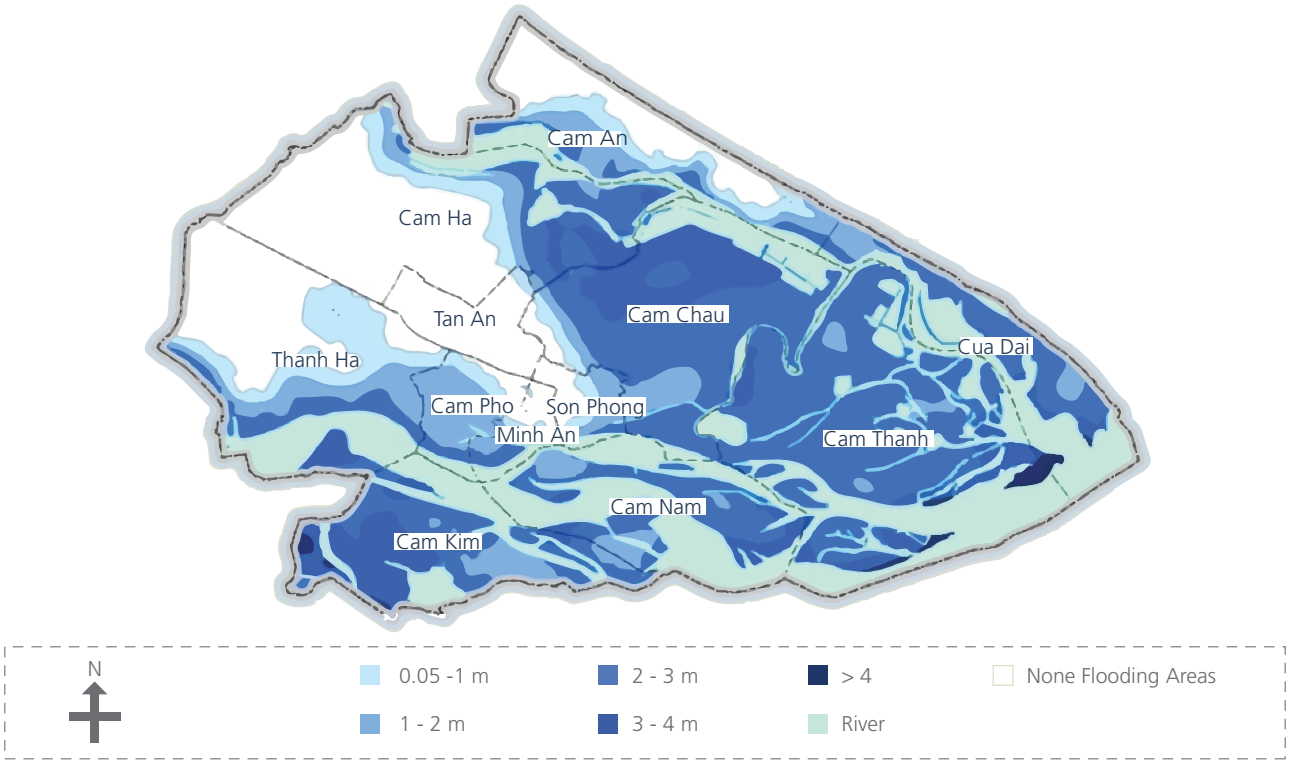
Source: Vietnam Ministry of Natural Resource and Environment (2010)

As can be seen in table 1, the projected increases in rainfall are relatively minor, which means that the total area of inundation, according to geographic information systems maps prepared by the assessment team, will not increase greatly. However the depth of inundation is likely to increase, even with only incremental changes in rainfall.

Taking 2011 as the base year, figures 6 and 7 show the combined effect of flash flooding and river flooding according to mid-level projections. While they do not show a significant increase in the total land area flooded –from 167.85 hectares inundated with greater than three metres of water in 2020, compared to 185.06 hectares by 2050 – they do show a substantial increase in the depth of inundation. For example, of the total flood prone area, 17.47 per cent will experience up to four metres of inundation in 2020, compared to 24.2 per cent in 2050. Flood forecasting results are calculated based on the MIKE _ GIS hydraulic model and climate change scenarios applied to Hoi An in 2020, 2050, 2100. The results show that a total area of 2912 hectares could be flooded by 2020, rising to 2946 hectares by 2050 and 3204 hectares by 2100, with depths of 1 to 4 metres.

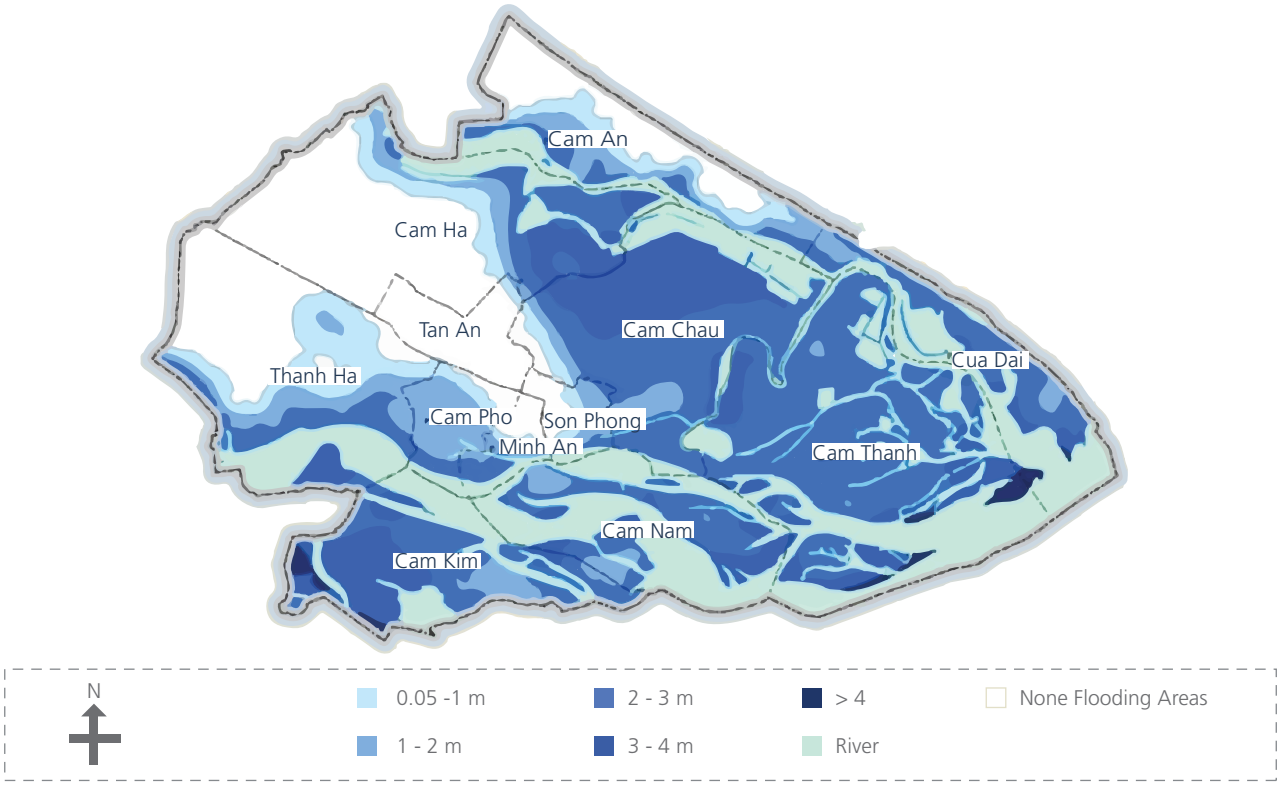
[4]Viet Nam Ministry of Natural Resources and the Environment (2010). Second National Communication, p.62

Figure 7: Areas likely to be inundated by floods in 2020



Source: UN-Habitat

Figure 8: Areas likely to be inundated by floods in 2050



Source: UN-Habitat

3.2.2 Sea-level Rise

According to projections for high emissions scenarios[5,6], sea-levels could rise by up to one metre by 2100. Moreover, according to the Intergovernmental Panel on Climate Change, projections for global sea-levels show could be even greater than one metre.

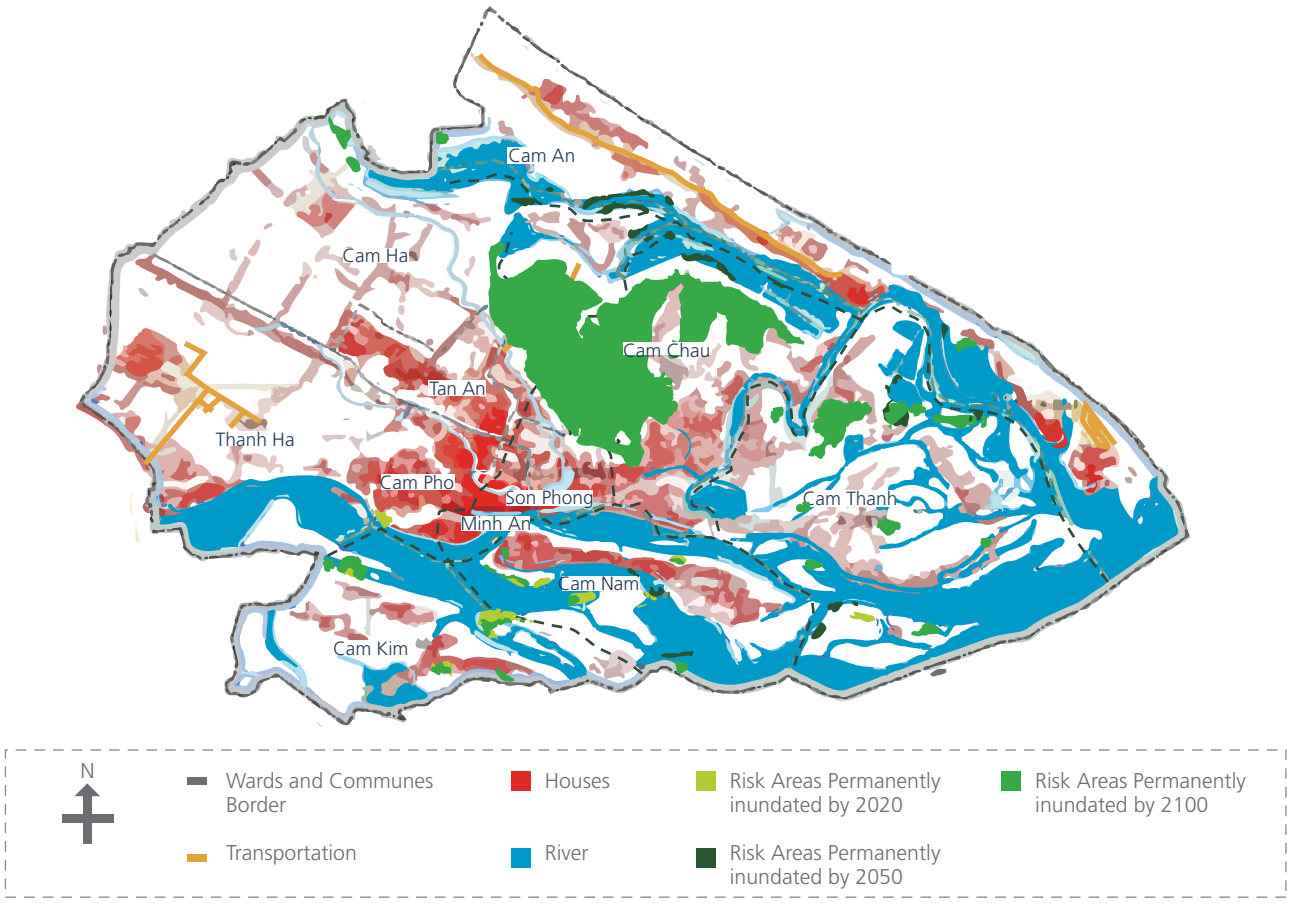
Hoi An experiences significant tidal variations, with high-tides reaching a maximum height of 1.55 metres above mean sea-level. Given the low-lying topography of much of the city, coupled with this tidal variation, even a small increase in sea-levels could lead to a substantial increase in the land area inundated by sea-water and salinity. According to the map in Figure 8, 53.46 hectares could be permanently inundated by sea water by 2020, rising to 69.64 hectares in 2050 and 87.38 hectares in 2100. These scenarios are calculated under a high emissions scenario and assuming no adaptation actions will be taken.

Table 2: Sea-level rise projection

	2020			2050			2100		
Scenario	B1	B2	A1F1	BA	B2	A1F1	BA	B2	A1F1
Centimetres sea-level rise	11	12	12	28	30	33	65	75	100

Source: Vietnam Ministry of Natural Resource and Environment (2010)

Figure 9: Potential land area inundated as a result of sea-level rise



Source: UN-Habitat

[5] Ministry of Natural Resource and Environment. Climate change and sea level rise scenario for Viet Nam. (2009)

[6] Ministry of Natural Resource and Environment. Climate change and sea level rise scenario for Viet Nam. (2011)

3.2.3 Salinity

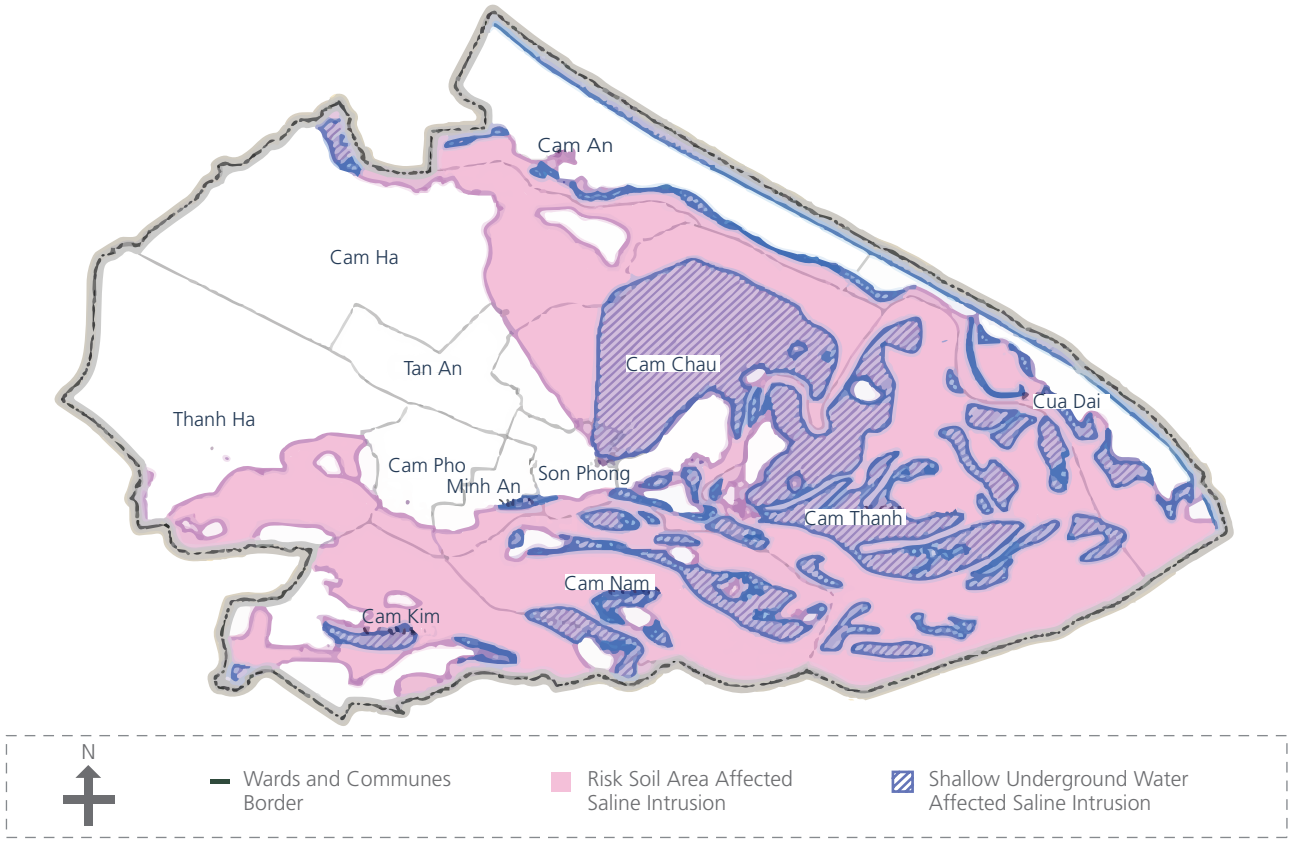
Linked to the increasing hazard of sea-level rise is the issue of saline intrusion, or salinity. Salinity is most serious at the end of the dry season between the months of April and July. The primary driver of salinity is low water levels in the rivers, meaning that high tides can push sea water further inland. This water then permeates agricultural land, causing reduced agricultural production, changes in the nature of aquatic eco-systems, damages to infrastructure through corrosion and it can affect ground water. In order to estimate salt water intrusion in the city, the assessment team used a digital terrain elevation model and combined this with high-tide data. The projections focused on the likelihood of soil and aquifer salinity and can be seen in figure 9, which shows the indicative areas where soil and water will be saline by 2020.

3.2.4 Coastal and Riverbank Erosion

Coastal erosion is also a severe problem in Hoi An, with many areas being affected by it. This has been especially apparent in the Cua Dai ward area, where the village of Phuoc Trach was lost to erosion. Another example of coastal erosion can be found in the bank of the Thu Bon river estuary. The erosion at the bank is further exacerbated by high waves and severe storms. The loss of pine forests along the coastline, which acted as barriers to storms and waves, has also aggravated the problem. In the most seriously affected areas of Cua Dai, between 10 and 20 metres of land on the shoreline are eroded every year.

Like coastal erosion, riverbank erosion is also an issue of concern around Hoi An. Serious landslides have occurred along the Thu Bon river in the Thanh Ha, Cam Nam wards, Cam Kim and Cam Thanh communes, and along the De Vong River in the Cam An and Cua Dai wards. Although the rainy season in Hoi An is short, around 80 per cent of the total water volume passing through the rivers occurs from September to December. Hence, there is a significantly different amount of water passing through the rivers (main driver of riverbank erosion) depending on the season.

Figure 10: Areas affected by saline intrusion



Source: UN-Habitat

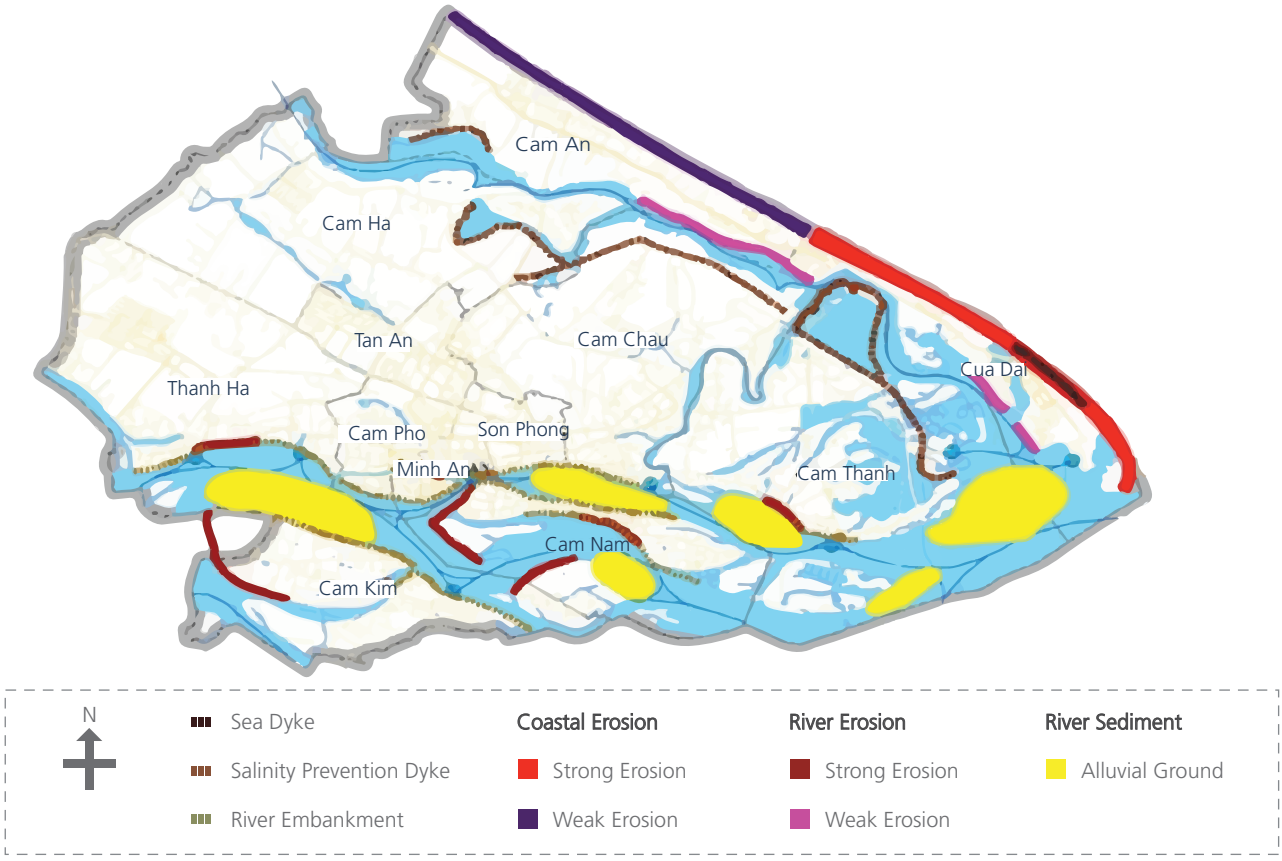
In addition to riverbank erosion, there is also the occurrence of river sand mining within the city. River sand mining has led to the destabilization of the riverbanks. The banks of the Thu Bon and De Vong rivers have a loose sediment composition, which means that they are more prone to erosion through increased water flow and human activity. The areas affected by coastal and river bank erosion can be seen in Figure 10.

3.2.5 Storms and Typhoons

Storms in Hoi An usually occur during the rainy season, between September and December. They are normally comprised of strong winds and heavy rain, and can also cause storm surges. This means that storms can cause damage as a result of high winds, local landslips and flash and coastal flooding. According to measurements recorded in nearby Danang, Hoi An experiences almost 25 per cent of storms that make landfall in Viet Nam. The most severe storms usually occur in years that have abnormally high rainfall – in excess of over 2,400 mm per year. During storms, wind speeds can reach 110 kilometres per hour, with unpredictable changes in direction, causing damage to buildings, including the culturally and economically important historic buildings found throughout the city. During such storms, wave height can be up to 3 metres above average sea-level, causing erosion and damage to natural banks and flood defences in the Cam An and Cua Dai wards.

In recent years, several storms have damaged property and injured people in Hoi An. Examples of such storms are Hurricane Xangsane in 2006, and Tropical Storm Lekima in 2007, which led to two separate flood peaks, leaving three quarters of the city's land area flooded. Impacts included severely damaged crops, which negatively impacted trade and the flooding also caused widespread damage to buildings. Typhoon Ketsana in 2009 caused similar damage, while in 2011, a severe storm combined with water discharge from the Song Tranh hydro-electric plant, upstream on the Thu Bon river, to cause serious flooding.

Figure 11: Areas affected by coastal and riverbank erosion



Source: UN-Habitat

3.2.6 Cumulative Impacts of Hazards

Hazards can cause severe impacts in isolation, however exposure and sensitivity is often greatest when a city experiences multiple or cumulative impacts of hazards. To demonstrate this, the assessment team prepared a table of accumulated impacts of hazards (Table 3) in order to reveal which hazards are likely to accumulate impacts, and where certain hazards can mitigate one another's impact.

The report will now give greater focus to the accumulated impacts of hazards, such as flooding and riverbank erosion.

3.3 Sensitivity

3.3.1 Sensitivity in Housing and Physical Systems

There is significant probability for housing to be negatively affected in Hoi An, seeing as over 50 per cent of houses in the city are classified as semi-permanent. Semi-permanent housing is significantly more sensitive to the effects of flooding, storms and sea-level rise. Erosion has already caused damaged to housing in the coastal area; the entire village of Phuoc Trach was relocated due to erosion affecting nearly 200 households. Within the next 3 to 5 years, it can be expected that around 55 houses in the area will be seriously impacted by erosion if no adaptation actions are taken.

Large areas of the city around the Thu Bon and De Vong rivers are at sub-two metre elevation, which means that they are sensitive to flooding effects. In addition, transportation infrastructure is often located in close proximity to these rivers. According to the Hoi An People's committee, it was estimated that Viet Nam Dong 2,842 billion (approximately USD 136 million) of damage was caused to roads as a result of flooding in 2007[7]. Hoi An only has very limited public transport infrastructure, and is not located on the main national railway line, so private vehicles and road transport are essential in the city. If one assumes that a road becomes unusable in flood water greater than 1 metre, it can be seen in figure 11 that a significant proportion of the city's roads will be deemed unusable

Table 3: Accumulated Impacts of Hazards

	Storms	Flooding	Salinity	Coastal erosion	Riverbank Erosion
Storms		+	×	×	×
Flooding	+		−	×	+
Salinity	×	−		×	×
Coastal erosion	+	×	×		×
Riverbank Erosion	×	×	×	×	

\+ Hazards whose combination can increase the significance/intensity of impacts

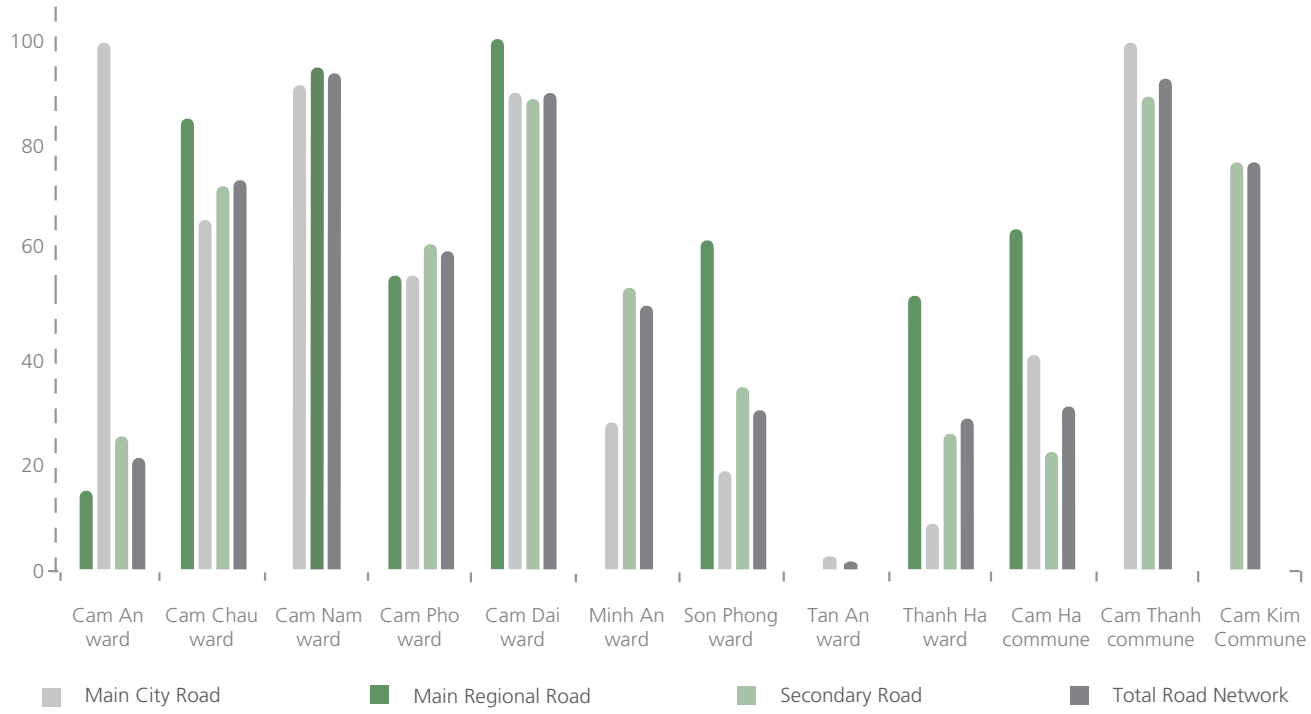
× Hazards that have no or little influence on each other

− Hazards that can decrease the impacts on each other

Source: UN-Habitat

[7] Hoi An People's Committee report (2007)

Figure 12: Percentage of roads affected by 1 metre flooding



Source: UN-Habitat

Table 4: Sensitivity to Erosion

Affected System /Sector	Scale of Impact	Significance
Housing and commercial buildings	Erosion affecting housing and commercial buildings from Cam An to Cua Dai	**In Cua Dai:** erosion destroyed the village of Phouc Trach and a row of villas of the Investment Development Joint Stock Company resort. Currently there are only 55 villas, housing and hotels that have not yet been affected by erosion. However, if there is no measure to protect the coastal line, the consequences will be serious in the next 3-5 year. **In Cam An:** about 23 houses and commercial buildings have been affected by erosion
Roads and embankments	**At Cua Dai:** Erosion directly impacts the road and embankment (about 100m)	**At Cua Dai:** The road to the sea (100m) is being threatened. It has been reinforced, but is showing signs of deterioration. **In Cam An:** About 260 m of roads in the planning area at risk of being affected
Ilmenite mine	**In Cam An:** Erosion may affect traffic At Cua Dai: erosion has a direct impact on the Ilmenite mine minerals	Erosion has destroyed a mine

Source: UN-Habitat

during flood periods.

Erosion also is found to affect roads in coastal areas. The Cua Dai ward is already showing signs of deterioration, even though over 100 metres of the coast road was strengthened and reinforced in order to protect it from erosion. A similar situation is occurring with the 260 metres coastal road in the Cam An ward. More examples can be found in table 4, which shows additional impacts of erosion in Cua Dai and Cam An.

There are still several areas of the city, notably Cam Thanh, Cam Kim, Cam Chau and Cua Dai, where piped water is not currently available, or where the water supply capacity is inadequate to meet the needs of all households. This means that residents in these areas have to rely on wells and ground water as their primary source for water. These areas are primarily low-lying, between 0.5 and 1.7 metres above sea-level, and are subject to frequent flooding. Moreover, the wells are normally inundated due to flood height, meaning that the water quality available to households in this area is negatively impacted during the flooding period.

Saline intrusion also seriously affects water resources in Hoi An, as water is primarily extracted from the surface at a shallow depth. Saline water intrusion has resulted in the Hoi An water supply network being unable to operate 24 hours per day in the dry season, with cuts in water supply of up to 12 hours per day. Moreover, saline intrusion also affects shallow underground water resources, which people use when piped water supplies are cut. People are consequently forced to rely on water from wells which, especially when salinity is an issue, has health impacts. Alternatively, they are forced to buy bottled water, which is very expensive for the poor.

Drainage provision is variable throughout the city. Some areas are equipped with underground sewage lines which do not pose a risk of cross-contaminating water. However, other areas have open drainage culverts or no drainage infrastructure at all. In order to analyze the sensitivity of the drainage system, the team divided the system into two parts: local drainage capacity and whole city drainage capacity. Local drainage capacity is analyzed based on the distribution and quality of the sewage network, i.e. the ability to discharge contaminated water under normal rainfall. The

Table 5: Sensitivity of the city's drainage system

	Local drainage sensitivity	Whole city drainage sensitivity
Inner city area		
Tan An	High	Very high
Son Phong	Very high	Average
Cam Pho	Very high	Average
Minh An	Very high	Low
Coastal tourism zones		
Cam An	High	High
Cua Dai	High	Low
Suburban region		
Cam Ha	Average	Very high
Thanh Ha	Low	Average
Cam Chau	Average	Very low
Cam Thanh	Average	Very low
Cam Kim	Very low	Very low
Cam Nam	Very low	Very low

Source: UN-Habitat

whole city drainage capacity was analyzed based on the flood model shown in figures 6 and 7.

3.3.2 Sensitivity in the Drainage System

City-wide drainage capacity was evaluated based on the possibility of an area becoming deeply inundated if there is flash flooding (based on flood modelling for the city). The areas are rated as such: Areas which are not inundated are given a low sensitivity rating; Areas where inundation ranges from 0 to 2 metres or less are given an average rating; Areas where inundation is deeper than 2 metres are given a high rating; Areas where inundation is deeper than 3m are given a very high rating.

Local drainage capacity is an area where there are underground or closed drainage pipeline systems which are not affected during floods. These are given a low sensitivity rating grade. The additional areas are rated as such: Areas where there are open drainage ditches are given an average rating; Areas where there are open drainage ditches that are in poor condition are given a high sensitivity rating; Areas where there is no drainage system (wastewater and storm water drainage are not collected) are given a very high rating.

3.3.3 Sensitivity in Livelihoods, Social and Ecosystems

The assessment team found that livelihoods were especially sensitive to the impacts of flooding. Sensitivity

Community Focus groups in Cam Chau.
Photo © UN Habitat / Hoang Dinh Thien

Table 6: Sensitivity to Erosion

Affected System /Sector	Scale of Impact	Significance
Beaches	Erosion affects the entire coastal area from Can An to Cua Dai	**In Cua Dai**, which has a 4 km coastline, 10 to 15 metres of erosion occurs each year, rising to 20 metres per year in some places. **In Cam An**: loss of land due to erosion speed is slower (0 to 2 metres per year)
Tourism	**At Cua Dai**: Erosion can negatively affect the volume of tourists that visit the area. **In Cam An**: A small amount of erosion can affect tourism	**At Cua Dai**: Erosion can negatively affect the volume of tourists that visit the area. **In Cam An**: No consequences
Service activities	**At Cua Dai**: Erosion can affect livelihoods related to tourism **In Cam An**: Erosion may affect livelihoods	**At Cua Dai**: loss of beach as a result of erosion, causing serious damage relative to the livelihood of residents **In Cam An**: No effects observed

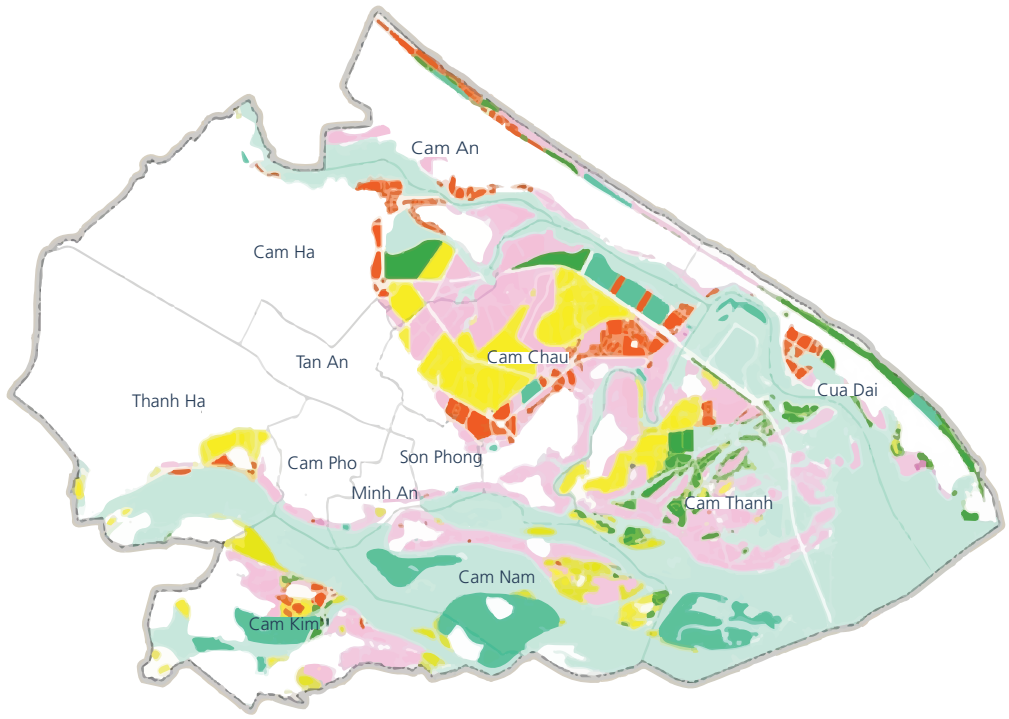
Source: UN-Habitat

is especially high in the Cam Kim, Cam Chau and Cam Nam wards, where agriculture is the primary source of livelihood. In the more central wards, where trade and services dominate, there are also negative impacts, but people have a greater capacity to practice alternative livelihoods. In order to determine a profile of sensitivity in livelihoods, community interviews and focus groups were conducted. Results of community meetings in the An My block, Cam Chau ward, Phuoc Thang hamlet and Cam Kim commune showed that surface water salinity is also a serious issue affecting agricultural livelihoods; it can reduce crop yields by up to 50 per cent.

Salinity levels have several impacts, including the following: the inability of local people to grow crops; damage to ground and surface water, which in turn affects water quality; and erosion, especially in riverbank areas. Salinity issues have also been exacerbated by urban development. Between 1975 and 2000, many residents in Hoi An grew poplar trees in order to stop storm surges, to alleviate the impact of strong winds and to reduce salinity. However, with the onset of tourism growth since the year 2000, poplar forests have been reduced in size in order to accommodate tourism infrastructure. Effects include some local residents reporting that salinity has reduced their rice yield by up to 50 per cent.

The salinity of soil and groundwater aquifers is calculated using the topography elevation model and the highest storm surge level (according to sea level rise scenarios in Hoi An). For Hoi An, the total area subjected to being inundated without preventive measures will be 2,700 hectares (about 50 per cent of the entire city).

Figures 13: Saline areas in Hoi An



Ward/ Commune	Saline area
Cam Thanh	634.9ha
Cam Chau	262.1ha
Cam Nam	239.2ha
Cua Dai	164.3ha
Cam Kim	133.2ha
Cam Ha	131.6ha
Thanh Ha	93.4ha
Cam An	78ha
Minh An	12ha
Cam Pho	10.2ha
Son Phong	6.4ha

N

- Land for military
- Land for tourism
- Land for agriculture
- Land for government buildings
- Vacant land
- Land for forestry
- Land for residential use
- Water surface
- Public land
- Land for cemetrey
- Land for production and commerce
- Land not influenced by salinity

Source: UN-Habitat

3.3.4 Ranking Combined Exposure and Sensitivity

The exposure and sensitivity of each hazard was quantified for the target groups. An expert stakeholder used the agreed upon scale of assessment to rank the exposure and sensitivity of each target system or sector (technical infrastructure, natural resource and eco system and socio-economic activities) for each hazard or for a combination of two hazards (flooding, salinity, coastal erosion, riverbank erosion and storms, combination of storm and flooding and combination of storm and coastal erosion). Each target group was assigned a value on a scale from 1 to 4 (combining exposure and sensitivity). The combined result of this analysis is presented in Table 7 and the original rankings by hazard can be found in Annex 1.

3.4 Adaptive Capacity

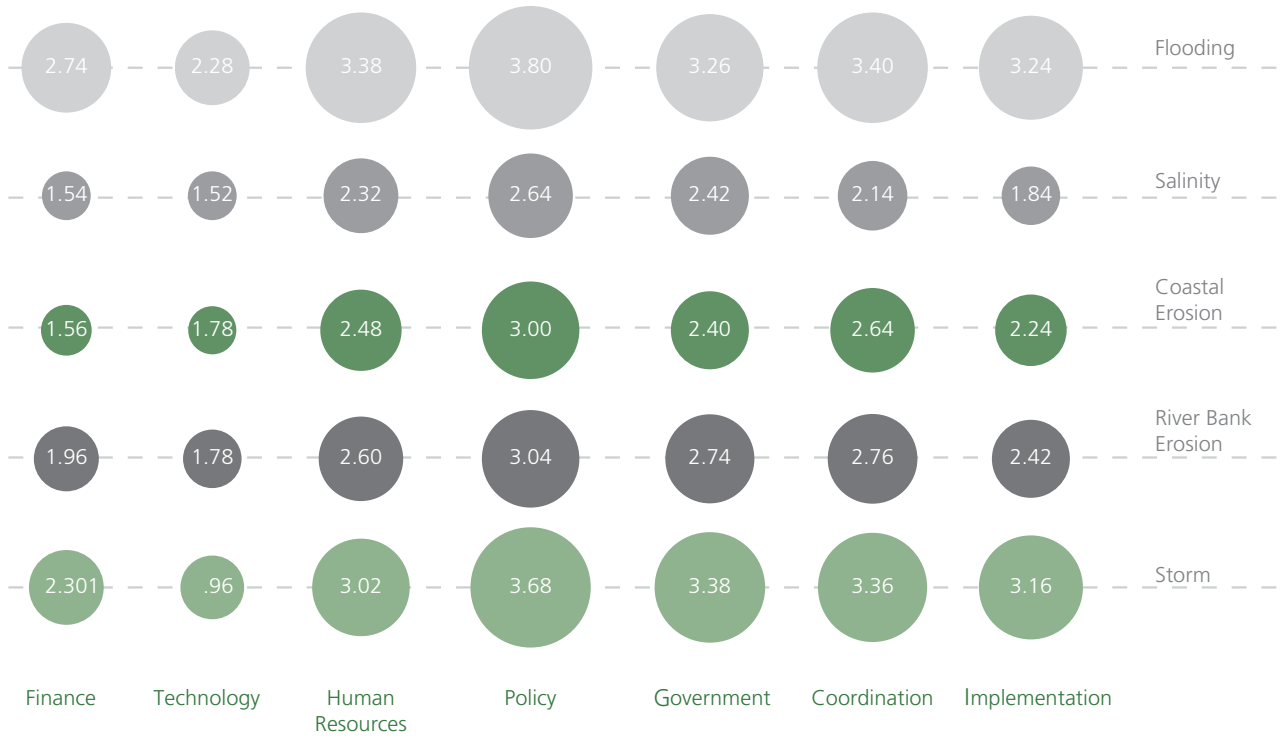
The assessment of adaptive capacity focused on the five main hazards analyzed throughout the assessment, which are flooding, salinity, coastal erosion, riverbank erosion and storms. The assessment team devised both a qualitative and quantitative analysis to determine adaptive capacity using four determinants: technology, finance, human resources and institutions. Please note that within the institutional determinant, there are then four sub-components: policy, implementation, coordination and management. Questionnaires including both qualitative and quantitative sections were then distributed to 25 key stakeholders, primarily from the city government, who were asked to give ratings on a scale of one to four (one= worst and four= best). The results of the questionnaires are summarized in the following figures:

Table 7: Combine Exposure and Sensitivity Ranking

Hazards	Exposure and Sensitivity (E+S)		
	2011	2020	2050
Flooding	4.5	5.0	5.3
Salinity	3.6	3.7	3.7
Coastal erosion	3.8		
Riverbank erosion	3.0		

Source: UN-Habitat

Figures 14: Adaptive capacity questionnaire results



Source: UN-Habitat

3.4.1 Adaptive Capacity at the Policy Level

At the national level, the government provides a legal framework using the following four policies: the National Target Program for Climate Change Response, the National Strategy for Climate Change Response, the National Strategy for Natural Disaster Prevention and the National Target Program on Energy Efficiency and Conservation. These four policies are used in addition to the first and second national communications to the UNFCCC, which were submitted in 2003 and 2010 respectively.

The strategic objectives of the National Target Program of Climate Change Response are to assess climate change impacts on all domains, sectors and localities and to formulate feasible short-term and long-term action plans in response to climate change. According to the National Target Program, the People's Committees of provinces, cities and districts are responsible for preparing and implementing climate change response action plans.

The National Strategy on Climate Change Response was approved by the Prime Minister at the end of 2011. Viet Nam is anticipated to complete the development of a system to monitor climate change and sea level rise by 2015. By 2020, a comprehensive system of monitoring and forecasting of extreme climate phenomena that meets international standards is expected to be completed. Other plans include the percentage of forest land to be increased to 45 per cent by 2020, in parallel with an improvement in forest quality and strengthened protection, management and development of mangroves and wetland ecosystems. In addition to the National Strategy on Climate Change Response, the Ministry of Natural Resources and Environment also developed scenarios of climate change and sea level rise for Viet Nam, which serve in the development, planning and design process.

Though Viet Nam has a long history of natural disasters, the National Strategy for Natural Disaster Prevention is primarily retrospective – focusing on response, rather than protection. The Ministry of Agriculture and Rural Development and the Central Committee for

Flood and Storm Control are the lead agencies for the implementation of the strategy. At the sub-national level, provinces, cities and districts are responsible for disaster response and mitigation planning, as well as necessary horizontal and vertical reporting.

Finally, the National Target Program on Energy Efficiency and Conservation, implemented by the Ministry of Industry and Trade, aims to see a reduction in consumption of energy by five to eight per cent for the period from 2012 to 2015. This will be done through a variety of means, including energy efficiency measures, replacement of older technologies with new ones and more efficient transportation. As with other target programmes, the provinces and city levels are expected to devise corresponding strategies.

3.4.2 Provincial Level

At the provincial level, Quang Nam Province is preparing its Provincial Development Strategy, which provides an overarching framework for sustainable development. Among other things, the Provincial Development Strategy aims to increase climate resilience in the coastal areas, while decreasing economic losses occurring from " inappropriate" urban expansion. The province will also incorporate ongoing work on Cu Lao Cham, the UNESCO biosphere reserve island off Hoi An, which has conducted its own vulnerability assessment and has an ongoing solid waste management programme. The province provides financing to the city through the five-yearly Socio-economic Development Plan, which is updated and financed on an annual basis. The current five year plan covers the period from 2011 to 2015.

3.4.3 City Level

Hoi An, like most cities in Viet Nam, still lacks an institutional body to coordinate the preparation and implementation of climate change action plans, as well as to ensure the link between these action plans and existing interventions related to sustainable urban development. Local officials are required by the National Target Programme on Climate Change Response and by the Government to complete both the Climate Change Response Action Plan and the City Master Plan. However, these are presently being done separately by different teams (Division of Natural resource and Environment and Division of Urban management, respectively) with different objectives, thus allowing for limited consistency and coordination between the plans.

Although it has been stipulated in the National Target Program on Climate Change and the National Adaptation Strategy that local governments can be proactive in mobilizing funds for implementation of climate change response measures (10 per cent budget for National Target Program implementation from local government and 10 per cent from local community), there has not been a reflection of this policy in legal documents on decentralization. In other words, there is no enabling mechanism for local governments to increase their budget for climate change response activities. The master plan approach being applied in most of cities, which doesn't include participation from the private sector and nor the local community, has also been a constraint for cities in mobilizing various sources of funding for urban development and climate change response.

A training needs assessment conducted by the Urban Environmental Planning Programme in Viet Nam determined that there are significant knowledge and skill gaps related to strategic urban planning among local urban planners. These weaknesses, in light of decentralization, are a concern because if urban planners are not capable of preparing strategic and participatory urban development plans, their ability to contribute to the city level action plan to respond to climate change is also questionable.

House in Cam Thanh
Photo © UN Habitat / Alyssa Grinberg

Table 8: Adaptive Capacity Indicators by Ward [8]

Ward/ communes	(%)Rate of Poor households	(%)Rate of Households having sanitary pit latrine	(%)Rate of Households having accessibility to clean water	(%)Rate of Children suffering from malnutrition
Minh An ward	0.28	100	100	4.54
Tan An ward	2.24	100	100	7.74
Cam Pho ward	2.89	100	100	5.55
Thanh Ha ward	4.55	100	100	6.74
Son Phong ward	0.54	100	100	6.71
Cam Chau ward	1.72	98.8	100	8.19
Cua Dai ward	3.75	100	96.6	9.8
Cam An ward	6.41	99.2	100	10
Cam Nam ward	4.17	99	100	8.33
Cam Ha commune	4.98	99.7	98	7.92
Cam Kim commune	12.16	98.6	100	9.28
Cam Thanh commune	4.71	93.7	97.2	7.39
Tan Hiep commune	5.04	94.7	100	8.57
Total	**3.85**	**98.9**	**99.4**	**7.48**

Source: Compiled by UN-Habitat

[8] Statistics Bureau of Hoi An, 2010 and Report of Hoi An Division of Health care, 2010.

3.4.4 Adaptive Capacity at Implementation Level

The City Government of Hoi An has taken the initiative to prepare the Eco-city Development Plan for 2030, which was approved by the People's Committee in December 2009. The Eco-city Development Plan has three pillars: green city planning and urban services, socio-cultural aspects and governance, and natural resources sustainability. There are 37 forthcoming projects that will be implemented under the three pillars of the plan.

The Division of Natural Resources and the Environment is responsible for implementing the Eco-city Development Plan. However, it has faced challenges coordinating all of the agencies involved. There is, as yet, no clear mechanism in place to implement projects (or to support their implementation) when collaboration between multiple agencies/divisions is required. There is also a lack of coordination between the Division of Natural Resources and Environment and the Division of Planning and Investment. The Division of Planning and Investment is responsible for funding the Eco-city Development Plan (through the city budget), but it is not clear how the plan will be prioritized vis-a-vis other funding priorities of the city.

In order to address this institutional and capacity gap, as well as to support the city in promoting its initiative in Eco-city development, UN-Habitat and Portland State University have partnered with the Hoi An city government and with Division of Natural Resource and Environment to review and implement the Eco-city plan. The partnership, of which the Division of Natural Resources and Environment is the focal point, began in 2010. Analysis conducted by Portland State University established that several important areas weren't addressed in the plan, such as the use of renewable energy, ecosystem protection and air quality. Conversely, the University noted that measures to improve socio-cultural resources were well addressed in the plan. In addition, recommendations relating to governance were made in order to make the planning and implementation process more transparent and hold stakeholders more accountable. An example of the latter would be the strengthening of governance mechanisms at the lowest levels. As a result of this analysis, the Eco-city Development Plan was revised to include re-assessed goals, additional projects, priorities and monitoring of indicators.
The Eco-city Development Plan is an initiative of the Hoi An City Government which is designed to be complimentary to the city's masterplan process. City masterplans are required under Viet Nam's planning laws, and tend to focus more on physical infrastructure and related investments. The Eco-city plan is multi-sectoral and more holistic, and aims to be complimentary to the existing plans in the city.

3.4.5 Autonomous Adaptation at the Community Level

Due to their experience with floods and storms every year, communities in Hoi An have a particularly high awareness rates related to disaster preparedness, social cohesiveness and mutual support. Interviews with local communities showed that, in addition to Farmer's Associations, Women's Associations and Youth Associations, which usually lead community activities, household to household support during the flood and storm season is also very common. In many cases, households that have multi-storey houses will offer rooms to others living in temporary housing during flooding evacuation. Each hamlet has an assembled rescue team that prioritizes people living in temporary homes, the elderly, women and children. Another example of adaptation at the community level includes initiatives in forest plantation to prevent coastal and river bank erosion and the application of crop rotation to cope with salinity. The Farmer's Association and Women's Association hold separate monthly meetings to address communities' areas of interest and both groups offer loans with low interest rates to households for livelihood development, housing and post disaster recovery.

Social change at the community level is at risk due to the influence of urbanization and tourism activities and is particularly evident in the Ancient Quarter. Although many families still live and work in the same homes as they have for generations, due to increases in land value, many have sold their properties and moved to the edge of the city. Accompanying the selling of property in the Ancient Quarter is a perceived shift in attitude away from heritage and cultural preservation. It is thought that this may be the result of increased international tourism. Another factor that may have negative influence over the existing social structure is the decrease in population in some communes, as the younger generation no longer wishes to be involved in agricultural production and fishery activities. Instead, they are seeking other employment opportunities with higher incomes in the service sector or migrating to larger cities.

Quantitative results show that flooding has the greatest impact at the community level. In Hoi An, the community and the city government are accustomed to flooding, so their capacity to adapt to flood hazards is high. However, the potential impact of flooding to the city is still significant. Riverbank erosion is considered to bring lesser damage to the city. The adaptive capacity of cities to salinity is considered the lowest, which means the community and the local government have difficulty in coping with the issue. Table 9 below describes the categorization levels of exposure, sensitivity and adaptive capacity.

Table 9: Categorization of Exposure, Sensitivity and Adaptive Capacity Rankings

Level	Exposure and sensitivity	Adaptive Capacity
Very high	> 5	> 3
High	4 - 5	2.5 - 3
Average	3 - 4	2 – 2.5
Low	< 3	< 2

Source: UN-Habitat

Table 10: Assessment of exposure, sensitivity, adaptive Capacity and Vulnerability

Hazards	Exposure and Sensitivity (E+S)			Adaptive Capacity - A	Vulnerability – V
	2011	2020	2050		
Flooding	4.5	5.0	5.3	3.0	Medium – High
Salinity	3.6	3.7	3.7	1.9	Medium
Coastal Erosion	3.8			2.1	Medium
Riverbank Erosion	3.0			2.3	Low
Storm	5.0			2.8	Medium – High
Storm + Flooding	5.8			3	High-Very high
Storm + Coastal Erosion	5.4			2.8	High

Source: UN-Habitat

Based on an assessment of Exposure (E), Sensitivity (S) and Adaptive capacity (as can be noted in Table 10), the level of vulnerability of Hoi An city to each hazard and combination of hazards was assessed: low (riverbank erosion), average (salinity, coastal erosion), average-high (flooding, storms), high (combination between storm + coastal erosion) and high - very high (combination between storm + flooding). The calculation of adaptive capacity and vulnerability will be the basis for the strategic orientation of the government and communities to cope with climate change.

Self made protective wall in Cam Thanh
Photo © UN Habitat / Alyssa Grinberg

04

Vulnerable People, Places and Sectors

The assessment team utilized the analysis presented above in conjunction with city officials to identify 'hot-spot' areas which are considered most vulnerable to the negative impacts of climate change and, as such, are priorities for action. In order to make this analysis systematic, the following criteria were considered in identifying hotspot areas:

- Areas exposed to multiple hazards;
- Areas which are less economically developed and/or

Figure 15: Vulnerability 'Hotspots' in Hoi An

Source: UN-Habitat

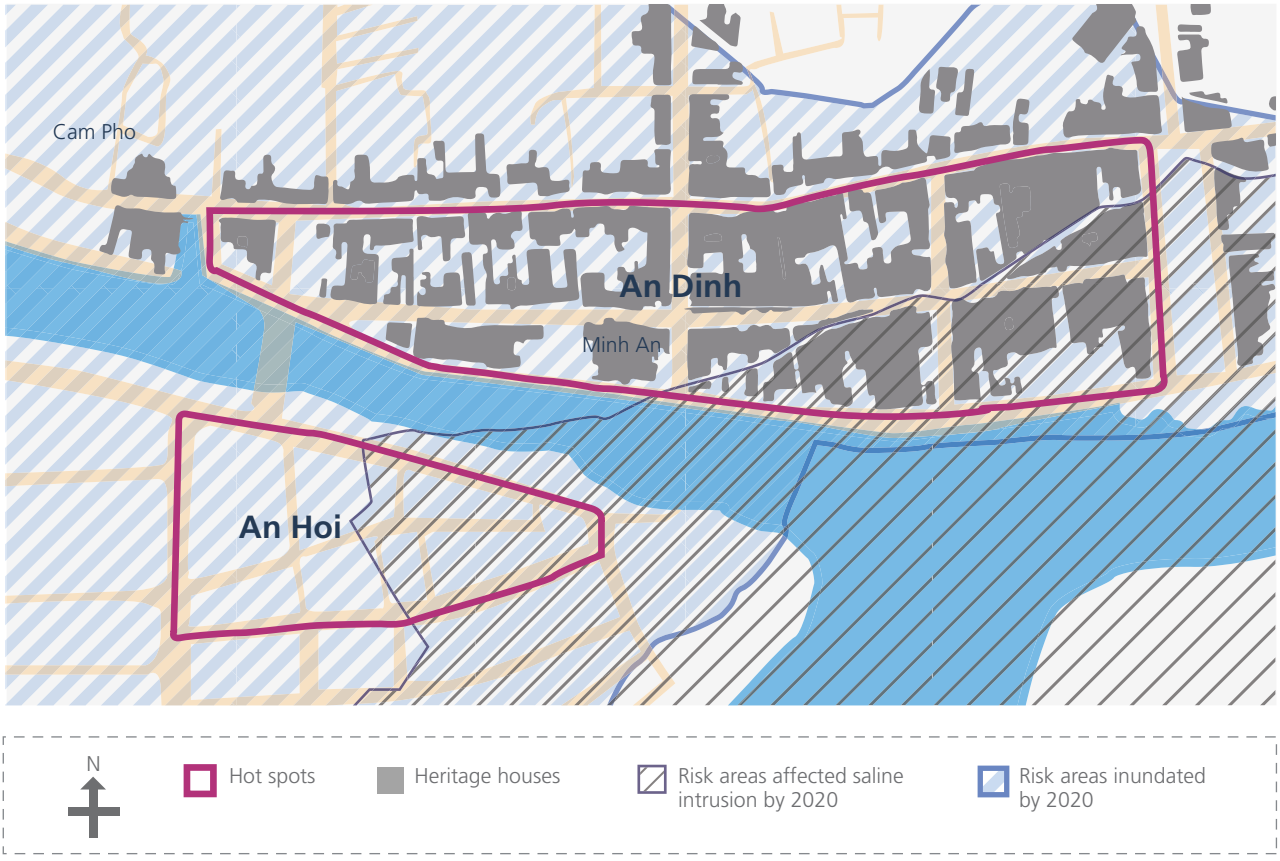
have less infrastructure and lower access to basic services;
- Areas of strategic economic interest;
- Areas which provide livelihoods in specific, climate sensitive sectors (tourism, fisheries, agriculture, etc.);
- Wards which were identified as having low adaptive capacity.

The analysis led to the results identified in figure 14.

The hotspots are not ranked, but given equal weight in the analysis. **Hotspot 1** is Phuoc Thang village, in Cam Kim ward in the southwest of the city. Phuoc Thang has an area of 1.23 km² and is home to 198 households. The main livelihood options in Phuoc Thang are agriculture, fisheries, flower growing and selling and handicrafts. The poverty rate in the village is low at around 6.7 per cent below the poverty line, however, some basic service provisions are lacking; there is minimal access to communications through phones and the internet and there is no access to piped water, with water for domestic use coming from wells. This water is subject to salinity, which negatively affects the quality and availability of drinking water. The village also lacks drainage infrastructure, which means that it lacks capacity to cope with flood waters.

The elevation of Phuoc Thang is between one to two metres above mean sea level. This means that it is highly exposed to coastal flooding, which on average happens four to five times per year and can last for up to seven days. In 2008, a flood inundated the village for more than ten days. During flood periods, students are identified as being the most vulnerable groups. Since the village is cut off from the main high school,

Figure 16: Magnified view of An Hoi Hotspot Area



Source: UN-Habitat

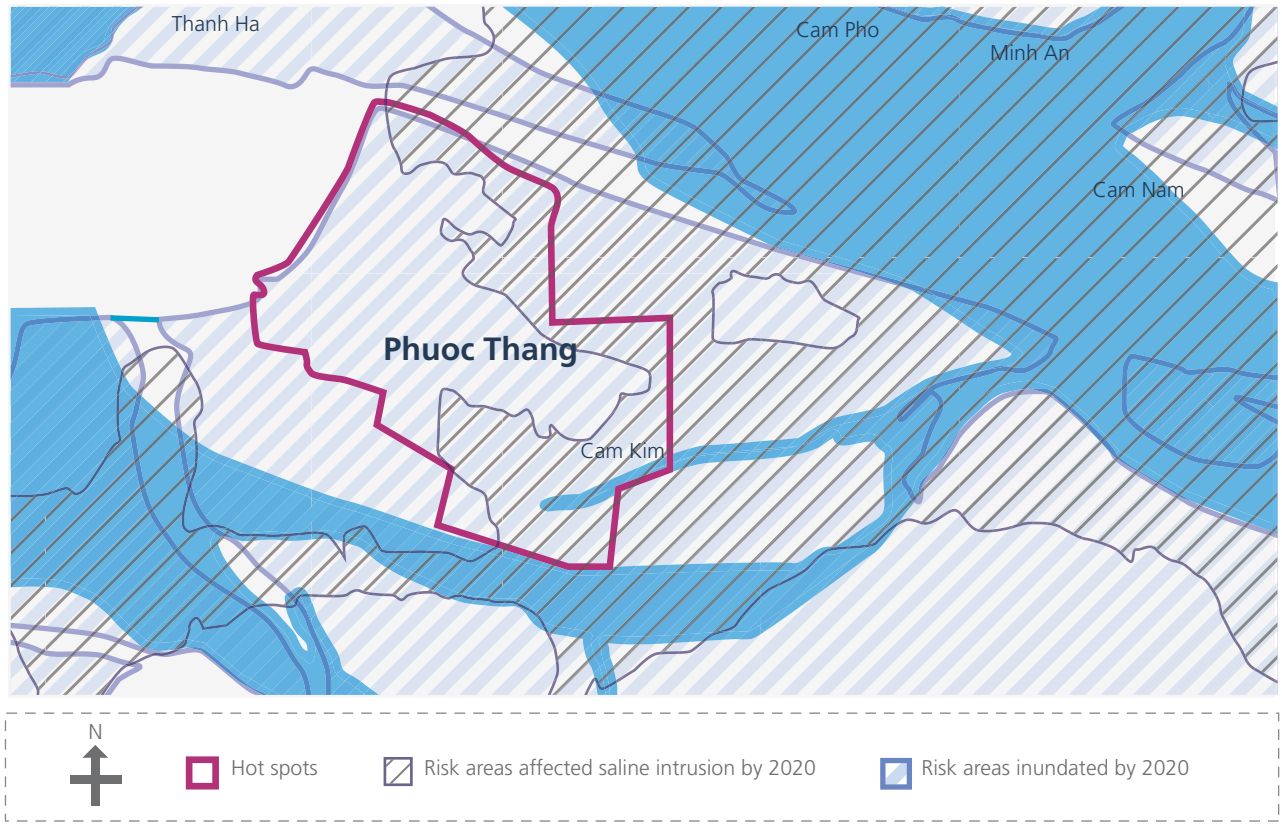
students are forced to miss up to four weeks' of lessons per year. Sea-level rise scenarios show that the problem will become more severe in the future; the 2020 sea-level rise scenario suggests that inundations of up to four metres will be possible.

Salinity can also impact livelihoods because reservoirs are affected by it. For example, prior to 1983, there was the possibility of growing three crops of rice per year. However, on average only one crop of rice per year can currently be grown. The poor that live away from the main road are forced to use both saline and contaminated well water when the area is flooded. In addition to flooding and salinity impacts, Phuoc Thang village in particular, and Cam Kim commune in general, are subjected to river bank erosion. Riverbank erosion is not only caused by natural disasters, but also by illegal sand mining. Every day, the southern bank of Thu Bon River between Cam Kim commune and Dien Ban district encroaches inland, causing the loss of agricultural land in Phuoc Thang and Trung Chau villages. One part of riverbank in Phuoc Thang village has an embankment, while the other part is still subject to erosion.

Hotspot 2 is the An Dinh and An Hoi neighbourhood, located in Minh An Ward in central Hoi An. These areas are the cultural and commercial heart of the city. In 2007, there were almost 700 retail businesses in central Hoi An with an additional 70 restaurants and bars, many of which are located in An Hoi and Minh An. Poverty rates are lower in Minh An than in any other ward in the city and business revenues are the highest, implying that many people rely on economic activity in this area for their livelihoods.

Because the area is low-lying – An Dinh and An Hoi are entirely sub-2 metres elevation – local people have to cope with flooding, both from increased water levels from the river basin and from higher tides in the sea. In November 2011, there was a flash flood that discharged 3000 m³ of water from the Tranh River Hydropower plant and flooded the entire ward. An Hoi and Minh An experienced flood waters of up to three

Figure 17: Magnified view of Phuoc Thang hotspot area



Source: UN-Habitat

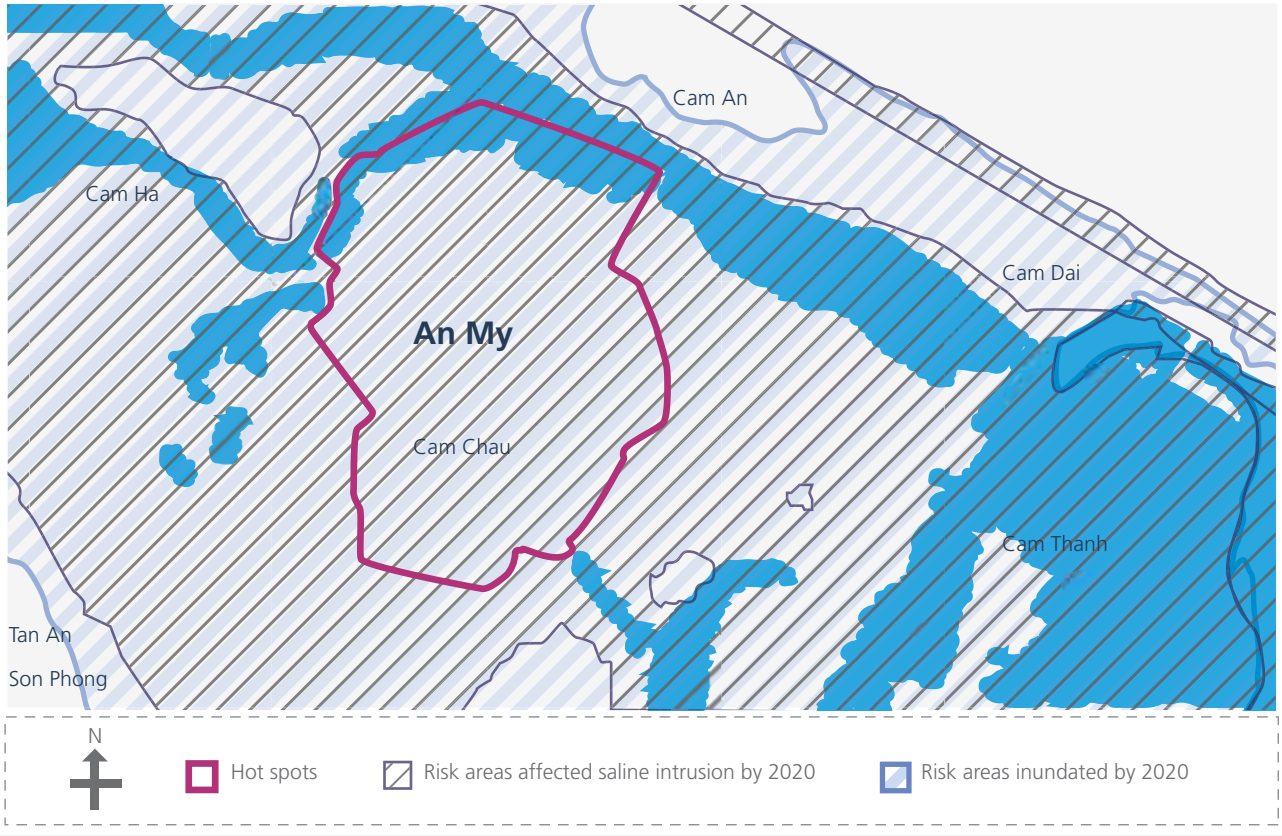
metres, damaging more than 1000 houses, some of which were several hundred years old.

The An Dinh area of Minh An ward lies across the Hoai River and is connected by a small foot-bridge. Here, the main incomes sources for local people are fishing, weaving and trade. This area has no drainage infrastructure, which leads to regular flooding. An Dinh and An Hoi also suffer from salinity. While piped water is available to most local people, this service is often unavailable during floods, so households have to switch to alternative water sources.

Hotspot 3 is the An My village neighbourhood of Cam Chau ward. An My is the largest village neighbourhood in Cam Chau with an area of 1149 km² and a total population of 993 people in 251 households. The population density is low compared to the rest of the city at 939 persons per km². Agriculture and eco-tourism are the main livelihoods of the city. 51.8 per cent of households depend primarily on agriculture for their livelihood.

An My is sub-two metres in elevation, and large parts of the area are below one metre. This means that flooding is a regular occurrence in the rainy season, especially in September and October. In 2009, the flooding was three metres deep and affected five out of the six neighbourhood blocks in the ward. The effect of this is that local livelihoods – which primarily consist of agriculture and aquaculture – are damaged because rice crops flood and hardware is damaged. In the dry season, irrigation infrastructure also becomes less effective in this area due to salinity.
A salinity prevention dyke was built in 1973 from Thanh Tay to Tra Que, however the dyke is low and the water coconut trees have been cleared and replaced by shrimp ponds. The area is subjected to salinity of water and soil due to spill over of seawater. Surface water cannot be used for irrigation due to salinity and contamination. The summer-autumn crop yield in 2010 was reduced by 50 per cent due to salinity and frost.

Figure 18: Magnified view of An My hotspot area



Source: UN-Habitat

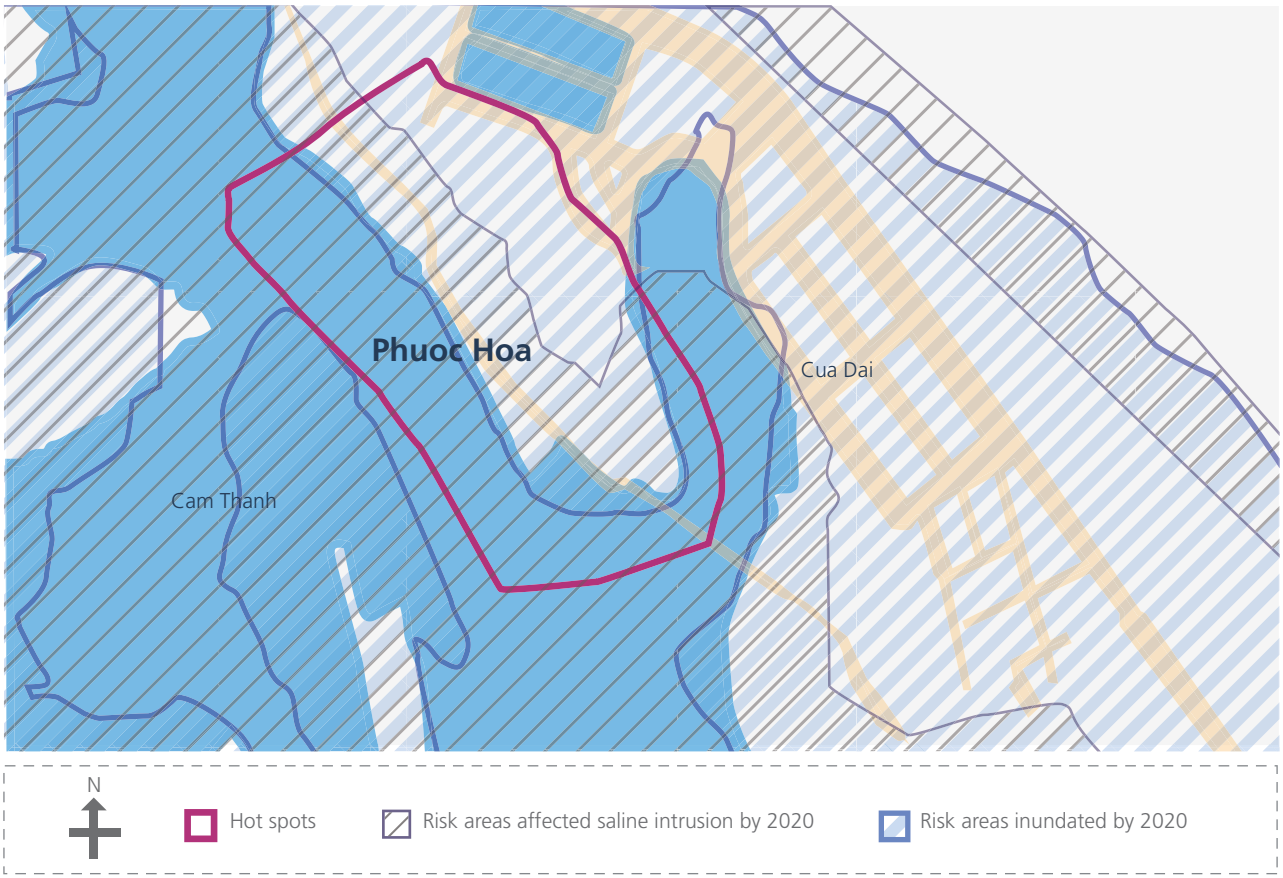
The local government has been supporting numerous people in the community by creating evacuation points for natural disasters, improving mortgage lending and housing for the poor, providing seeds to the community and assisting in career changes for people that relocate. People in An My also aspire to reinforce the salinity prevention dyke and plant trees that can prevent salinity, which will ease the impacts on agriculture and livelihood of the people.

Hotspot 4 is the Phuoc Ha block in the Cua Dai ward. This area is an extension of land between the coast and the Co Co river estuary. Phuoc Ha has around 240 households and people depend primarily on the tourism trade (50 per cent), fisheries (30 per cent) and other industries (20 per cent). Phuoc Ha faces inundation due to its low elevation, but the most urgent challenge facing it is river bank erosion and salinity. There is no access to piped drinking water in Phuoc Ha, which means that all households rely on 10 metre wells for their water. Riverbank erosion also damages aquaculture and reduces the size of land plots which people can use for homes and livelihoods.

Cua Dai Ward is severely affected by climate change and sea level rise. The most severe disasters such as storms, flooding, salinity, coastal erosion, riverbank erosion and coastal estuarine sedimentation all take place here. Phuoc Hoa also floods and erosion can be problematic. River bank erosion also affects aquaculture, leading to loss of agricultural land. Coastal erosion is significant due to deforestation for tourism development projects. Ward officials said that in the past seven years, the sea has encroached 120 to 150 metres into the land[9] .

Although there is a sea dyke, erosion is still a serious issue and has caused damage to the embankment. In the absence of tap water, Phuoc Hoa people have to use water from wells at a depth of ten metres, and due to salinity, they have to buy bottled water for drinking and cooking. During the rainy season, the local authority reinforces embankments and repairs the roads; however, there is still significant need for piped water in the community.

Figure 19: Magnified view of Phuoc Hoa hotspot area



Source: UN-Habitat

[9] Chaobuoisang, http://chaobuoisang.net/nguy-co-mat-trang-bai-bien-do-xam-thuc-1683100.htm, Accessed 24th of July 2013

05

Identifying Key Adaptation Options

With a particular focus on the hotspot areas, the assessment team devised the following adaptation priority actions:

Table 11: Identifying Adaptation Options

Area	Adaptation Actions
Phuoc Thang	• Safeguarde transportation routes to prevent the area becoming an " island"; • Improve housing, including raising existing houses; • Identify evacuation areas; • Support people to be able to switch livelihood means, when necessary; • Improved and varied seasonal crops; • Crops which can withstand salinity; • Improve water supply infrastructure and/or improving access to clean water for poor households; • Consider relocation as a long term option, but not in the short term, and only if inundation cannot be prevented by other means.
An Dinh	• Devise and install an early warning system, especially to protect against the impacts of flooding; • Linked to this, devize an evacuation strategy for the area; • Mitigate loss of assets caused by frequent flooding; • Undertake conservation measures for culturally important heritage buildings; • Devise a flood water discharge plan, to improve drainage and resilience in the event of flooding.
An My	• Diversify livelihoods in the area to move away from dependence on agriculture; • Improve the ability of crops to cope with the effects of climate change, especially flooding; • Consider relocation as a long term option, but not in the short term, and only if inundation cannot be prevented through other means
Phuoc Hoa	• Reforest the coastal area to prevent erosion; • Improve access to clean water; • Improve sanitation and water drainage infrastructure.

Source: UN-Habitat

06

Recommendations and Conclusions

There are four solutions for improving capacity to adapt to climate change:

(1) policy, institutional and coordination;
(2) finance and investment;
(3) human resources and information;
(4) technology and infrastructure.

Policy, institutional and coordination:
The Eco-City Development Plan Report proposed a vision for the city of Hoi An of sustainable development with an effective response to climate change. It also integrates climate change issues into socio-economic development planning and the master plan of Hoi An, with special attention paid to permanent inundation in lowland areas of the city and areas with saline intrusion. It also developed plans for the resettlement of residents out of permanently inundated areas, reviewing 13 plans among 37 plans/projects listed in the Hoi An Eco city development plan. A strategic response to climate change must be directed and implemented at all levels from households to wards/communes, cities and provinces in the overall national strategy of climate change.

In addition to storm and flood response policies, there should also be additional policies to cope with other disasters like salinity and policies to attract enterprises to respond to climate change. Mechanisms are required to manage urban development in accordance with approved plans and climate change response action plans, giving investment priorities for the most vulnerable areas and communities. Other priorities include the implementation of projects which respond to climate change and prevent disasters, contributing to the transformation of livelihoods (seeds, livestock and agricultural production), especially for areas that are subjected to flooding and salinity. The continued reinforcement of existing embankments is also important, while at the same time, studying the construction of embankments for riverside areas which are likely to be eroded.

Finance and investment:
The vulnerability assessment has shown that finance and technology are the two weakest aspects in the adaptive capacity of the city. It is proposed that, as a world heritage city, Hoi An positions itself to take advantage of any funding available from the state budget, city budget, international cooperation or through the participation of enterprises. Hoi An should develop an investment plan for the city to respond to climate change and prevent disasters. Results of this assessment should be used for climate change response action plans at all levels from hotspots, wards/communes to city and provincial levels (river basins).

Human resources and information: this report proposes that the city pro-actively develop a plan to raise awareness in the community to actively respond to climate change and transform the challenges of the latter into opportunities for improvement of living conditions and community development. The report also recommends the use of the flooding model, and an assessment of each hazard as a basis for amending sectoral plans. It also recommends drafting action plans to respond to climate change for each sector, increasing the adaptability of each sector and integrating climate change issues into the impact assessments of socio-economic development projects in the city.

Technology and infrastructure:
This report proposes investment in technology for climate change forecasting, early warning and disaster management and the promotion of green technology, clean technology and information technology to increase adaptability to climate change.

Solutions to reduce climate change related disaster impacts on Hoi An:

- Develop an early warning and monitoring system, especially for storms and flooding;

- Calculate the water balance and flood drainage capacity for Hoi An in case the Co Co river gate is closed and identify appropriate solutions;

- Develop a safe flood discharge process, preventing downstream flooding due to flood discharge from upstream hydropower (A Vuong - Song Tranh II);

- Integrate urban infrastructure issues in flood forecasting models, develop and provide flood forecasting maps to Hoi An city for disaster management;

- Assess quantity and quality of ground water for water supply of Hoi An city;

- Conduct a survey to forecast saline intrusion of surface water, groundwater and soil, and assess their impact on the socio-economic development of Hoi An;

- Develop a plan for the effective use of surface water and groundwater of Hoi An; apply holistic solutions (for example reforestation, reinforcing embankment, or construction of a soft dyke) to prevent coastal erosion in the city;

- Calculate the quantity of river sand mining and widen the Thu Bon river channels with stable discharge flow to ensure flood drainage and stabilization of the riverbank.

Hoi An Ancient City

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Annex 1 – Sensitivity Tables

Table 12: Flood Hazard

Affected Groups	Flood Hazard									
	Exposure (E)			Sensitivity (S)			Weight	Average E+S		
	2011	2020	2050	2011	2020	2050		2011	2020	2050
Technical Infrastructure							**0.3**	**4.8**	**5.5**	**5.7**
Land use	2	3	4	3	4	4	0.2	1.0	1.4	1.6
Housing	2	3	4	2	3	3	0.2	0.8	1.2	1.4
Power and telecommunication infrastructure	2	1	1	2	2	1	0.1	0.4	0.3	0.2
Transportation	3	3	3	2	2.9	3	0.2	1.0	1.2	1.2
Water supply system	3	2.5	2	3	2	1.28	0.15	0.9	0.7	0.5
Drainage system	2.4	2.7	3	2.2	2.4	2.6	0.15	0.7	0.8	0.8
Natural Resource - Environment							**0.3**	**4.7**	**4.8**	**5.0**
Forest	4	4	4	1	2	3	0.15	0.8	0.9	1.1
Paddy fields	3	3	3	3	3	3	0.45	2.7	2.7	2.7
Surface water	1	1	1	1	1	1	0.05	0.1	0.1	0.1
Ground water	1	1	1	1	1	1	0.05	0.1	0.1	0.1
Aquaculture resource	2	2	2	2	2	2	0.2	0.8	0.8	0.8
Minerals	1	1	1	1	1	1	0.05	0.1	0.1	0.1
Cemeteries	1	1	1	1	1	1	0.05	0.1	0.1	0.1
Socio-economy (Economic sectors)							**0.4**	**4.1**	**4.6**	**5.1**
Industry-Handicraft	1.73	1.92	2.11	1.73	1.92	2.11	0.3	1.0	1.2	1.3
Agriculture	2.14	2.38	2.62	2.76	3.07	3.38	0.3	1.5	1.6	1.8
Commerce-service	1.94	2.15	2.37	2.13	2.37	2.61	0.4	1.6	1.8	2.0
Total								**4.5**	**4.9**	**5.2**

Source: UN-Habitat

Table 13: Salinity

Affected Groups	Salinity									
	Exposure (E)			Sensitivity (S)			Weight	Average E+S		
	2011	2020	2050	2011	2020	2050		2011	2020	2050
Technical Infrastructure							**0.2**	**4.2**	**3.5**	**3.0**
Land use	3	2	2	4	3	2	0.2	1.4	1.0	0.8
Housing	2	2	2	3	3	2	0.2	1.0	1.0	0.8
Power and telecommunication infrastructure	1	1	1	2	2	1	0.1	0.3	0.3	0.2
Transportation	1	1	1	1	1	1	0.2	0.4	0.4	0.4
Water supply system	3	2	2	2	1.25	1.25	0.15	0.8	0.5	0.5
Drainage system	1	1	1	1	1	1	0.15	0.3	0.3	0.3
Natural resource - Environment							**0.35**	**4.4**	**4.7**	**4.8**
Forest	1	1	1	1	1	1	0.05	0.1	0.1	0.1
Paddy fields	1	1	1	3	3	3	0.3	1.2	1.2	1.2
Surface water	4	4	4	3	3	3	0.15	1.1	1.1	1.1
Ground water	1	2	2	1	2	3	0.15	0.3	0.6	0.8
Aquaculture resource	2	2	2	4	4	4	0.25	1.5	1.5	1.5
Minerals	1	1	1	1	1	1	0.05	0.1	0.1	0.1
Cemeteries	1	1	1	1	1	1	0.05	0.1	0.1	0.1
Socio-economy (Economic sectors)							**0.45**	**3.0**	**3.3**	**3.6**
Industry-Handicraft	1.5	1.6	1.8	1.3	1.5	1.6	0.3	0.8	0.9	1.0
Agriculture	1.8	2.0	2.2	2.2	2.5	2.7	0.3	1.2	1.3	1.5
Commerce-service	1.2	1.3	1.4	1.1	1.2	1.3	0.4	0.9	1.0	1.1
Total								**3.7**	**3.8**	**3.8**

Source: UN-Habitat

Table 14: Coastal Erosion

Affected Groups	Coastal Erosion			
	Exposure (E)	Sensitivity (S)	Weight	Average E+S
Technical Infrastructure			**0.35**	**3.6**
Land use	3	2	0.2	1.0
Housing	2	2	0.2	0.8
Power and telecommunication infrastructure	2	2	0.1	0.4
Transportation	2	2	0.2	0.8
Water supply system	1	1	0.15	0.3
Drainage system	1	1	0.15	0.3
Natural resource - Environment			**0.3**	**6.1**
Forest	4	4	0.45	3.6
Surface water	1	1	0.1	0.2
Ground water	1	1	0.1	0.2
Aquaculture resource	1	1	0.05	0.1
Minerals	2	3	0.25	1.3
Cemeteries	1	1	0.05	0.1
Socio-economy (Economic sectors)			**0.35**	**2.6**
Industry-Handicraft	1.2	1.2	0.3	0.7
Agriculture	1.6	1.7	0.3	1.0
Commerce-service	1.3	1.1	0.4	1.0
Total				**3.8**

Source: UN-Habitat

Table 15: Riverbank Erosion

Affected Groups	Riverbank Erosion			
	Exposure (E)	Sensitivity (S)	Weight	Average E+S
Technical Infrastructure			**0.35**	**3.4**
Land use	3	2	0.2	1.0
Housing	2	2	0.2	0.8
Power and telecommuni cation infrastructure	1	1	0.1	0.2
Transportation	2	2	0.2	0.8
Water supply system	1	1	0.15	0.3
Drainage system	1	1	0.15	0.3
Natural resource - Environment			**0.3**	**3.4**
Forest	1	1	0.05	0.1
Paddy fields	2	2	0.7	2.8
Surface water	1	1	0.05	0.1
Ground water	1	1	0.05	0.1
Aquaculture resource	1	1	0.05	0.1
Minerals	1	1	0.05	0.1
Cemeteries	1	1	0.05	0.1
Socio-economy (Economic sectors)			**0.35**	**2.3**
Industry-Handicraft	1.2	1.1	0.3	0.7
Agriculture	1.2	1.0	0.3	0.6
Commerce-service	1.2	1.2	0.4	0.9
Total				**3.0**

Source: UN-Habitat

Table 16: Storm

Affected Groups	Storm			
	Exposure (E)	Sensitivity (S)	Weight	Average E+S
Technical Infrastructure			**0.35**	**4.0**
Land use	1	1	0.2	0.4
Housing	4	3	0.2	1.4
Power and telecommunication infrastructure	4	2	0.1	0.6
Transportation	3	2	0.2	1.0
Water supply system	1	1	0.15	0.3
Drainage system	1	1	0.15	0.3
Natural resource - Environment			**0.3**	**5.9**
Forest	4	2	0.15	0.9
Paddy fields	4	3	0.45	3.2
Surface water	1	1	0.05	0.1
Ground water	1	1	0.05	0.1
Aquaculture resource	4	3	0.2	1.4
Minerals	1	1	0.05	0.1
Cemeteries	1	1	0.05	0.1
Socio-economy (Economic sectors)			**0.35**	**5.3**
Industry-Handicraft	2.0	2.0	0.3	1.2
Agriculture	4.0	3.0	0.3	2.1
Commerce-service	3.0	2	0.4	2.0
Total				**5.0**

Source: UN-Habitat

Table 17: Storm and Flooding

Affected Groups	Storm + Flooding			
	Exposure (E)	Sensitivity (S)	Weight	Average E+S
Technical Infrastructure			**0.35**	**6.0**
Land use	3	4	0.2	1.4
Housing	4	3	0.2	1.4
Power and telecommuni cation infrastructure	4	2	0.1	0.6
Transportation	3	2.9	0.2	1.2
Water supply system	2.5	2	0.15	0.7
Drainage system	2.7	2.4	0.15	0.8
Natural resource - Environment			**0.3**	**5.9**
Forest	4	2	0.15	0.9
Paddy fields	4	3	0.45	3.2
Surface water	1	1	0.05	0.1
Ground water	1	1	0.05	0.1
Aquaculture resource	4	3	0.2	1.4
Minerals	1	1	0.05	0.1
Cemeteries	1	1	0.05	0.1
Socio-economy (Economic sectors)			**0.35**	**5.5**
Industry-Handicraft	2.0	2.0	0.3	1.2
Agriculture	4.0	3.0	0.3	2.1
Commerce-service	3.0	2.4	0.4	2.2
Total				**5.8**

Source: UN-Habitat

Table 18: Storm and Coastal Erosion

Affected Groups	Storm + Coastal Erosion			
	Exposure (E)	Sensitivity (S)	Weight	Average E+S
Technical Infrastructure			**0.35**	**4.6**
Land use	3	2	0.2	1.0
Housing	4	3	0.2	1.4
Power and telecommunication infrastructure	4	2	0.1	0.6
Transportation	3	2	0.2	1.0
Water supply system	1	1	0.15	0.3
Drainage system	1	1	0.15	0.3
Natural resource - Environment			**0.3**	**6.3**
Forest	4	4	0.15	1.2
Paddy fields	4	3	0.45	3.2
Surface water	1	1	0.05	0.1
Ground water	1	1	0.05	0.1
Aquaculture resource	4	3	0.2	1.4
Minerals	2	3	0.05	0.3
Cemeteries	1	1	0.05	0.1
Socio-economy (Economic sectors)			**0.35**	**5.3**
Industry-Handicraft	2.0	2.0	0.3	1.2
Agriculture	4.0	3.0	0.3	2.1
Commerce-service	3.0	2	0.4	2.0
Total				**5.4**

Source: UN-Habitat

Table 19: Multi-hazards

Adaptive capacity	Flooding	Salinity	Coastal erosion	Riverbank erosion	Storm	Weight
Finance	2.74	1.54	1.56	1.96	2.3	0.21
Technology	2.28	1.52	1.48	1.78	1.96	0.22
Human resource	3.38	2.32	2.48	2.60	3.02	0.15
Policy	3.80	2.64	3.00	3.04	3.68	0.09
Government	3.26	2.42	2.40	2.74	3.38	0.10
Coordination	3.40	2.14	2.64	2.76	3.36	0.12
Implementation	3.24	1.84	2.24	2.42	3.16	0.12
Total	**3.0**	**1.9**	**2.1**	**2.3**	**2.8**	

Source: UN-Habitat

Table 20: Exposure and Sensitivity and Adaptive Capacity

Level	Exposure and Sensitivity	Adaptive capacity
Very High	>5	>3
High	4 - 5	2.5 - 3
Medium	3 - 4	2 – 2.5
Low	< 3	< 2

Source: UN-Habitat

Table 21: Exposure and Sensitivity, Adaptive Capacity, and Vulnerability

Hazards	Exposure and Sensitivity (E+S)			Adaptive Capacity - A	Vulnerability – V
	2011	2020	2050		
Flooding	4.5	5.0	5.3	3.0	Medium – High
Salinity	3.6	3.7	3.7	1.9	Medium
Coastal Erosion	3.8			2.1	Medium
Riverbank Erosion	3.0			2.3	Low
Storm	5.0			2.8	Medium – High
Storm + Flooding	5.8			3	High-Very high
Storm + Coastal Erosion	5.4			2.8	High

Source: UN-Habitat

UN-Habitat's Cities and Climate Change Initiative promotes enhanced climate change mitigation and adaptation in developing country cities. This document is an initial output of the Cities and Climate Change Initiative activities in Hoi An, Viet Nam. This abridged report is based on the report titled: "Hoi An, Vietnam – Climate Change Vulnerability Assessment" funded under the framework of One UN Initiative in Viet Nam in 2011, and the Cities and Climate Change Initiative.

Starting with a brief background of the city, this report addresses Hoi An's climate change situation from a climate risk perspective that focuses on hazards, vulnerabilities, and the adaptive capacities of the city. Following the insights gained from clarifying the climate change challenges, the report proposes the key sectors for climate change adaptation and mitigation measures in Hoi An. It finally recommends four solutions for improving capacity of Hoi An to adapt to climate change: (1) policy, institutional and coordination; (2) finance and investment; (3) human resources and information; (4) technology and infrastructure.

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