

LIVING WITH FLOODS

A GRASSROOTS ANALYSIS OF THE CAUSES AND IMPACTS OF TYPHOON MIRINAE

Michael DiGregorio, Ph.D.
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Introduction

Michael DiGregorio, Huynh Cao Van

On November 2, 2009, typhoon Mirinae slammed into the coast of central Vietnam killing 122 people and causing \$280 million in damage to property. While typhoons regularly strike the coasts of central Vietnam each fall, the severity of this storm took both meteorologists and local disaster relief authorities off guard. With the heaviest rains far inland, coastal communities in the rice growing deltas were not prepared for the flooding that followed.

Over the next 50 years, Vietnam's Ministry of Natural Resources and Environment (MONRE) has predicted that climate change will cause an increase in the number and severity of storms such as Mirinae. That may be true, and, in fact, many have suggested that severe storms have already begun to increase. For the people of central Vietnam, however, tropical storms have long been part of an environmental consciousness. Historically, in the late fall of each year, farmers prepare for seasonal storms, well aware that in any given year a severe storm could overwhelm them. Given this, the severity of damage and loss of life associated with typhoon

Mirinae might come as a surprise. Has climate change begun to produce storms that have exceeded the capacity of people living in the flood prone deltas of central Vietnam to prepare for and respond to storms? Or have other factors within the landscape changed to such a degree that established practices are no longer adequate?

This report proposes that, through the generation of more severe storms, climate change is creating a new disaster preparation and response equation. But this, however, is not the only equation. Vietnam is now engaged in a socio-economic development strategy that is committed to forms of economic growth that favors the expansion and development of coastal and lowland cities and towns. Increasingly, that growth needs to come to terms with environmental constraints. As city administrators, investors, and politicians confront these limits, the primary responses have been to protect new urban development from damage through site planning and storm related infrastructure, often at the expense of existing settlements.

This study of flooding associated with typhoon Mirinae in the suburban areas of Quy Nhon city will show that residents of these areas are accustomed to seasonal flooding and have, over generations, discovered means of dealing with the associated risks and benefits they provide. They are also aware of recent landscape transformations, including, among other things, the construction of new dams, roads, bridges, and dikes, and the infilling of floodplains for urban development. Rather than anticipated increases in the number and intensity of storms, they regard these new projects, and the failure of authorities to offer them adequate warning, as the key factors behind the severity of Mirinae's impacts. Evidence suggests that they are correct.

MIRINAE: WARNING, RESPONSE, IMPACTS AND EXPLANATIONS

Typhoon Mirinae developed east of the Philippine islands in late October 2009. By the end of October, it had entered the East Sea and was tracking towards the coast of central Vietnam. On October 31, 2009, Bui Minh Tang, director of the Central Storm Forecasting Agency, announced that the storm, the 11th to threaten the coasts of Vietnam that year, was powerful, rapid and would produce up to 400 mm of rain in Central Vietnam. On the same day, Deputy Prime Minister Hoang Trung Hai issued disaster preparation instructions. On November 2, all public schools in Binh Dinh province were officially closed, and people were advised to prepare for a severe storm. On the morning of November 2, 2009, tropical storm Mirinae, with wind speeds of 109 kph, made landfall in Phu Yen province, the province bordering Binh Dinh on the south. Over the next two days, a hydrological station at Van Canh, Binh Dinh, in the upper reaches of the Ha Thanh River, recorded 815 mm of rainfall. In Phu Yen, the province hardest hit by Mirinae, 69 people were killed. In Binh Dinh, to the north, 14 people were reported dead and 3 reported missing. In Khanh Hoa, further to the south, another 12 deaths were reported.



Map 1. The Ha Thanh river from Van Canh to Thi Nai, looking south towards Phu Yen

At around 4 PM on the afternoon of November 2, 2009, rain began to fall heavily in the highlands of Binh Dinh and Phu Yen. Over the next hour, a hydrological station in Van Canh town reported nearly 80 mm of rainfall. However, in the suburbs of Quy Nhon city, roughly 30 km distant, the storm produced only seasonally normal rain (Figure 1). At around 5 pm, heavy flooding was reported in Van Canh. Residents had never seen a flood in this upland area, and in disbelief, began calling friends and relatives in Quy Nhon to convey the news and share images taken on their mobile phones. As water swept down the eroded hills over the surface of saturated soils and into the Ha Thanh River, the river swelled with a crest that took approximately 60 minutes to reach the Highway 1A Bridge at Dieu Tri, 27 km away.

Despite the time delay, there was no official flash flood warning. Even those who had been warned by friends and relatives reacted slowly. The conditions in the lowlands were normal. Rainfall was light and the rivers and streams were within their banks. With conditions in the lowlands appearing normal, residents waited for an announcement about the release of water from one of the upriver reservoirs or hydroelectric dams. In their experience, this kind of warning was the signal to prepare for a sudden flood. With no official warning, they continued to rely on local signs.

Between 6-7 pm residents of settlements in Nhon Phu ward began to see water in their yards rising rapidly, and shortly thereafter, enter their houses. Only as floodwater passed the level of their foundations, a level they regarded as within the upper range of seasonal flooding, did they begin to respond. The suddenness of the flood caught most off guard.

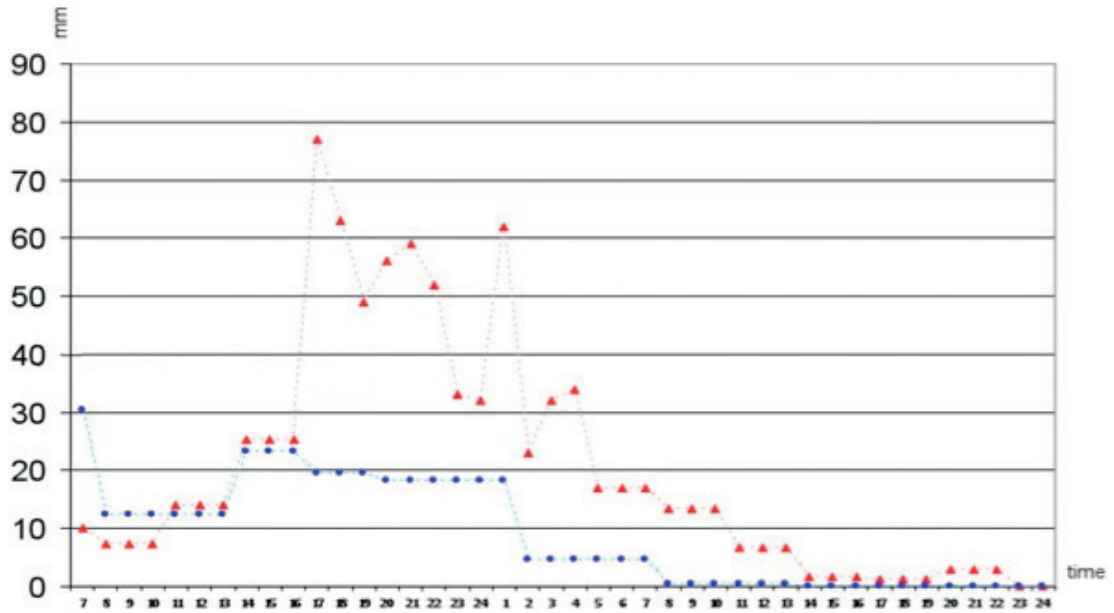


Figure 1. Rainfall recorded at the Van Canh and Quy Nhon hydrological stations, November 2-3, 2009.

People living in the lower reaches of the Ha Thanh River are accustomed to flooding. Many regard it as a seasonal annoyance and some consider it a benefit. They prepare for flooding, and respond in stages. Given this, why was the impact of Mirinae so great?

RESIDENTS OF THE DELTA GIVE THREE MAIN REASONS

First, as the brief narrative above illustrates, they were not informed of the potential for flash floods. From the initial discovery of floodwater in the yards of people living in Nhon Phu at 6 pm to the arrival of floodwater at the eastern dike in Nhon Binh at 10 pm, not one of the 30 people we interviewed reported hearing an official warning of the impending flood on any mass media outlet. Given that the flood developed during the evening, when many households were watching their televisions, this lack of information on the evolving flood is disturbing. Nearly every household we interviewed told us that lack of time to respond was the major reason for the losses they suffered. The floodwater rose so quickly that, once they realized that this was more than a normal flood, it was too late to respond.

Second, many of the people we talked to believed that the suddenness of the flood was, in fact, caused by the release of water from reservoirs upriver. Some people repeated a persistent rumor of villages being wiped out when the dams were opened or collapsed, particularly in Phu Yen, the neighboring province. This rumor has been denied many times; and at least one of the people we interviewed recognized this denial, but did

not accept it. In the experience of people living in the lower Ha Thanh, flash floods have only been caused by the release of water from irrigation and hydroelectric reservoirs. With no other information, many continue to hold onto this belief.

Third, they regard recent changes in the landscape of the lower Ha Thanh as the major source of risk to people living in existing settlements. Upgraded dikes and dike roads; renovated roads that are now much higher than in the past; new urban areas, projects sites and industrial zones located on foundations more than one meter above the surrounding paddy fields, and narrow bridges that cannot accommodate the flow of severe floodwater are all new landscape features in the floodplain. These changes in the face of the land have contributed to higher levels of standing water, creation of danger zones in places where floodwater descends over barriers, faster current within flood channels, and longer periods of time for floodwater to discharge into Thi Nai lagoon.

In the following sections of this report, we will try to understand these assessments and analyze them in a wider context of urbanization of the lower Ha Thanh river delta.

Adapting to the Laws of Nature

Over the course of this research, we heard stories of terrible floods that have affected the floodplain of the lower Ha Thanh River. Men and women in their 80s can remember being told about the great Nham Ti storm of 1912, the mother of all storms, which wiped out whole villages. But these elderly people, as well as younger men and women, could also give us personal recollections of extreme storms in 1955, 1966, 1979 and 2009. They could describe severe but less extreme storms like those experienced in 2007 and 2010. Their memories are etched with these experiences, but so also are their homes. Nearly every home we visited bore the scars of floods. This visual record – low flood lines for severe but normal floods, and high water lines for extreme floods – is a constant and very present reminder of the natural cycles of flooding within the lower Ha Thanh. Given this experience, during the annual flood season they watch for and respond to signs in their environment. They watch water rising in paddy fields, entering yards and then crossing foundations into their homes. They watch floodwater rise to reach its maximum height, stop, then begin to recede. They wait for water to recede quickly as a signal to begin cleaning out sediment, then wait for water to recede below their foundations to signal the beginning of a return to normalcy. Nearly everyone we talked to could recall when the 2009 flood passed each of these stages because they were responding to events as they happened. Their observations of the flood allowed us to understand its evolution. But more than this, and despite the losses people suffered, the ways they described responses to the flood suggested a shared knowledge and history of adaptation to the environment.



Photo 1. Woman in Van Ha, Nhon Phu showing height of the 2009 flood.



Map 2. Interview sites

BAMBOO DIKES AND FLOODWATER MANAGEMENT

Mr. Do Thanh Tin guided us to the banks of the Ha Thanh River outside his house. Below, an upgraded, two level dike stretched out along the river. He pointed to the loose stones packed in between the larger rocks that made up the dike. “I don’t like that. They’ll be washed away. The spaces between the rocks will be exposed to flood water.” At the bottom of the dike, close to the water’s edge, he pointed to a few banana trees he had planted. Mr. Tin had already told us how his parents and those before them used banana trees as both weights on their roofs and rafts during the storm season. Now he was going to take us to see something else he learned from them.

Upstream from this section of upgraded dike on the southern Ha Thanh river in Van Ha village, Nhon Phu ward, there is what looks like a natural bamboo grove; a common sight along many rivers in Vietnam. This, and other bamboo groves are clearly visible in Google Earth satellite images. We had never bothered to look too carefully at these common sights, never noticed the embankments by the river or the tangles of debris hanging high in the clumps of bamboo.

“I began building this embankment (bè) in 1956”, he continues. Mr. Tin, born in 1929, was not the creator of this floodwater management system. He is a practitioner, like many generations before him. Nevertheless, he is an able spokesperson. “In a big flood, water at the surface runs quickly, but down below, it flows so-so, not fast like the surface. The banks of the river are eroded most when the flood is small and the current is most intense at deeper levels, not when the water is deep. When the flood is deep, the embankment won’t be affected.” In the late 1950s, Tin dug up mud from the river to create an 80 cm high embankment along the riverside of his property.



Photo 2. Mr. Tin explains how water flows over his bamboo dike.

He planted clumps of bamboo both on the embankment and behind it. Fifty-five years later, and after many storms, his dike is intact.

Mr. Tin's "bamboo dike", like others built elsewhere in the lower Ha Thanh, does not prevent flooding. The two things farmers fear most are fast flowing water, which can knock down a house, and standing water, which can undermine the foundation. The "bamboo dike" controls erosion along the banks of the river during seasonal flooding, preventing land from being swept away, and reduces the flow of floodwater

in severe and extreme storms, preventing structures from being washed away. And because the dikes are low and placed strategically, rather than everywhere along rivers and streams, they allow floodwater to discharge into Thi Nai lagoon rapidly.

Except where local, city and provincial governments have built stone dikes, rivers and streams in the lower Ha Thanh are bordered with bamboo. We have not visited all these sites, and we don't know how common this form of dike is. From what we have seen, however, Mr. Tin has introduced us to a fundamental difference between past and current water management systems. While in the past floods were regarded as a natural part of the seasonal water cycle that needed to be *managed*, an increasingly urban focus on the protection of property has resulted in a re-interpretation of that natural cycle as a threat that needs to be *prevented*¹.

FLOODING AND FERTILITY

Over the course of this research, we gradually came to appreciate the fertility of this river delta, a fertility that is partly due to seasonal flooding. Throughout the lower Ha Thanh, farmers are able to grow three main crops per year, at the same time, raising vegetables, fruit, and livestock in commercial gardens on their residential plots. In estuary areas of Nhon Binh, where salinization of ground water makes the soil less fertile, farmers can compensate with coastal resources salt, seaweed², crabs, fish, shrimp, clams and snails. By the time we reached Dong Dinh near barrage No. 3, it became clear to us that nature offered rice farmers, salt makers and fish farmers sufficient resources to meet their needs, and in fact, to live happy and productive lives. Many of

1 Andrew Smith points out that before the French colonial administration of northern Vietnam, nearly all dikes in the Red River delta allowed for seasonal flooding of paddy fields. This was considered part of the natural cycle and beneficial to agriculture. New dikes were constructed by the French in order to protect the property of a new urban class and support the development of commercial agriculture by reducing risks associated with rare but devastating floods. Smith, Andrew (2002) *Water first, a political history of delta hydraulics in Vietnam's Red River Delta*. Australian National University.

2 *Sphaerococcus* sp. used to make agar-agar.

the people we met had raised large families, and many of their children were now in college or recently graduated. The seasonal cycles of flooding were intimately connected to this prosperity.

We first became aware of how flooding helps to fertilize the soil through discussions with Mr. Tin. Ms. Truong Thi Thau, in nearby Nhon Ha, also told us how seasonal flood cycles determined what could be planted, and when. But it was Mr. Tran Van Tri in Luat Le who offered us a full perspective on the relationship between flooding and agriculture.

“Whenever I feel like it is going to rain hard, I run to the market to buy some noodles to keep at home,” Tri’s wife remarks, “but he goes off to watch his paddy fields.” Mr. Tran Van Tri is a gentle man with a sincere smile. He lives in Luat Le, in Tuy Phuoc district, a hundred meters from a branch of the Ha Thanh River that borders Nhon Phu ward. He is a rice farmer and bonsai hobbyist and lives in a house originally constructed by his grandfather.

He is focused, fixed on communicating, as he speaks. “If floods are not too frequent or too big, paddy yields will be high. Every *sào*³ will produce an additional 100 kg.” Like most areas of the delta, farmers expect flooding several times a year. These normal floods, referred to as “every year floods” (*lụt hàng năm*), rise and fall in the space of 8 to 12 hours, often at night. Flooding is more frequent in western and southern Nhon Phu, and less frequent nearer the coast. Normally, floodwater remains outside homes, flooding only yards, and most importantly, fields. “If flooding is not as bad as 2007 and 2009, but only normal, it will overflow the low embankments around paddy fields,” Mr. Tri explains. “If this happens frequently over the flood season, it will kill agricultural pests and diseases. If flooding is not too high—big floods are disasters—but just overflows the low embankments, yields will be high...very high. That is a law of nature...a law of nature.”

“Law of nature” is key to understanding how people have adapted to this environment, and prospered. For uncountable generations, agriculture and flood cycles have been integrated into seasonal calendars. From the beginning of the planting season during the 11th lunar month (November-December on the solar calendar), until the storm season beginning in the 9th lunar month (September-October on the solar calendar), most farmers are able to grow three main field crops. Areas with the most reliable supplies of fresh water will plant three crops of irrigated rice. Areas that are constrained by a lack of fresh water in the early part of the year will leave their land fallow during the first growing season or grow another crop that requires less water. Ms. Thau in Nhon Binh, for example, plants sesame as a cash crop. Some farmers living in areas of Nhon Binh and Nhon Phu that are affected by salt water in the dry season also leave their land fallow. Others have converted their less productive rice fields into shrimp and fish ponds.

In addition to their main field crops, most households also keep commercial gardens. These gardens, located on residential plots, are vital to the regional food supply. While the

3 500 m²



Photo 3. Woman in Van Ha, Nhon Phu pointing to upper limit of normal seasonal flooding.



Photo 4. Mr. Ba's herb garden

gardens are individually small, repeated over the whole delta, households in Quy Nhon supply not only much of the city's fruits, vegetables and herbs, but also contribute to the food supply of neighboring provinces. Much of this food passes through markets like Truong Uc Hill Market in Tuy Phuoc, and Dinh Market and Vinh Market in Quy Nhon.

Mr. Nguyen Dinh Ba sees us walking down his lane. This area of Phu Hoa is crowded with vegetable gardens fit in-between houses. His wife and daughter, picking herbs, smile as we take a photograph. Mr. Ba invites us into his house. "I sell vegetables in Vinh Market", he says. "My son transports them." We mention Ms. Thau in Nhon My, whom he has met. "Like Ms. Thau, I use my motorcycle to carry vegetables from one place to another, except she sells by day. I arrive in the market at 2-3 am; she arrives at 5-6 am - when I am leaving. Here, we sell vegetables late at night."

Many of the farmers here in Phu Hoa grow herbs. In the late afternoon and evening, women cut and bundle mints for sale in the night market. They will be used fresh in the city's *phở* shops in the morning, and many will be transported overnight to neighboring provinces. Mr. Ba grows three crops in his home garden and two crops on his four *sào*⁴ of irrigated paddy land. Like most people living in the estuary of the Ha Thanh River, his first rice crop is constrained by a lack of fresh water. In the fourth quarter of the lunar year, he leaves his paddy land fallow and allows his third vegetable crop to gradually go to seed. "This is the flood season," he reminds us.

The flood season starts at the end of the 8th lunar month, August or September in the solar calendar. During the last week of this month, weirs and water gates on the lower Ha Thanh will be opened to prepare for flooding. Given the very high water table, flooding of

⁴ 2,000 m²

the delta is needed to flush out salt in the groundwater and prepare for the growing season. For the next 2-3 months, agricultural land will remain fallow as the soil recovers.

Salt production and aquaculture follow a similar cycle. Salt makers begin preparing their salt ponds in the 1st and 2nd lunar months (January-March), and harvest salt from the 3rd to 6th month. By the 7th lunar month, the salt making season is over. During the height of the season, salt makers can harvest every 4-5 days. Many salt makers are also fish and shrimp farmers. As the salt season ends, they focus more attention on fish, crab and shrimp ponds – always with the advent of the rainy season in mind. If they cannot harvest their last crops of fish, shrimp and crabs in time, there is a good chance they will be lost in a flood.

BUILDING FOR A FLOOD PRONE ENVIRONMENT

The laws of nature have not only affected how residents of the delta have developed their seasonal agricultural cycles, but also their architectural styles. Off the main roads, where multistory cement shop houses dominate, the architecture begins to change. The houses are smaller, most only with 1-3 rooms, and many are single story. The newest houses have the highest foundations, the oldest, the lowest. Some of the newer one-story houses are shaped like tube houses, with the peaks of their corrugated metal roofs set near the back third of the house. While most of the older houses have gardens, these newer ones, set closer to the streets and lanes, have small retail and service shops.

Mr. Tin, who introduced us to the bamboo dike, also introduced us to the architecture of the lower Ha Thanh delta. “In the past, only Mandarins were able to build brick houses. In 1945, back then, times were tough and the houses were low to the ground.” The houses he described were similar to the earthen walled, straw roofed houses formerly found in many areas of coastal Vietnam. The high roofs relative to low walls were intended to resist storms. “They were so low you had to duck to come in”, adds Mr. Tin. The key to these homes were their internal frames made of solid timber. While the walls would wash out in an extreme flood, the timbers would remain in place, with families sheltered under the roofs. “There’s a few of these houses still around, today”, Mr. Tin adds.

A day later, as we talked to Mr. Tri about his home in Luat Le, we began to understand what Mr. Tin meant.

Mr. Tri’s “L” shaped house borders a large courtyard. From the outside, this house is similar to many others built in the 1960s and 1970s. The house sits on a foundation about 40 cm above the yard. Like most people living in this area, the height of his foundation is a reflection of the height of the nearest barrier to the flow of water at the time of construction. Here, it was a low earthen dike road across the river in Nhon Phu. As Tri shows us where



Photo 5. Mr. Tri and wife in old section of the house.



Photo 6. Upgraded housing style of the 1960s-1980s.

he and his wife took shelter in an attic during the 2009 storm, we realize that this section of the house is older. “This house has been around since 1957,” Tri explains. “At that time, my grandfather and grandmother went up to Cu Mong pass, cut the trees for construction, and carried them back here one at a time...one day, one tree.” The old house, with its heavy but movable frame, had been incorporated into the new, and its attic, which protected previous generations, also served him. During the height of the storm, Tri and his wife took refuge in this space, the same space his grandparents had prepared for similar floods.

The houses many now regard as the traditional farmhouses of the south central coast were not built before the early 1960s. Mr. Tin explains. “The housing situation advanced a lot in the early 1960s, was quite inventive in fact, because at that time the Rural Development Committees began promoting construction of these single-story, brick and tile houses.” This period of construction, beginning in the 1960s and lasting through the 1980s, gives us some sense of flood expectations in the lower Ha Thanh. The foundations of these houses are generally 20–40 cm above their yards, depending on the location. As in Mr. Tri’s house, the height of foundations generally reflects the height of seasonal flooding, given the drainage system of the area. We understood this most clearly in a settlement near bridge No. 7 in Nhon Binh. Here a middle-aged man and elderly woman living near a new rural road, raised about 10 cm above the old road bed, complained that the new road now flooded their houses. “When the road was nearly the same level as the rice fields”, the elderly woman tells us, “floodwater could run out.” “Water could run over the road”, her neighbor continues. “Now, since the road was built higher, water is blocked and we have to accept the consequences.”

Raising foundations above the level of seasonal flooding is one means of adaptation. Annual tropical storms produce floods of varying intensity. Unfortunately, the intensity of flooding produced by any given storm is difficult to predict. For this reason, people often respond in stages. People may not begin to respond to a flood until water reaches the threshold of their homes. If water crosses the threshold – a clear sign that a seasonal flood is becoming a severe flood – any paddy stored in the house will be placed on a wooden platform bed or other raised area in the house. If the water continues to rise, furniture will be tied together to prevent them from floating



Photo 7. Table and chairs used by elderly men to climb into an attic during the 2009 flood.



Photo 8. Loft in Mr. Ba's house in Phu Hoa, Nhon Phu.

out of the house; doors and windows will be closed and locked, and family members will wait out the flood sitting on chairs placed on tables. If the water continues to rise, they will use these same chairs to climb up into the attic, bringing whatever they can with them. They will wait in the attic for the floodwaters to recede, pulling aside roof tiles for air and to signal rescuers.

While older houses have attics, newer houses in the lower Ha Thanh generally have lofts (*gác lờ*). There are two reasons for these lofts. They keep family altars safe and dry and provide a refuge from floods for family members. Mr. Nguyen Dinh Ba's house is an example. He had previously lived in this area for six to seven years in a house whose foundation was much lower, and during that time, floodwater never rose above the foundation. In 2008 he built his new house on a foundation one meter above his yard and built a loft in the house primarily to protect his altar. He was being cautious, following the example of people who built their homes closer to main roads. In 2009, water rose over 2 meters deep in this area of southern Nhon Phu, flooding his new house. The loft became his refuge. As the water rose, he lifted whatever he could up to the higher level.

We heard this again and again from the people in the delta we spoke to about the 2009 flood: the story of families retreating to their lofts during the storm, bringing with them whatever they could carry. Ms. Pham Thi Tuyet Suong, who runs a bicycle repair shop out of her small house next to a floodway in Nhon Binh, had 10 children and 5 adults crowded into her loft as the water rose late at night. Do Thi Hien, her 76-year old mother, and 10-year old daughter living in Phu Vinh, southern Nhon Phu, fled to a neighbor's house about 200 meters away. Ms. Hien sells *beo* cakes and had bought rice earlier that morning. At 8 PM, when floodwater was up to her knees, she ran to her neighbor's house carrying only those three kilograms of rice. "I live from day to day", she says. "I cannot survive another flood like this."

From the Farm and From the City, Perspectives on Flooding Differ



Map 3. Hydrological model illustrating the Center for Planning and Construction's commentary on the Nhon Binh master plan to 2020

FLOODING AND RIVER SYSTEMS

Nearly everyone we talked to said that they felt that floods had become deeper and more frequent and that the period of time for water to recede had become longer over the past few years. Many are aware of climate change, but did not associate flooding with the increased storms predicted by climate models. Rather, they have focused on the changing landscape around them. Having adapted to this flood prone environment, they are aware of even the smallest landscape changes that increase flooding.

In a 2008 commentary on the master plan for Nhon Binh, the Binh Dinh provincial Center for Planning and Construction noted that during heavy rainfall, floodwater flows fairly



Map 4. River network of the lower Ha Thanh River in relation to flooding Image circa 2009

evenly over both the north and south branches of the Ha Thanh River. In the north, it may also meet floodwater in the Tham Do River. As floodwater crests over river banks in Nhon Phu and Dieu Tri, paddy fields and residential areas in the wards will be flooded. As Nhon Phu floods, water will run through culverts under roads into Nhon Binh, and from there, through barrages on the eastern dike into Nai Nai lagoon¹. Our research suggests that the simple hydrological model presented above is *seriously inadequate*.

The northern branch of the Ha Thanh flows through Dieu Tri town, passes under the Truong Uc hill bridge in Tuy Phuoc town, and then serves as the border between Nhon Binh ward and Phuoc Thuan communes (Map 4). A smaller branch of the river follows the border between Nhon Phu ward and Dieu Tri town (0). This branch of the Ha Thanh, one of the main sources of flooding in Nhon Phu, is not discussed in the Center's commentary². The river enters Nhon Phu at Van Ha village and, after passing under bridge No. 8 near Truong Uc hill, enters Nhon Binh (1). From there, after passing through an irrigation reservoir, the natural stream is incorporated into the irrigation system. According to a 1:50,000 map published in 1969, this branch of the Ha Thanh river formerly entered Thi Nai lagoon at what is now Barrage No. 3 on the eastern sea dike (2). The river is still represented as following this course in the hydrology layer of the GIS used by the General Statistical Office

1 Center for Planning and Construction inspection of Binh Dinh province, 2008

2 This is the river that passes near Mr. Tri's house.

of Vietnam. The river now flows north where it terminates in a large pond bordering an upgraded dike along the northern branch of the Ha Thanh River in Nhon Binh (3). Also not considered within the Center's commentary on flooding is another branch of this same river (4) that flows through Nhon Phu toward bridge No. 7 on highway 19 (5). This river is known locally as the Vung Phen River but is also referred to as the Cat (Sand) river. Mr. Nguyen Van Minh, who lives near the terminus of this river a few hundred meters west of bridge No. 7, told us that during heavy storms, this river carries large amounts of sand into surrounding paddy fields. This is clearly evident in Google Earth satellite imagery. The high sediment load of this river suggests that it is a major floodway. Farmers already know this. Floodwater is channeled through these two rivers into Nhon Phu, and from there, into Nhon Binh.

While these two rivers are a major source of seasonal flooding in Nhon Phu, and a significant source of flooding in Nhon Binh, they are not the only sources³.

Another river, the Dinh Market River (6) channels floodwater directly into Nhon Binh from the southern branch of the Ha Thanh. Starting at a water gate in southern Nhon Phu, the Dinh Market river flows under the rail line, Hung Vuong Street and Tran Hung Dao Street into Nhon Binh ward, around the Nhon Binh Industrial Cluster, and through Barrage No. 1 (7) on the eastern dike into Dong Da ward and Thi Nai lagoon. The Dinh Market river is the only channel for floodwater in the southern branch of the Ha Thanh river to flow directly (8) into Nhon Binh ward. The main branch of the southern Ha Thanh continue past the Dinh Market river, past a weir, and under Double bridge on Tran Hung Dao Street (9) at the border between Nhon Phu, Nhon Binh and Dong Da wards. A short distance after Double Bridge, it enter Thi Nai lagoon in Dong Da ward. The Dinh Market River and the channel under Double Bridge are the only two exit points for floodwater in the southern Ha Thanh. With Tay Son Road on the south and west (10), Tran Hung Dao Street on the north, and only two narrow channels for floodwater to exit into the lagoon, southern Nhon Phu has become an easily flooded, low-lying flood basin.

Why and how could the Center for Planning and Construction miss these three important sources of flooding? Even a brief examination of satellite images on Google Earth clearly shows each of the rivers noted above. They are clearly marked on 1:50,000 maps as well. Given that the presence of these rivers is well known, what other reasons would prevent the Center from taking them into consideration? The simple answer is that the Center's analysis comes with a purpose in mind. By excising these rivers from their narrative, the Center has overstated the role of the main branches of the Ha Thanh River in flooding, understated the role of the smaller rivers within the agricultural ecology of the delta, and prepared the conceptual groundwork for construction of a city-wide dike system.

³ People living in Phu Hoa told us that Tay Son road can be flooded by streams and surface flows down Hon Cha mountain. They also mentioned that a small river also flows out of Bau Lac lake in Bui Thi Xuan ward into southern Nhon Phu near the Ngang River bridge.



Photo 9. Division of the Ha Thanh river near Van Ha village, Nhon Phu ward.

EVOLUTION OF THE 2009 FLOOD

As we sought to understand how the 2009 flood had evolved and become a disaster, we realized we needed to disregard the Center’s analysis and focus our attention on the accounts of people who experienced the flood firsthand. The 2009 flood began in the late afternoon as heavy rainfall in Van Canh, falling on saturated and eroded slopes, swept down into the Ha Thanh River. Floodwater reached the division of the northern and southern branches of the Ha Thanh River at about 6 pm the same evening. Based on interviews with residents, floodwater entered into Van Ha and Nhon My in the northern part of Nhon Phu ward through the Vung Phen river, and into Phu Vinh in the south through the southern branch of the Ha Thanh. Flooding appeared at roughly the same time, between 6 and 7 pm⁴, in both areas.

Mr. Tin recalls cooking his dinner as the water began to rise. Mr. Tan Son, near Ngang River Bridge, had just returned from Dac Lak. Exhausted, he discounted the rising water as nothing more than a normal flood, and lacking any information to the contrary, he went to a neighbor’s house to drink and chat. At 6 pm, Mrs. Hien in Phu Vinh saw water begin to rise in her yard. Her home is near a narrow part of the southern Ha Thanh, at the point where the Dinh Market River branches off⁵. At 7 pm, Ms. Thau, in Nhon My, was lying on her bed watching television when the daughter of an elderly neighbor called. She was concerned about her father, in his late 80s, having heard news reports about a possible flood. When Ms. Thau put her feet on the floor, she was surprised to find water already in her home. Within an hour, it was up to her waist.

By 7 pm floodwater had reached bridge No. 7 on highway 19, and by 8 pm, people living in Tay Dinh village in Nhon Binh ward reported water in their yards. Both locations are within the main floodway, the Vung Phen river. Also at around 8 pm, Mrs. Do Thi Hien reported that a man ran through her neighborhood beating a metal gong, crying, “the embankment has been breached (lở bờ)”. She did not see the man, but both Mrs. Hien and her mother assume he was a member of the local dike protection committee.

4 We have relied on people’s memories of when they first saw water in their yards. These estimates are not precise. In some cases, people notice water as it was approaching the level of their foundations. In other cases, they saw water as it crept over nearby roads. Given that the flood was unexpected, unless specifically noted, the times indicated in this narrative should be considered within the upper limits of a range.

5 The low foundation in Mrs. Hen’s house is cracked. During floods, water gushes up through these cracks through capillary action, like water in an artesian well.

Among the 30 people we interviewed in 21 sites, this is the only example of an official warning that we heard of, anywhere. Ms. Hien's mother told us that, for as long as she has lived here, about 35 years in total, village men have monitored flooding in the river, and if necessary, made the call to other men to come to sandbag the embankment⁶.

By 9 pm, floodwater passing through the Dinh Market river combined with water passing through the Vung Phen to enter the Binh Thanh area of Nhon Binh ward. At the same time, people living near the Coconut Tree weir (đập Cây Dừa), on the northern Ha Thanh near Truong Uc hill, were discovering water in their yards. It has now been roughly four hours since flooding was first reported in Van Canh, and two – three hours since floodwater was seen in Van Ha, Nhon My, Phu Vinh, and the area near bridge No 7. Only now, however, has the rising water begun to break over the banks of the river, rise up over roads, and pass into people's yards in the area near Truong Uc hill. Given their lack of information, people here, as others throughout the flood zone, regarded the rising water as a normal flood.

Up to this point, no upgraded dikes or dike roads have been crested. Rather, water entering through the Vung Phen river surged toward bridge No. 7, spreading out in a circular, backflow pattern into residential areas near Hung Vuong Street. Several people living south of the Vung Phen told us that whenever there is a flood, they now look to the backs of their houses rather than to the Ha Thanh river as a means of estimating the flood's intensity. This was a particularly intense flood that demolished concrete walls as it spread out from the Vung Phen river towards Hung Vuong Street and the dike road.

Between 9 and 10 pm, Mr. Do Thanh Tin, who lives beside a section of upgraded dike in Van Ha, saw water spill over the dike there. This corresponds to a period of heavy rainfall in Van Canh (Figure 1). Unlike his bamboo dike, Mr. Tin told us that the force of water spilling over an upgraded stone dike or dike road will scour out soils and undermine foundations as it descends into lower areas. Given that his home is now *below* the upgraded dike, the descending water was a matter of deep concern for him. Fortunately, his house survived. Many houses in Nhon Phu did not.

As water was coming over the dike in Van Ha, it was already rising in Nhon Binh. By 10 pm, floodwater had reached settlements inside the upgraded dike at Lac Truong, in the northern part of Nhon Binh near Truong Uc hill. Mr. Nguyen Ngoc Son reported a sound "like a train" as water poured over the dam on an irrigation reservoir near bridge No. 8. Floodwater was pouring over highway 19 at a depth of about 60 cm. Along the southern branch of the Ha Thanh, water was now moving up the slopes into the relatively higher land in Phu Hoa, at a Pagoda near Double bridge, and close to Tay Son road. By 10

6 Mr. Nguyen Van Son, who lives near Tay Son Road, also told us that people living in Phu Vinh and Phu Hoa have a strategy to deal with floods. At the first sign of a severe flood, those living in the low areas will move uphill to the houses of children, friends and relatives. They will lead their livestock into the Petrolimex storage area on Tay Son road.



Map 5. Time floodwater first noticed in yards, 2-3 November 2009.

pm, people near barrage No. 1 outside the eastern dike also noticed water in their yards. At 9.07 pm, a 1.9 meter tide had already reached its peak⁷. The rising tide earlier that evening, combined with light rainfall, made it difficult for Mr. Nguyen Van Ninh, who lives near barrage No. 3, to recognize the coming flood. At its height, he had 60 cm of water in his house. Like many people living in the estuary, however, he made it clear that flooding could have been much worse if the tide was rising when the floodwater reached the barrages on the eastern dike. In the absence of a high tide or tidal surge, he attributed flooding in his area, Dong Dinh in northeastern Nhon Binh, to urban construction.

At the embankment, at Hung Vuong Street, that's where the floodwater comes from⁸. At the college. In the past, water flowed past Dinh Market. Do you know where that is? In the past, water ran past Dinh Market, and from there to barrage No. 1, and barrage No. 2, and then to me at barrage No. 3. Now it runs completely outside this channel. Water is blocked like water in a high tide – it can't run out in time. Now it is pushed up here.

–Mr. Nguyen Van Ninh

⁷ http://www.csg.com.vn/code/e_tidalchart.jsp

⁸ Two floodways in this area are partially blocked by new construction.

A group of women living beside the upgraded dike at Lac Truong noted that floodwater had spilled over a low section of the dike at about midnight. One of these women told us that her daughter, who lives about three km upstream, called at 11 pm to warn her that a flood was coming. By midnight, her house on the dike was flooded. In front of her house, however, water was still about 20 cm below the top of the upgraded dike.

Between 1 and 2 am, Mr. Huynh Tan Son, living near the Ngang River bridge close to Hung Vuong Street, recorded water coming over the dike road on this mobile phone. The dike here is about two meters above the river, and the water spilling over the top was about 40 cm deep. His house, below the dike, was damaged beyond repair. At around the same time, the rector of Binh Dinh College reported that floodwater surging toward the college through two nearby railroad bridges, damaged both bridges and knocked down a section of the wall surrounding the college's property. A man living in Nhon Binh near bridge No. 7 told us he was shaken out of bed between 1-2 am by the sound of water rushing through, and over, the bridge. At roughly the same time, floodwater crested Hung Vuong Street from the northern side, adding to the flooding in the southern part of the ward. As in earlier crests, this corresponded to heavy rainfall in Van Canh.

Mr. Vo Van Tung living across the river from a resettlement area in Dong Da district, didn't see floodwater outside his home until around 1 am. Closer to Thi Nai lagoon, Mr. Vo Van Tong and his wife Vo Thi Phuong did not see water rising at all. Rather, they were told by neighbors the next morning that water began to rise in nearby fish and shrimp ponds at around 4 am. Their home is not more than 20 cm above the embankment of one of these ponds. It was never flooded.

We caution our readers not to read the times we have noted above as precise. The people we interviewed were not expecting a flood, and therefore noticed floodwater in their yards at different points in its evolution. Rather, what we can read in these accounts is a sense of the progression of flooding from one place to the next. Reading the times noted above in this way points to the role of the Vung Phien river as a major flood channel, directly linking Nhon Phu and Nhon Binh wards. The second flood channel is the branch of the Ha Thanh river that passes through the southern part of Nhon Phu ward. Some extremely low areas in southern Nhon Phu are regularly affected by flooding. These two channels flood first, after which flooding will appear along the Dinh Market river and the area east of bridge No. 7. During the 2009 flood, water spilled over the road at the Coconut Tree



Photo 10. Height of floodwater on Highway 19.



Photo 11. Looking northeast from Binh Dinh College showing direction of floodwater & damage

weir at roughly the same time. From this point forward, people in the northern part of Nhon Binh, the area bordered by highway 19 and the upgraded dike along the northern Ha Thanh river, began to see water in their yards. Finally, roughly four hours after the flood was first discovered in Van Ha and Nhon My, people living outside the eastern dike, an area whose flood regime is regulated by tides, began to see water rising in their yards.

In the case of typhoon Mirinae, the intensity of flooding was also related to the intensity of rainfall upstream. From the initial appearance of floodwater in Van Ha, Nhon My and Phu Vinh at 6 pm, which corresponded to heavy rainfall upriver one hour earlier, each observation of water breaking over the dike in Van Ha and Ngang River bridge, over highway 19, and over the northern dike roughly corresponded to periods of intense rainfall in Van Canh.

The depth of flooding varied by location and topography. Some of the deepest flooding, for example, was reported in southern Nhon Phu where people living in older homes had water up to the main beams in their houses. Relative to paddy fields, this would be close to three meters of water. Mr. Ba in Phu Hoa had 1.5 meters of water in his house. Relative to neighboring paddy fields, one meter of floodwater in his house would translate to 2.5-2.6 meters of standing water outside. Mr. Tin, who took shelter in his son's house, pointed to a line about 30 cm above a window as the high water mark in this area of Van Ha. He told us that the upgraded dike was two meters high. All things considered, this would mean that the flood crested over the dike in Van Ha at a height of over 2.5 meters. This level was confirmed by Ms. Thau in Nhon My and Mr. Tan Son near the Ngang River bridge.

Ms. Thau referenced the height of the flood against the height of the rail line close to her house, and Mr. Son referenced the two meter high dike road on which he now lives. These high levels on dikes and dike roads correspond to the cresting levels in rivers. Flooding below the dikes was lower, depending on the terrain and discharge rates within specific

areas. Mr. Tri, living near a branch of the Ha Thanh that borders Nhon Phu and Dieu Tri, had about 1.6 meters of water in his house. Given the height of his foundation, and height of his yard, this would suggest that this area of Luat Le experienced between 2.2 and 2.4 meters of flooding relative to paddy fields. We found similar heights in Mr. Minh's house on the Nhon Phu side of bridge No. 7. Closer to Truong Uc hill, at Coconut Tree weir on the northern branch of the Ha Thanh in Tuy Phuoc, the levels of flooding were substantially lower. There are no dikes along this section of the river. Floodwater did not rise inside dikes as it did in Van Ha, but rather, spilled over the banks of the river into settlements and rice fields. The absence of dikes and other barriers allowed floodwater to spread over a large area, which may have contributed to its lower level here. Mr. Cong living near Coconut Tree weir showed us a flood line roughly 40 cm above a windowsill, which would correspond to 1.6-1.8 meters of flooding, taking into consideration the height of his foundation and yard relative to paddy fields. We found the same height of flooding across highway 19, below bridge No. 8 in Mr. Ngoc Son's house. Closer to the Dinh Market river, floodwater levels were similar. Mrs. Suong and Mr. Hung, referenced walls in their houses, and Mr. Tuan, who lives next the Nhon Binh Industrial Cluster, referenced his family altar. Each indicated flood heights in the 1.6-1.8 meter range relative to paddy fields. Water spilled 0.4 - 0.6 meters over the eastern dike at barrage No. 1. Mr. Vu, one of our guides in this research, measured the level of water in his house as an example. The eastern dike is old, and its level is uneven, but it is generally between 1.75 and 2.0 meters high. This would give a maximum height of flooding in Nhon Binh at roughly 2.5 meters, that is, above the maximum height of flood gauges in the main floodways of Nhon Binh. Outside the eastern dike, in the estuary of the Ha Thanh, floodwater heights dropped dramatically. Just outside barrage No. 1, for example, Mr. Cuong told us that floodwater reached the level of a 0.8 m high railing on his front porch. His foundation is 0.4 m high, and so also is the level of his yard relative to nearby salt ponds. So here, roughly 200 meters from Barrage No. 1, floodwater levels were nearly one meter lower than the nearby dike. As the water spread into the relatively open and barrier free estuary and lagoon, it reached a level roughly 0.4 meters above salt ponds. This was true for both Mr. Tung, near the Dong Da resettlement area, and Mr. Tong, on the margins of the lagoon. The causeway of the Thi Nai bridge seems to have had no impact on flood height and regression. However, both Mr. Tung and Mr. Tong noted that, had the tide been high, flooding would have been much worse. "There are storms every year, and with storms, come floods", Mr. Tong told us. "If there is a high tide, the roads on the embankments will be flooded. A storm with high tides only floods the roads. But if there is a storm with a tidal surge, then our houses will be flooded as well."

Based on this evidence, what can we say about the evolution of the 2009 flood? The simple answer is to repeat key factors noted by residents:

1. Bridges limit how quickly floodwater can pass from one area to the next

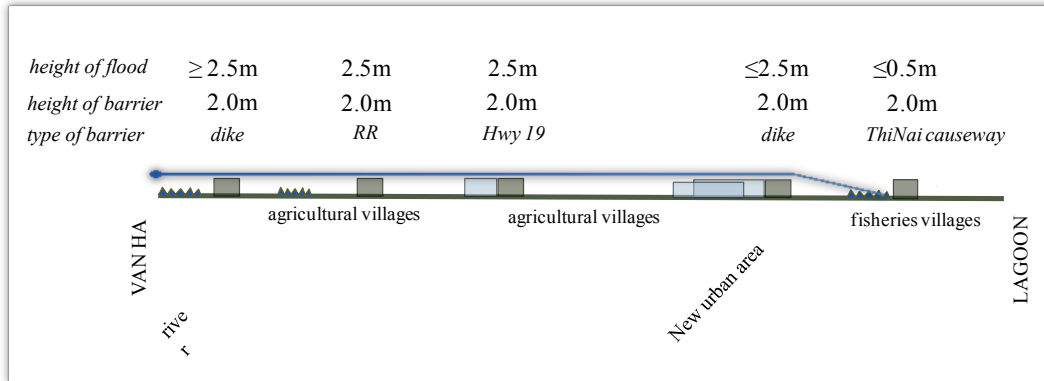


Figure 2. Flood heights in relation to barriers in the floodplain

2. In an extreme flood, floodwater will rise to the level of barriers like roads and dikes
3. Geography favors settlements at slightly higher elevations over those at lower levels
4. Surface flows allow water to spread out over a larger area and lower level, and
5. Tides can facilitate or hinder the discharge of water into Thi Nai lagoon.

In summary, any factor that *slows* the discharge of water into Thi Nai lagoon or *raises* the level of barriers in the floodplain will *increase* flooding. Figure 2, below, illustrates this observation through a cross-sectional diagram of conditions in 2009. The upgraded dike in Van Ha near Mr. Tin's house is on the left, and the Hung Thanh area of Dong Da ward on Thi Nai lagoon is on the right.

Grassroots Explanations for the Causes and Severity of Typhoon Mirinae

Everywhere in the delta of the Ha Thanh river, we heard three common themes regarding the causes of the severity of flooding associated with typhoon Mirinae. First, apart from Ms. Hien in Phu Vinh, none of the people we spoke to had any official warning of the coming flood. They recognized that they were warned of the typhoon in advance, and many prepared. But in their experience, floodwater rises slowly unless there is a sudden release from dams on the Ha Thanh river. Without any information regarding the release of water from dams, they assumed that they would experience a severe but normal flood. Second, despite repeated denials in the press, many of the people we talked to continued to believe that flooding *was* caused by the release of water from one or more dams upstream. Third, having lived in this flood prone area their whole lives, they have a long-term perspective on the impacts of changes in the landscape. For many, uncoordinated construction of roads, dikes, bridges, industrial zones, public institutions, and residential areas in the flood plain is the main cause of both the severity of Mirinae and increased flooding in general.

CHANGES IN THE FACE OF THE LAND

To understand the perspective of residents of the lower Ha Thanh, we need to take a step back in time and imagine this area as it existed before the construction of roads and dikes. This is not very hard to do because many of the people we talked to grew up in a time when the only



Map 6. Section of 1:50,000 map of Quy Nhon, 1969.



Photo 12. The Ha Thanh river estuary in 1967 looking west into Nhon Binh.

obstruction to the flow of water in the delta was the rail line from the main station at Dieu Tri to Quy Nhon. Mr. Tin, Mr. Tri, Mr. Tan Son, Mr. Ngoc Son, Mr. Ninh, and many others told us that in the past extreme floods were very rare, so rare that people can remember only one or two in their lifetimes. In large part this was because water quickly discharged into Thi Nai lagoon. Though the delta is nearly flat, the low level of roads and embankments, and the clustering of settlements left space for floodwater to spread out over a large area and a lower depth.

The section of highway 19 passing between Nhon Binh and Nhon Phu is of particular concern to many of the people we talked to. Mr. Le Van Minh lived on highway 19 since 1971. He is an incredibly resourceful man. When the 2009 flood deposited tons of sand in nearby paddy fields, Minh took out long-term leases on the land in exchange for removing the sand. He sold the sand for a profit and now farms the land. When the storm washed tree roots and branches under bridge No. 7, he collected the wood. He now uses it to make furniture. Having rescued his neighbors with a small “xong” boat, Minh now manufactures these boats on order largely for neighbors who also suffered through the flood. He is thin, dark and quiet. “In that area, in the past, in the place where the university is being built, there used to be a place for water to pass, the Hong Thuy gate. It was right there on the road, the road that was built in the French time.” He describes the Hong Thuy gate as a cemented dip in the road, what road engineers would call a “drift”. Drifts are normally built in seasonal floodways.

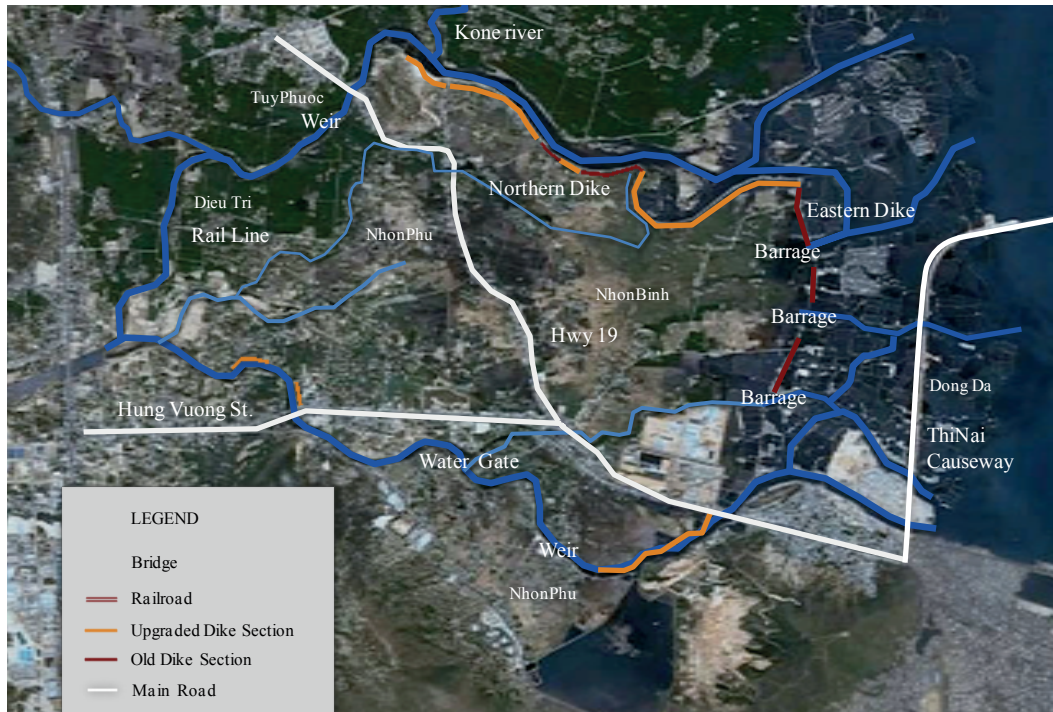
Before 2003, when the road was rebuilt, the main route west followed Hung Vuong Street to Phu Tai, then crossed the bridge at Dieu Tri heading north to An Nhon. At An Nhon, highway 19 headed west to Pleiku and Highway 1 continued north to Phu Cat airport. The section of highway between Nhon Binh and Nhon Phu that is now part of national highway 19, was referred to as provincial road 441 in the 1960s, then national road 1A in the early 1970s, and finally provincial road 639 after liberation. In the mid-1990s, there were only five bridges on provincial road 639 – Dinh Market bridge, bridge No. 6, bridge No. 7, bridge No. 8 and Truong Uc bridge.¹ There were also two “cầu bản”, one being the Hong Thuy gate described by Mr. Minh. Minh describes the Hong Thuy gate as the most important floodway. “In the past, if I wanted to compare, flooding was mostly in the Hong Thuy gate.” Until highway 639 was upgraded in 2003, the foundation of his house was 40 cm higher than the roadbed nearby, and the Hong Thuy gate was near the level of paddy fields. Minh also reminded us that in 1971, there were hardly any houses on the road to prevent the flow of floodwater across it.

Off the main roads around and between Nhon Phu and Nhon Binh, roads were rare. In fact, the only rural roads that existed were the dike paths around paddy fields, salt ponds and impounded marshlands². After liberation in 1975, focus on the delta as an agricultural area resulted in the construction of water management systems that accommodated natural cycles of flooding, drought, and tides. The barrages, revetments, weirs and water gates built in Nhon Binh and Nhon Phu after 1975 were constructed to improve agricultural productivity by preventing salt water intrusion from high tides and tidal surges, while allowing normal floods to recharge groundwater and fertilize soils. The system also made it possible for floodwater from severe and extreme floods to discharge rapidly into Thi Nai lagoon. This predictable system with its seasonal calendar forms the context in which the delta’s farmers have been able to provide food for their families, the city, and the region.

But this view of floods as a valued resource began to lose influence over government expenditures as the drive to urbanize emerged in the late-1990s. From an urban perspective, flooding is a risk associated with the destruction of economic value measured in property, labor and financial capital. Unlike farmers, who perceive benefits in normal seasonal flooding, urban property owners see only threats. Thus, recent projects in the lower Ha Thanh delta have either been built directly for flood prevention, as in the upgraded northern dike, or as part of a systematic effort to elevate sites above predicted flood levels, as in the construction of new roads and urban and industrial areas.

1 Lo Voi bridge, near bridge No. 8, is off the main road.

2 According to Mr. Tong, building embankments, polders or levees around marshland was a way of claiming land. To this day, in the marshland around Thi Nai lagoon, property owners are referred to as “owners of the embankments” (chủ bờ).

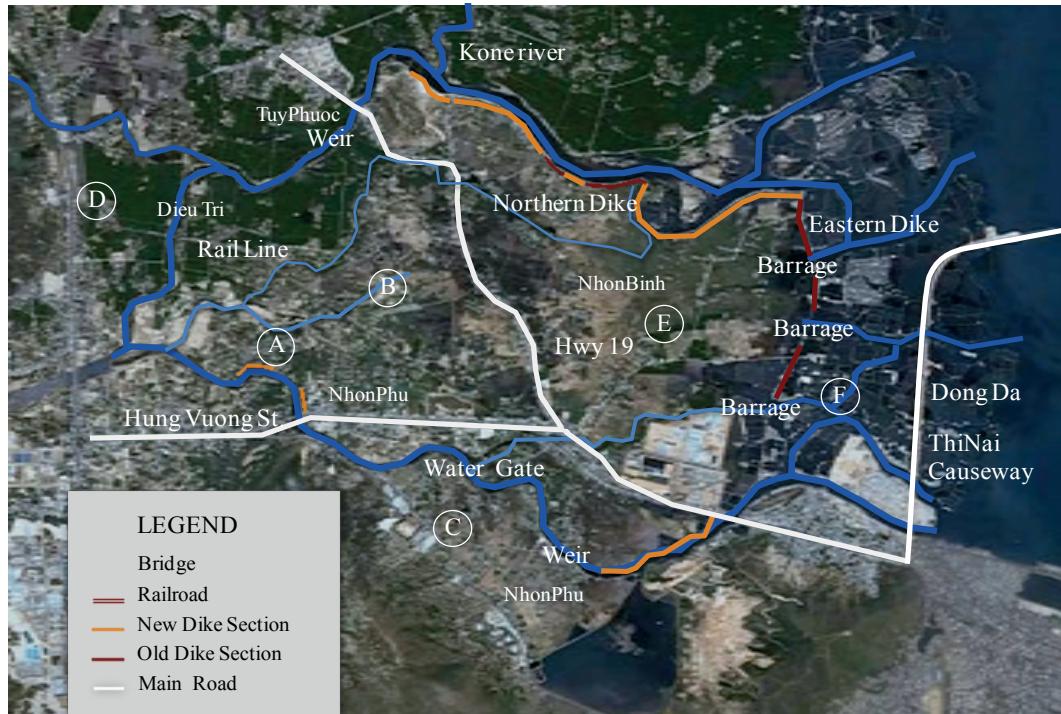


Map 7. Roads, bridges and dikes in the floodplain circa 2009.

Map 7, below, illustrates some changes in the landscape of the lower Ha Thanh that took place prior to the 2009 flood. As already mentioned, the rail line between Quy Nhon and Dieu Tri was the highest barrier to the flow of floodwater in the delta until existing roads were raised in 2003. *These roads now effectively serve as dikes.* Not long after these roads were rebuilt, they began to pose new challenges to water management and flood prevention. In Vietnam, as in most of Southeast Asia, property owners and property developers regard roads that are elevated above the level of seasonal floods as safe and commercially viable construction sites. Not long after Hung Vuong Street and highway 19 were raised, construction increased. By late 2009, most of their lengths were occupied. In the 2009 flood, walls around property functioned as additional barriers along these roads, pushing greater amounts of floodwater into the remaining open channels under bridges and between houses.

In addition to road construction, the decade of urbanization leading up to 2009 has also seen a focus on dike construction. In 2004, sections of the northern dike near Truong Uc hill were hardened, widened and raised. This construction, which is still underway, is aimed at preventing flooding on the northern branch of the Ha Thanh river, caused in large part by a branch of the Kone river.

Upgraded dikes and dike roads combined with the existing rail line, construction sites, and bridges, has effectively turned the lower Ha Thanh into a series of basins, each defined



Map 8. Flood control and water management infrastructure in the lower Ha Thanh river delta circa 2009 relative to flood basins.

by barriers to the discharge of floodwater. In order of flooding, these basins can be seen as (A) Northern Nhon Phu and Dieu Tri bordered by the rail line, the northern branch of the Ha Thanh river, and Hung Vuong Street; (B) Nhon Phu from the rail line to highway 19; (C) Nhon Phu south of Tran Hung Dao Street; (D) Dieu Tri between Nhon Phu and the northern branch of the Ha Thanh; (E) all of Nhon Binh, and (F) the impounded marshes, shrimp ponds and salt ponds outside the eastern dike. For perspective, floodwater appeared at between 6 and 7 pm in basin (A) and around 7 pm near the end of the Vung Phen river in basin (B); began to rise rapidly at 8 pm in basin (C) and 9 PM in basin (D). In Nhon Binh, flooding appeared at around 8 pm near bridge No. 7 and at 10 pm near barrage No. 1. In basin (E), outside the eastern dike, floodwater appeared at around 10 pm but was not noticed on the shores of Thi Nai lagoon until 4 am the next morning.

The level of flooding is affected by rainfall, terrain, the rate of inflow and outflow between these basins, and the physical space available for water to spread out. Changes in the landscape that affect the level or discharge rate of floodwater are the major concerns of the people we interviewed since these two factors make flooding issues related to rainfall and natural geography worse.

INFRASTRUCTURE AND FLOODING

Mr. Tin, now in his 80s, has the perspective of age. As he speaks to us on “spontaneous and uncoordinated road and dike construction” in the lower Ha Thanh, his voice is nearly inaudible, then reaches a crescendo as he makes his main points, then drifts away again as if the whole effort has exhausted him. We have now gotten used to his challenging way of speaking, listening intently to his slow and quiet rationales well aware that he will rise with intensity as he makes his points. “I am an old man,” he says in a whisper, “but I have an idea to improve the situation in my homeland.”

“I am afraid of big floods. They will continue to happen — it’s not over — because the roads and dikes were all upgraded and, when water rises, so many problems follow.” His voice begins to rise and his arms begin to hammer the point as he makes his point. But he senses our uncertainty. “I mean to say,” he continues, “the dikes and roads were all built higher. For example, the road from Tuy Phuoc to Quy Nhon³ used to be lower. That road was so terrible that no one wanted to drive on it. Now that road has been replaced and it’s full of houses. I’m sure that it will prevent water from running out.” His voice now begins tailing off, his energy expended, he continues. “I’ve lived here since I was a child. In the past, floodwater ran out very quickly because the area is so flat. But now there are dikes everywhere. So if water rises just a little, every house is flooded. The second problem is, the water is now deep and people drown.” Finally, in nearly a whisper, he reaches his conclusion. “So at this time, we need to restore the drainage system. We need good drainage.”

In the past, severe and extreme floods could spill over the road, producing relatively low flooding and relatively mild currents. New construction along these roads creates additional barriers, forcing floodwater under and over bridges or any other open channel available, increasing the height of severe and extreme floods, reducing the discharge rate into Thi Nai lagoon, and increasing localized currents.

Mr. Tin’s observations were repeated by many of the people we interviewed. Ms. Thau told us that the railroad bridge near her house is too narrow, which forced water over the top of the tracks, completely destroying her house and partially destroying the home of her elderly neighbor. “At this time, the first priority is to widen that bridge by two spans,” she adds. “That’s the only way for water to drain.” Mr. Ba and Mr. Nguyen Van Son in southern Nhon Phu complained that Double Bridge is too narrow and also needs to be widened. Mr. Son framed the problem as a research question. We were sitting in the living room of his house near Tay Son Rd., his son by his side, and his wife periodically coming into the room to take part in the conversation, as he explained this. “I’ve done my research,” he says, “and the situation was 88 percent of what I had predicted.”⁴

³ Highway 19

⁴ Some flooding on Tay Son road is caused by streams coming out of the hills.



Photo 13. Quang Trung University blocks the flow of floodwater through New bridge on highway 19.

The rain was very normal. There was nothing special about it. But when the source of flooding is upstream, when water pours onto the Ha Thanh river, how can it discharge in time?

No, floodwater will back up here.

It's because of Double bridge.

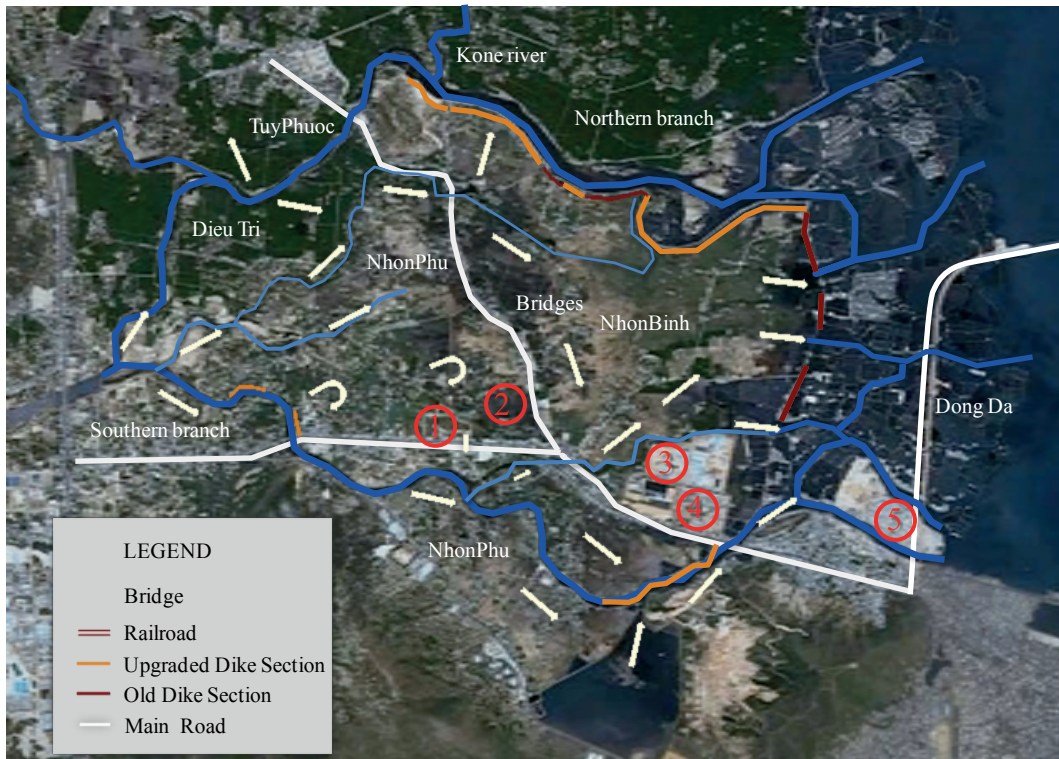
All the water upstream pours into this river, the Ha Thanh river, which is very small. The water pours in, but the bridge is too narrow so water cannot pass through in time. Water gets stuck under the bridge, and gradually backs up along the embankments.

—Nguyen Van Son

Nhon Binh benefits from being a much larger area with much more direct channels for floodwater to enter Thi Nai lagoon. But it also has flooding problems. Here, they are caused less by barriers for floodwater to flow out of the ward, and more by infilling of the floodplain.

In 2009, large areas of the floodplain in Nhon Binh and a smaller but important area of Nhon Phu had already been filled for urban development. These areas, marked on Map 9, below, include Binh Dinh College (1), the foundation and walls of Quang Trung University (2), a new residential area in Nhon Binh (3), the Nhon Binh Industrial Cluster (4) and phase one of the Dong Da Resettlement Area (5).

Looking back on their experiences in 2009, residents pointed to the location of Quang Trung University directly in front of New bridge on highway 19, the place formerly known as the Hong Thuy gate, as increasing flooding in Nhon Phu and forcing floodwater back through two railroad bridges into Binh Dinh College. They point to the height of Nhon Binh Industrial Cluster, which blocked the flow of floodwater and increased the depth of flooding affecting people living near Dinh Market. People living near the Dinh Market floodway also noted the odd way that water appeared out of the north,

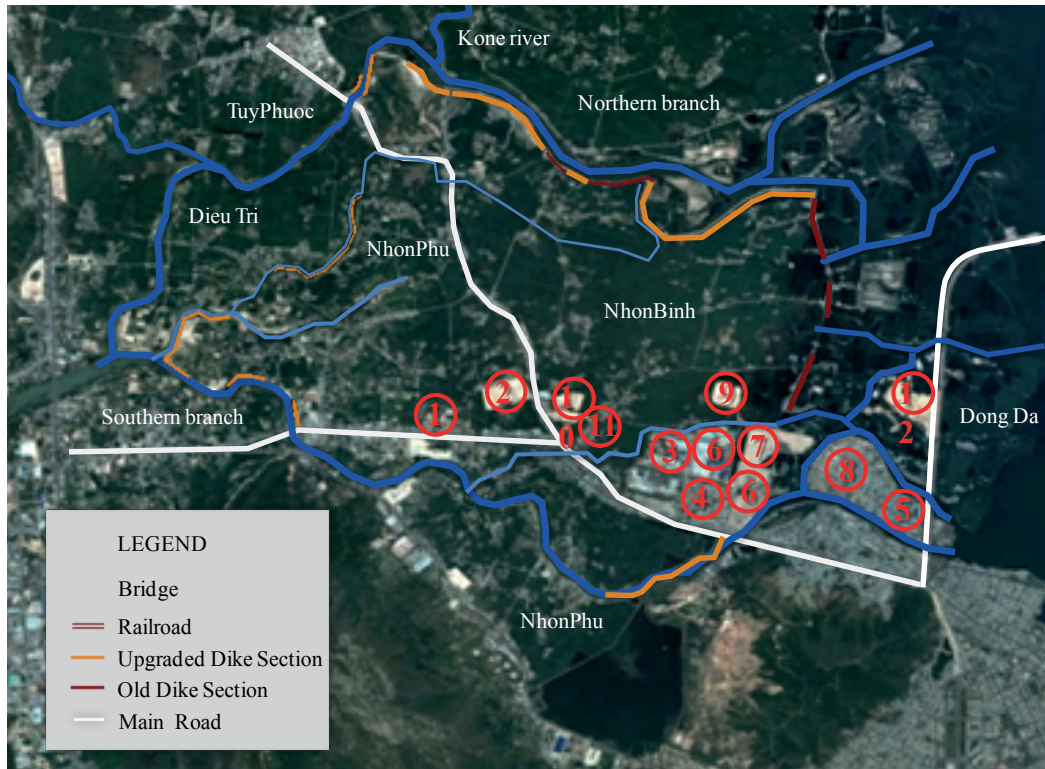


Map 9. Location of recent construction in the lower Ha Thanh floodplain relative to flood direction of floodwater, circa 2009

rather than out of the west, as they expected. Dinh market is directly east of the bridge blocked by Quang Trung University. And even people living in the northeastern part of Nhon Binh, the area farthest from new construction, complained that blockage of the Dinh Market floodway had forced floodwater north to barrages No 2. and No. 3.

Since 2009, and despite evidence of the risks it creates, the pace of infilling has only increased. New residential areas on foundations two meters above surrounding paddy fields are being constructed in Nhon Binh (6) (7). A school for disabled children, SOS Village, was built on a raised foundation next to the floodway blocked by Quang Trung University (10), and next to SOS village, a new Dinh Market (11) is being constructed, also on a raised foundation. Opposite the Nhon Binh Industrial Cluster, a new wastewater treatment plant (9) is being constructed on a 2.5 meter high foundation. The Dinh Market river currently crosses an access road to the site through a single, 30-inch cement pipe. And finally, outside the eastern dike, the An Phu Thinh new urban area (12) is being built between the floodways of barrage No. 2 and No. 3 in Dong Da and Nhon Binh wards.

Continued infilling frightens many of the residents of settlements in Nhon Binh and Dong Da. Mrs. Huynh Thi Sa, living with her husband Nguyen Duc Hung near the 2.5 meter high foundation of the Belgian funded wastewater treatment plant, points out that construction is



Map 10. New construction in Nhon Binh.

making normal floods worse. “If we have another flood like last year [2010], the water will be up to our windows.” Mr. Tung, wedged between the growing piles of sand being used to create the An Phu Thinh new urban area and the Dong Da resettlement area across the river, simply said, “Water seeks the lowest level, so what do you think I expect to happen when the next flood comes.” Nhon Binh residents regarded this issue as the single largest contributor to increased flooding, and given that construction has continued unabated, despite the 2009 flood, many feel frustrated and angry. As a group of people living near barrage No.1 told us:

First man: Before that area was backfilled⁵, it already flooded here. After backfilling, if there is another flood, the whole village will be wiped out.

Second man: Rapidly flowing water, not deep water, is the problem. We fear fast flowing water.

First man: Before that area was backfilled, water passed over there⁶, and then into the Ha Thanh river. Now, the water is blocked and will flow directly into the village and dig under our houses.

⁵ The new resettlement area in Nhon Binh.

⁶ This is a commonly repeated theme in our research. In the past, surface flows over paddy fields and salt ponds reduced flooding. Now, as these areas have been filled, floodwater is being directed into old settlement areas.

Second man: Now people look at that retaining wall like looking at a ghost. We sent our comments [to the Quy Nhon Department of Construction], but they told us to wait for them to decide. People here are so sick of this that we have no choice but to complain to the World Bank.

COMMENTS FROM GROUP OF PEOPLE LIVING NEAR BARRAGE NO. 1

Are these people's fears realistic?

Mr. Tuan's house, near the Nhon Binh Industrial Cluster, was built by his parents in 1972. It is a classic farmhouse from that period. As we have learned, in the past settlements were built on the highest available ground within a given area, and foundations were built with the nearest barrier to flooding in mind. Mr. Tuan's house is no exception; it was once the highest house in his neighborhood. "Whenever we had a storm, the lane was flooded, but water never came into the house. Even in the 1983 storm, floodwater was never higher than the grass." The lane in front of his house used to lead to rice fields nearby. Now it leads to the industrial cluster. "Our high road was lost when that industrial cluster was built." Mr. Tuan is a building contractor. As the industrial zone was being constructed, he got together with other men in this neighborhood to raise funds to raise the height of the lane in front of his house. "We are still 0.6 meters below the level of the industrial zone," he tells us. "Because this lane is being raised by citizens not the government, we can only work slowly as we collect money." The men from Tuan's generation living here have known each other since childhood. Without that history of living together over generations, it would have been hard for them to even begin their community project. They can't prevent what goes on outside their neighborhood, however. Mr. Tuan's house, once the highest in the village, is now below the lane. Across the lane is an abandoned pond. At the far side, storm water from Dao Tan Street pours into the pond during storms, filling the neighborhood with a mixture of rainwater and wastewater. "That's why I have to build up," he says. "If I don't upgrade, I will be flooded".

We have seen this situation repeated across many cities in Vietnam as new urban areas and industrial zones are constructed without regard to existing settlements. Tuan takes it all in stride. The industrial cluster, itself, was a victim of flooding. The abandoned pond across the lane from Tuan's house is actually the remnants of a canal. The industrial zone was constructed directly in that floodway. In the 2009 flood, its foundation, raised to a level roughly equal to the eastern dike, could not protect it, causing the animal feed processors there to suffer huge losses. "At that time, they lost a lot." Tuan explains that he has seen some statistics on flood damage on TV. "According to the statistics, I don't remember exactly, but the damage was in the tens of billions of dong."



Photo 14. View of the new residential area (right) under construction near barrage No. 1.

INFORMATION AND RESPONSES

While several of the people we met had heard about flooding from friends and relatives living upstream, few of them acted in time. For most, this flood was odd. As Mr. Hoan noted, “it was not what we expected.” During storms, people look for signs of possible flooding. They note the direction of the wind, the behavior of animals, the date, even the position of rainbows, as a means of predicting the severity of the storm. Mr. Tin, for example, told us that the odd behavior of his dog tipped him off regarding the severity of the coming flood. “That dog is still around” he said, “and so am I.” In addition to signs, they watch the flow of water in streams, the level of water in paddy fields, and the pace of rising water in their yards. During typhoon Mirinae, which produced the heaviest rain upstream away from major population centers, this was not enough: they needed information.

Lack of warning was for many the source of personal tragedy. Though most people were aware of the typhoon, they were not aware of the flood even as water began to fill their yards. Ms. Thau in Nhon My was watching TV while floodwater was rising in her house. Mr. Minh, near bridge No. 7, was waiting for news because of the earlier typhoon warning, and Mr. Ninh in Dong Dinh told us that he was listening to the evening news broadcast on the public address system in his village in the early evening. None of these people, nor almost anyone else we spoke with, heard anything about flooding.

In the absence of news in the mass media, some people were lucky enough to have received warnings from people upstream or living elsewhere in the river basin. Even these people had little time to prepare. Ms. Thau in Nhon My told us how she was warned by a phone call at 7 pm.

Around 7 pm in the evening. I was watching TV when a young woman called to say, “Auntie, watch out, a flood is coming.” But I saw nothing. My house is too high, I didn’t

think water would come in⁷. But when I put my foot down, I felt water. After that, there was no time to react.

—Truong Thi Thau

Mr. Ba in Phu Vinh also told us of a neighbor who received a warning from a daughter working in an industrial zone in Phu Tai. The phone call came at 8 pm.

At that time, Mrs. Hien, just one kilometer upstream, was running to a neighbor's house in waist deep water. But in Phu Vinh, the situation looked normal. "That family lost 1,500 local chickens already in cages prepared to send to market," says Mr. Ba. Mr. Ngoc Son and Mr. Hoan, his neighbor, told us of another neighbor who was warned by a friend hours before the flood crossed highway 19 into Nhon Binh. Despite the warning, he did not respond appropriately.

Mr. Hoan: It didn't happen as we expected. Fields here were dry. If you said there was going to be a flood, no one would have believed you. No one suspected that so much water would descend on us.

Mr. Ngoc Son: But that guy Phuc was really careless.

Mr. Hoan: Even though somebody upstream phoned to tell him that a flood was coming, he didn't move his paddy to a high enough place at home.

Mr. Ngoc Son: He lost 3 tons of rice. He could have been rich now.

That evening, Ngoc Son was celebrating the death anniversary of his grandfather with relatives. Had his relatives not been in his house as the water began to rise, he would have lost everything prepared for the celebration. Instead, he was able to move his offerings to a loft in his house — but he forgot his chickens, 20 of them, all of which died in the flood. Ngoc Son also told us that in normal circumstances, families would need about 2 hours to prepare. During the 2009 flood, the water rose so quickly after first being discovered than most people had less than an hour. One of Ngoc Son's neighbors, a woman who lives on a nearby lane in the village told us that by the time she was aware that the flood was serious, floodwater was pouring through the village. Her small, one storey house was quickly flooded. We asked if there were any "safe houses" nearby. "Yes", she said, "across the street in the elementary school. But the force of water in the lane was so strong, I couldn't cross." Mrs. Suong near Dinh market told us the same story — the force of water was so great that she dared not try to go to a nearby safe house. All of these people made it clear to us that they could have prepared if given time, but time is not what they had. They had to react quickly to save whatever they could.

⁷ In 30 years in this spot, the flood in 2009 was the first time water came into her house.

Nguyen Van Son, living in the higher ground near Tay Son Road close to Phu Hoa lake was one of the luckier victims of this flood. At 10 pm, he was asleep, but his wife was preparing herbs for sale in Vinh market. As water began to rise in their yard, she woke her husband. By 11 pm, water was coming into the house. In 20 years, he has only seen two or three floods here. Despite this, he responded quickly, warning his neighbors as he moved his livestock uphill to a safe area within the walls of the PETROLIMEX gas storage facility nearby.

Mr. Le Phuoc, who was 87 years old in 2009, was another flood victim with relatively good fortune—or rather, good relations with his neighbors. One of his children called Ms. Thau to ask her to check on their father. She waded through waist deep water to reach his house.

When I got here, he was here, in the attic. The old man climbed into the attic, up here. His daughters and sons live far away. That evening one of them called for help. She didn't know the area was already flooded. They call from time to time to check on him. The water was running by here wicked fast, he would have been crushed [when the house collapsed]. We went out the back door, and turned around over there, then stopped because we couldn't go around to the front. The water was terrible. How could we move? It just poured in here. I was afraid because he is a bit forgetful and he is deaf. I led him by hand out the back. The ground is higher in the back so the floodwater ran slower. Right after going out the back, there's another door in the back, he fell.

Look, his oil lamp is still up there [in the attic].

—Truong Thi Thau

We saw this story repeated all over the delta. Though people had little time to take care of their own families, many made an effort to help others as the water rose. Given more time, they might have been able to save more of their property, their livestock, and each other.

RELEASE OF WATER FROM DAMS

Many people who had warnings from friends and family did not prepare, because they were waiting for information. In particular, what they were expecting to hear was an announcement that water in one of the reservoirs upstream would be released. According to Vietnamese law, reservoir operators must give at least two hours' notice before the release of floodwater. That notice never came. What did come was a sudden flood, with periodic peaks as water surged over dikes and roads. Given that other conditions were normal, this was exactly the kind of flooding they might expect from the sudden release of water from dams.

Many of the people we talked to insisted that water was, in fact, released from one or more dams upriver. Many of these people pointed to a rumor that this occurred in Phu Yen. The story involves a group of entrepreneurs from Ho Chi Minh City who reportedly went to Phu

Yen for charity work. There they discovered villages and towns that had nearly been wiped out by a collapsed dam. Only a few people remained alive, and were staggering among the rubble in a state of shock. The images, and even the names of these destroyed villages, An Phu, An Dan, and An Dinh, were repeated to us with a degree of certainty and concreteness.

On 07 November 2009, Youth Newspaper reported that this rumor was entirely false⁸ and even offered interviews with people in the affected towns and communes. Despite this, many people in Nhon Phu and Nhon Binh continue to believe the rumors. “Reporters don’t dare tell this story,” one man told us, “this kind of information is never reported.”

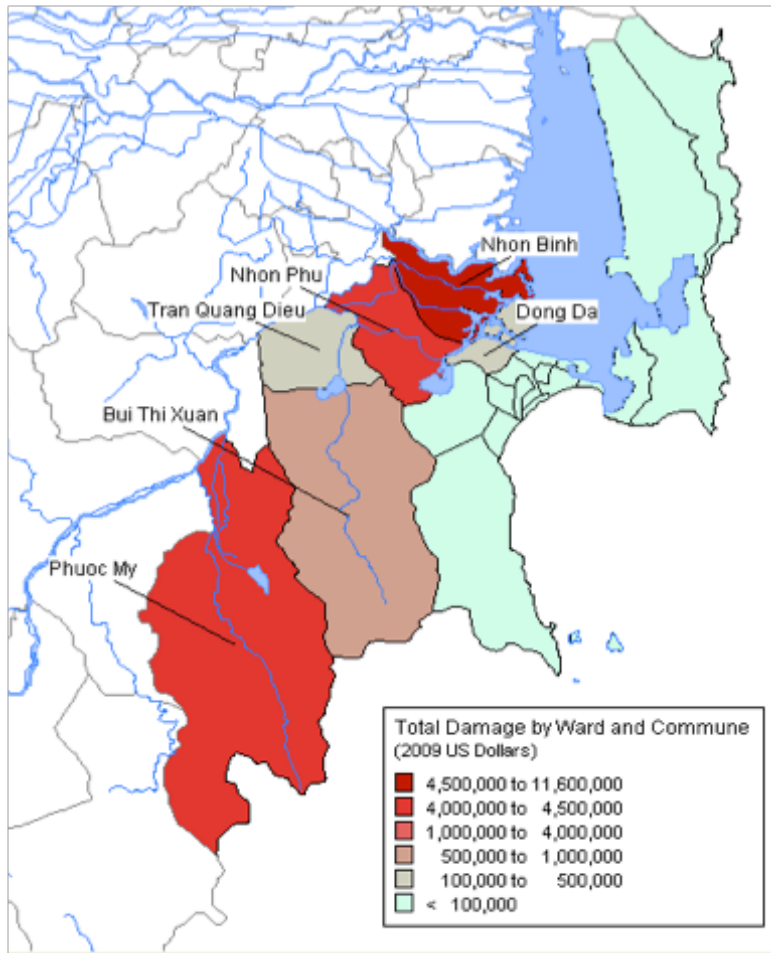
How should we interpret this? It would be easy to discount this widely circulated rumor as ignorance. But there is more to it than this. First, insistence that release of water from dams upstream was the cause of sudden floods reflects the only experiences of these kinds of floods most people in the delta have ever had. Many people told us how normal flooding generally happened in the evening, and by morning, most of the water had already receded. In their experience, sudden floods have only been the outcome of water being released from dams. Second, suspicion of a cover up reflects lack of information about the flood. This was an unusual storm that produced the heaviest rainfall upstream, far from the more densely populated delta. While the press focused on damage and relief, very little attention was placed on why and how this flood produced such sudden and intense floods. No one explained how eroded hills and thin soils upstream could not contain the rainfall and no one explained how the periods of heaviest rainfall in Van Canh corresponded to peaks in flooding downstream. Upstream, for them, means reservoirs and sudden floods means release of water from dams. Given the lack of alternative information, the rumor sounded reasonable, and thus, so did the cover up.

8 <http://tuoitre.vn/Chinh-tri-Xa-hoi/346662/Hai-ho-chua-nuoc-o-tinh-Phu-Yen-khong-bi-vo.html>

Flood Damage

Nearly everyone we met suffered some damage from the 2009 flood. At the minimum, they suffered floodwater damage to homes and property. At the extreme, like Ms. Thau, they lost their homes and all their possessions. Along this scale, there are many stories that could be told. Mrs. Hien, a poor woman supporting her mother and daughter by selling “beo” cakes, saved her small house, but lost nearly all of the contents. Mrs. Suong, who took neighbors into her loft during the flood, lost all of her bicycle repair equipment – her only source of income. Mr. Tan Son near Ngang River bridge, lost his café by the river. While he was able to repair many of his possessions, his home was so badly damaged that he was forced to rebuild. Nearly everyone lost chickens and many lost pigs, though no one we spoke to lost a buffalo. Death, loss and damage in these existing settlements were severe, and in many cases, represented all or nearly all of a given household’s assets.

Quy Nhon City’s Economic Department maintains records of damage reported for every major storm. According to the Department’s Economic Office, typhoon Mirinae caused roughly \$22 million US dollars (374.5 billion VND) in damage. The distribution of total damage in 2009 US dollars across city wards and communes is mapped on the left. The coastal wards and wards within the inner city reported the least amount of damage. This is what we might expect. The flood was not associated with a storm



Map 11. Distribution of damage caused by typhoon Mirinae by ward and commune.

surge, which would have affected the coasts more severely and increased damage overall. Damage from typhoon Mirinae was largely due to flooding within the Ha Thanh river.

- Dong Da ward on Thi Nai lagoon: \$454,436 US dollars in total damage. Nearly 70 percent of this total were due to losses to fisheries, boats and tackle.
- Tran Quang Dieu ward, site of the Phu Tai industrial zone: \$365,685 in total damage. About half of this total were due to damage to dikes and roads.
- Bui Thi Xuan ward, further up the same valley: \$1.3 million dollars in damage. About half of the ward's losses were related to agriculture, fisheries and forestry and about 40 percent were due to damage in the ward's industrial zones. While these industrial zones are located away from the Ha Thanh River, they are still affected by flooding in streams, Bau Lac Lake and surfaces flows down the

slopes of surrounding hills. Nevertheless, while Bui Thi Xuan ward contains more industrial area than Nhon Binh, damage in the latter was much greater.

- Phuoc My commune, upstream from the Dieu Tri bridge: \$4.1 million in damage. More than half of this amount was due to damage to industrial forest plantations. Out of a total of 22 sq. km of forestry land damaged by the storm, 19 sq. km, with a total value of \$2,781,364 were in Phuoc My. In addition, farmers in Phuoc My lost 327 buffalo and cattle, 3,721 pigs and 21,536 chickens and ducks. This amounted to about 40 percent of the total losses in livestock in Quy Nhon.
- Nhon Phu ward: \$4 million in damage. Residents of Nhon Phu suffered the largest losses in damage to homes. Out of 2,302 houses damaged or destroyed due to the flood, 2,061, with a total cost of \$1,248,650 US dollars, were in Nhon Phu. Southern Nhon Phu suffered extreme flooding during typhoon Mirinae. Two of the seven people killed in Quy Nhon were living in Nhon Phu. In addition, Nhon Phu lost nearly half the total number of chickens and ducks killed during the flood, 40 percent of the total damage to paddy fields, plus one-fifth of the pigs, buffaloes and cattle.
- Nhon Binh: \$11.6 million in total damage. This included \$637,249 in losses to agriculture, forestry and fisheries, a level of losses similar to the \$699,038 in losses suffered by Nhon Phu. \$10.4 million in damage, 93 percent of the total damage in Nhon Binh and nearly half of the total storm damage fell within the sub-category of “other” within category of damage to “dikes, roads and irrigation systems”. As in other wards, the category covers damage and losses in industrial zones, in this case, the Nhon Binh Industrial Cluster.

Mr. Tuan and many of his neighbors spent the night of the flood in a shrine on the edge of the Nhon Binh Industrial Cluster. His account of the flood describes damage to the industrial cluster as “huge” and his recollection of the estimate “in the tens of billions” is in the range recorded by the Department of Natural Resources and Environment. The foundation of the Nhon Binh Industrial Cluster is roughly the same height as the eastern dike. As we learned from residents of existing settlements in the floodplain of the Ha Thanh river, floodwater in an extreme storm will rise to the height of the nearest barrier. In 2009, water rose 0.4-0.6 m over the eastern dike. At this level, much of the industrial zone would have been under water as Mr. Tuan described. More recent construction in the flood plain has attempted to prevent the kind of disaster faced by manufacturers in the Nhon Binh Industrial Cluster by building higher foundations. But as new roads are built in the ward; as the eastern dike is upgraded; as new construction restricts surface flows across the impounded marshes, salt ponds and fish ponds bordering Thi Nai lagoon, these efforts are likely to fail.

Shifting the Burden of Flood Risks

The relatively flat geography of the delta formerly allowed floodwater from extreme events to spread out over a large area at a low height and to discharge quickly into Thi Nai lagoon. In the past, residents of existing settlements in the flood plain recognized seasonal flooding as part of a natural cycle that recharged groundwater, fertilized soil, and reduced agricultural pests. In order to benefit from flooding while also protecting their property, houses in the lower Ha Thanh were grouped in small clusters on elevated land, their foundations slightly higher than nearby roads and embankments. This protected homes from seasonal flooding while allowing floodwater easy passage over surrounding paddy fields, salt ponds and impounded marshes. Beginning with construction of the rail line from Dieu Tri to Quy Nhon, the delta has been gradually broken up into a series of basins, each bounded by man-made barriers. As these dikes and roads have been raised – in part to prevent flooding – risks associated with flooding have increased. This has been compounded by new construction in the flood plain that blocks floodways, displaces floodwater, or both.

We approached our assessment of current plans for urbanization of the lower Ha Thanh with these observations in mind, using the experience of flooding associated with typhoon Mirinae as our guide. We have taken this “event driven” approach because, while we do not know when another storm like Mirinae will occur, we do know that storms of this scale will occur again in the near- and long-term. Furthermore, climate change forecasts

for Central Vietnam point to an increase in the frequency and intensity of tropical storms, even under the most hopeful scenarios. Focusing on the experience of Mirinae gives us a benchmark, a tool for assessing near term and climate change related risk.

Based on this research, our assessment of master planning and individual project planning in the lower Ha Thanh is not positive. These master plans and project plans, if fully implemented, are very likely to reduce the capacity of floodwater to discharge into Thi Nai lagoon and therefore cause *greater loss of life and damage to property* when the city is struck by another extreme storm. We are aware that dikes, water gates, barrages and roads can be used to provide a system of flood protection for the city. At the same time, we recognize that these protective systems cannot prevent floods; they can only displace floodwater to other areas. We prefer use of flood protection infrastructure combined with limited development in the floodplains of the Ha Thanh as a means of reducing risks. Therefore, our assessment of these master plans and projects plans stand even if the logic of flood prevention results in construction of a city-wide dike system.

We began this study of typhoon Mirinae upstream in Nhon Phu. Here, we begin our conclusions on the shores of Thi Nai lagoon. In 2009, the level of flooding dropped dramatically as water spilled over the eastern dike into salt ponds, fishponds and impounded marshes. There were two main reasons for this. First, by the time the flood reached the eastern dike, the tide was retreating, pulling floodwater out to sea. Second, in 2009, there were very few barriers to the flow of floodwater over the surface of fishponds and salt ponds. This allowed floodwater to rapidly spread out over a large area that also included the lagoon itself.

Mr. Tong, living on the edge of Thi Nai lagoon and Mr. Ninh, living near barrage No. 3 both told us that rising tides and storm surges make flooding in this area much worse. Mr. Tong gave us the example of extreme flooding in 1955 that was the result of this combination of factors. Tides are regular and tidal surges are the product of meteorological factors. We have no control over either. What we do have control over is the second factor in this analysis, that is, surface flow. In 2009, floodwater broke out of its normal channels in the tidal areas east of the eastern dike and rapidly spread out across surrounding marshes, salt ponds and fish ponds. This was the major reason for the flood's reduced impact in this area. If these channels are narrowed and raised, water will not flow uphill to fill the space of the narrowed and heightened channels, but rather, it will back up into areas outside and upstream. This is why Mr. Tung in Dong Da looks behind his house at the growing foundation of An Phu Think new urban area with a sense of doom. "Water seeks the lowest level," he tells us.

The An Phu Think new urban area and resort will fill most of the salt ponds, fishponds and impounded marshes on the edge of Thi Nai Lagoon in Dong Da and Nhon Binh wards (Map 10). Like a new project proposed for the Van Ha area of Nhon Phu, An Phu Think new urban area is an investor driven project that was not included in the master plan for



Map 12. Site plan of the An Phu Thinh new urban area .

Quy Nhon to 2020 or the Nhon Binh master plan to 2020. The project lays directly in the floodway of barrage No. 2, and borders barrage No. 1 and barrage No. 3. The project is divided into four islands roughly following the courses of natural channels. In order to prevent flooding in this new urban area, sand is being backfilled onto the construction site at roughly the same height as the two meter high causeway leading to Thi Nai Bridge.

In the event of extreme flooding within the Ha Thanh river, floodwater surging through barrage No. 2 would not be able to spread out over a wide surface as in the past, but rather, would be constrained within the banks of river channels. In a flood similar to Mirinae, the constrained channels will cause floodwater to back up into Nhon Binh ward. Given that the level of the foundation of An Phu Thinh is higher than the eastern dike, currently the highest barrier within the floodway, the result could be higher floods, greater damage and more severe loss of life and property in Nhon Binh. As in the 2009 flood, homes in existing settlements would be hardest hit. This includes settlements outside the eastern dike, as well, since the area is also impacted by floodwater entering the lagoon through Double bridge. This is the great fear of people living near barrage No. 1 who have watched the construction of new urban areas built on two-meter high foundations surround them. Furthermore, if flooding were accompanied by a high tide, a storm surge, or both, an extreme event like typhoon Mirinae would likely flood the area of An Phu Thinh west of Thi Nai bridge, as well. As we saw in the case of the Nhon Binh Industrial Cluster, foundations at the same height of



Map 13. Nhon Binh master plan to 2020 and An Phu Thinh new urban area.

dikes and other barriers are no protection in the case of extreme floods, especially if those sites are within floodways. An Phu Thinh lays directly in the floodway of barrage No. 2.

West of the eastern dike, the master plan for Nhon Binh calls for infilling of roughly half the area of the ward. Much of the construction planned for the ward is already built or underway (Map 11). This includes the Nhon Binh Industrial Cluster (1) and new residential areas (2), as well as Quang Trung University (3), SOS village (4), a new Dinh market (5) and the wastewater treatment plant (6). The master plan allocates most of the farmland south and east of bridge No. 7 on highway 19 for residential development (7). This residential development will completely block two floodways between the Dinh Market bridge and Bridge No. 7, forcing floodwater north into an area that drains into Thi Nai lagoon through barrage No. 2 and An Phu Thinh new urban area. A new cargo rail station will be placed directly within this floodway, as well (8). On the western side of highway 19, the Hong Thuy floodway, which Mr. Minh regarded as the most important, and the floodway under Hung Vuong Street leading to the southern Ha Thanh will be completely blocked by Quang Trung University. The Dinh Market river will continue to serve as a floodway into Nhon Binh through its watergate on the southern Ha Thanh (9). No provision has been made for the removal of buildings that have encroached on the river and, while a buffer zone around the new wastewater treatment plant provides

open area for floodwater to overflow the banks of the Dinh Market river, a causeway into the wastewater treatment plant blocking the flow of water to barrage No. 1 will force floodwater north across paddy fields and fishponds to barrage No. 2. New roads running south to north across Nhon Binh will create additional barriers. These roads will link with a new highway 19 connected to the Thi Nai bridge and the new port in Nhon Hoi. The route of highway 19, as presented in the master plan, would block the flow of floodwater through barrage No. 3, and force more of this water through barrage No. 2.

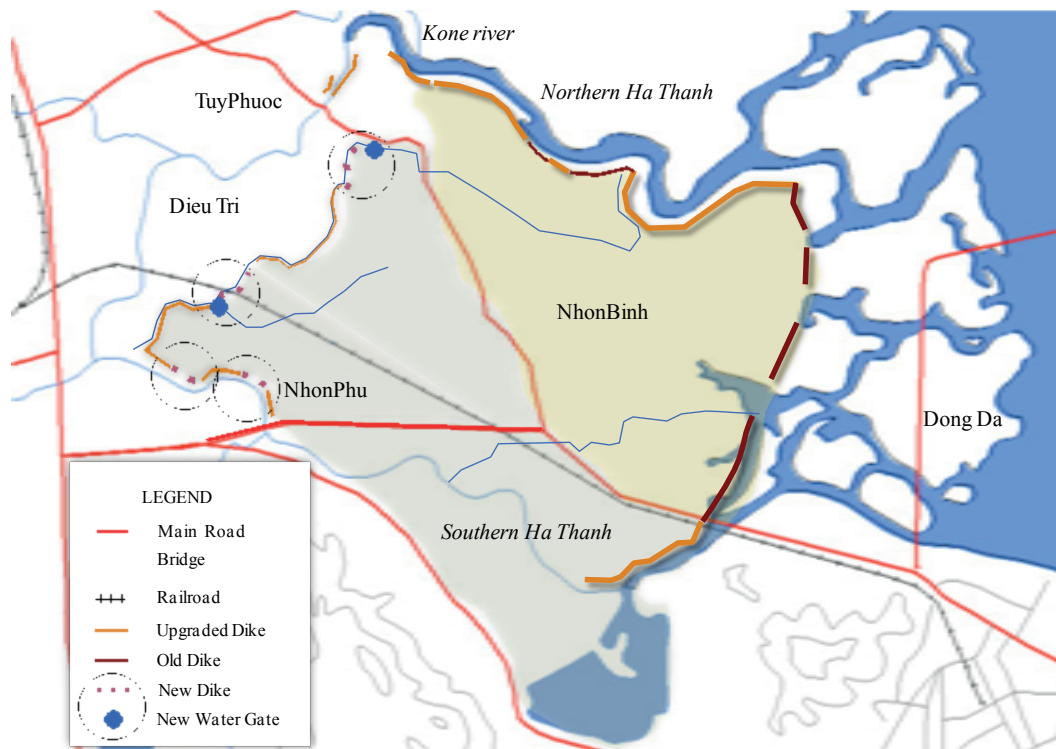
Taken together with construction of An Phu Thinh, the Nhon Binh master plan to 2020 severely underestimates the flood discharge requirements of the ward. If carried out as planned, most floodwater within the ward will be forced through barrage No. 2, itself constrained by construction of An Phu Thinh. Flood levels will rise in the ward up to the levels of new roadbeds, the foundations of new urban areas, and dikes before being able to spread out over surfaces and eventually enter Thi Nai lagoon. *This poses extreme risks to existing settlements not only in Nhon Binh but also in Nhon Phu.* With floodways under the current highway 19 blocked by new residential construction, floodwater will back up into Nhon Phu, causing more damage to this already flood prone ward.

COULD DIKES RESOLVE THESE ISSUES?

We have looked at this situation asking ourselves at the logic of these plans in relation to the clear risks associated with flooding and sea level rise. Our conclusion is that planners are assuming that a system of dikes, elevated roads, water gates and barrages can be used to prevent flooding in Nhon Binh. We also considered these possibilities early in our research. Our thoughts on the construction of a city-wide dike protection system began with the discovery of the Vung Phen river's role in severe and extreme flooding. If the flow of water in the river could be managed, then flooding could be reduced. To control the flow of water through this river would require a water gate, and the water gate would require a system of dikes.

We believe that this is the likely outcome of the incremental process of land conversion and dike construction currently underway. This observation led us to a thought experiment. We asked ourselves what a dike protection system for Nhon Phu and Nhon Binh would look like and what its impacts might be. Our logic and conclusions follow, below.

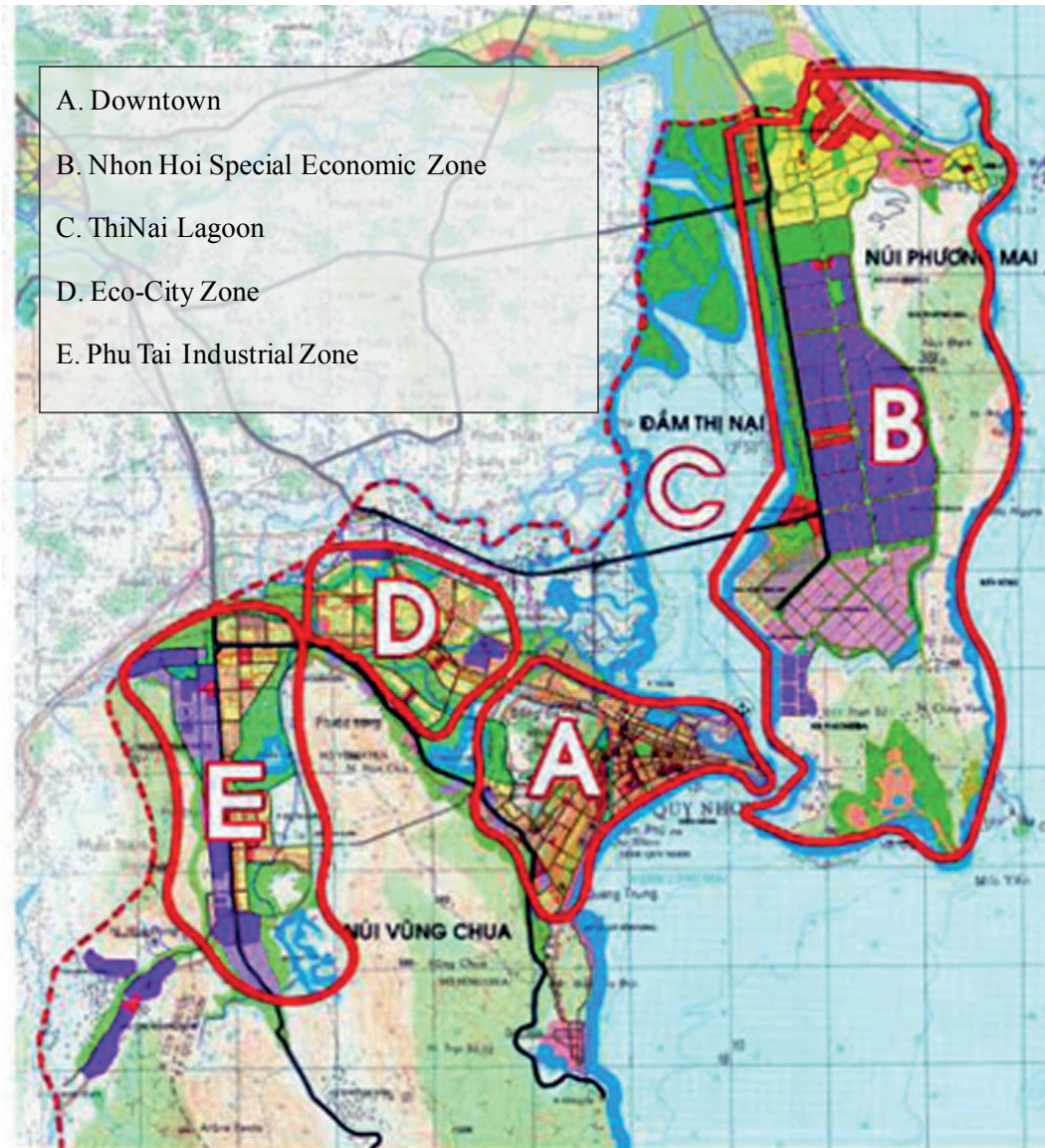
The entire area of Nhon Binh ward is already bounded by barriers, including highway 19, Tran Hung Dao Street, the eastern dike, and the northern dike to form an open flood basin connected to Nhon Phu ward through bridges and culverts (Map 14, above). By managing the flow of water into the ward through water gates at bridge No. 8 and the Dinh Market river, it may be possible to reduce damage due to severe flooding in the ward. Typhoon Mirinae, however, clearly illustrates that this system could not prevent



Map 14. Expected new dike sections and water gates

flooding from an extreme storm. To reduce impacts from an extreme storm, northern Nhon Phu would also have to be incorporated into a dike, road, and water management system. We see this system being built incrementally through, for example, construction of a new dike road along the river-border between Nhon Phu and Dieu Tri, new dikes in Van Ha, new revetments at Truong Uc bridge in Tuy Phuoc, and a new irrigation canal that would bring water over the dike into Nhon Phu. The logical extension of this process would require the construction of remaining dike sections along the ward's borders, and construction of water gates on the Vung Phen river at Van Ha, and on the border between Tuy Phuoc, Nhon Phu, and Nhon Binh at near bridge No. 8.

The more we understood the hydrology of the lower Ha Thanh, the less attractive this option appeared. Dikes cannot prevent flooding. They can only displace flooding to other areas. In this case, flooding would likely be displaced to three areas: First, with the Nhon Phu side of the border protected by a dike, floodwater water in the northern Ha Thanh is likely to be displaced into Dieu Tri and Tuy Phuoc. Not only would this increase the loss of life and damage to property in these towns, it would also add immense volumes of water to the northern branch of the Ha Thanh river. This would increase the possibility of floodwater cresting the northern dike in Nhon Binh and Phuoc Thuan. Second, floodwater displaced from the Vung Phen river would also be displaced into the



Map 15. Master plan for Quy Nhon to 2020.

southern branch of the Ha Thanh in Nhon Phu. The low-lying areas of southern Nhon Phu were severely impacted by typhoon Mirinae. We expect that the water gate on the Dinh Market river would *not* be opened during a flood since this would direct floodwater into Nhon Binh. Rather, we expect that the water gate would remain closed or nearly closed, leaving Double bridge as the only point for floodwater to discharge into Thi Nai lagoon. With mountains to the south and only a narrow channel under Double Bridge for water to exit into the lagoon, the risk of life threatening floods in southern Nhon Phu would increase dramatically. Finally, given that the discharge of floodwater in the lower Ha Thanh will be constrained by new infrastructure, floodwater is also likely to back up into Tran Quang Dieu and Bui Thi Xuan wards, as well as Phuoc My commune. All

three were impacted by typhoon Mirinae. If current urban plans are carried out without modification, in another extreme flood, they are likely to suffer even worse impacts.

All of this suggests that, if the master plans and project plans for Quy Nhon are carried out, the next flood is likely to result in new calls for flood prevention infrastructure in Dieu Tri, Tuy Phuoc, southern Nhon Phu, Tran Quang Dieu, and Phuoc My. In this way, the incremental process will continue upstream until the entire lower and middle levels of the river are diked. Eventually, the floodways will be so constrained that the protective dike system itself will be overcome.

With some modifications based on the experience of typhoon Mirinae, the original master plan for Quy Nhon to 2020 provides a much more sustainable orientation for the city's development. In that plan, the marshlands, fishponds and salt ponds in Dong Da and Nhon Binh have been placed within a Thi Nai lagoon "ecological district," and the remaining areas of Nhon Binh as well as all of Nhon Phu have been designated for "ecocity" development. Both of these designations would allow for urbanization that accepted the natural cycles of flooding, and prepared for the impacts of climate change. Modifications of this plan would require an increase in areas designated as floodways, a modification of building codes in light of the high risk of flooding, and climate sensitive infrastructure development.

Climate Change

The entry points for this research were questions about climate change and urbanization. Our original focus was on the future, with sea level rise and the intensification of storms leading our analysis of potential vulnerabilities. Our approach led us to analyze the impacts of a major storm event as a means of understanding what the future might hold. What we found was that urbanization was increasing current risks, especially for people living in existing rural and suburban settlements. Each of the weaknesses identified through this approach will become more severe under all scenarios of climate change. Using even the most hopeful scenario¹ of slower population growth, regionalized economies, and global application of sustainable technologies, central Vietnam is expected to experience hotter summers, longer and more intense periods of drought, and more frequent and more intense tropical storms. In combination with sea level rise, this scenario would result in increased flooding during the storm season, increased impacts from storm surges, and increased salinization of groundwater during periods of drought. In addition, ocean acidification is expected to severely impact the health of reefs, all forms of shellfish, and the basic microorganisms at the bottom of the marine food chain. In this scenario, maintaining the health of Thi Nai lagoon and its resources will be extremely important to the future food supply of the city. Finally, the moderate scenario for greenhouse gas emissions assumes a more regionalized economy and localized climate adaptation measures in large part because of rising energy costs. With

¹ The B2 scenario. See http://en.wikipedia.org/wiki/Special_Report_on_Emissions_Scenarios for more information.

Changes of temperature and rainfall in Quy Nhon city according to B2 scenario

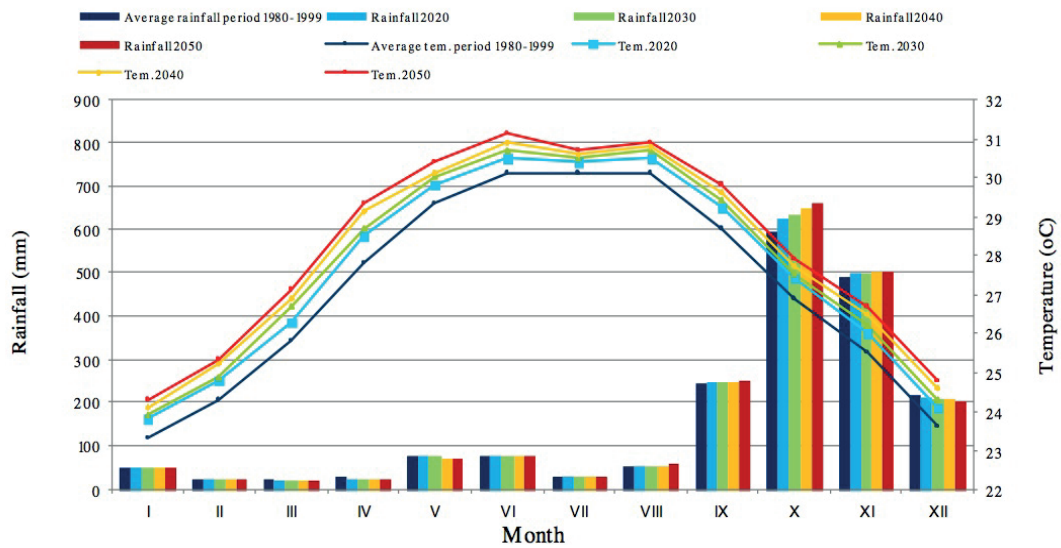


Figure 3. Temperature and rainfall forecasts for Quy Nhon under three greenhouse gas emission scenarios.

energy costs already playing an increasing role in food prices, maintaining local food supplies will be a key factor in the resilience of Quy Nhon to the economic impacts of climate change.

TEMPERATURE AND RAINFALL

Vietnam Institute of Hydrology, Meteorology and Environment (IMHEN) has projected that the monthly mean temperature in Quy Nhon would increase by 0.3°C in 2020 and by 1.5°C in 2050 (Figure 3). The monthly mean temperature from May to August is likely to be higher than 30°C . Daytime summer temperatures would, of course, be much higher than these monthly averages with temperature rising over 40°C during an increasing number of summer days. June is projected to be the hottest month of the year, with the average monthly temperature increasing by 0.7°C in 2020 and to 1.5°C in 2050. These forecasts do not take in account the “heat island effect”² of cities. As Quy Nhon grows, increasing amounts of asphalt and cement in the landscape will store more heat during the daytime, raising temperatures at night and increasing the potential for localized thunderstorms.

IMHEN’s climate change scenarios also project that by 2050, rainfall during the March to May dry season will decrease by about 14.5 mm (0.74%) while rainfall during the September to December storm season would increase by 82.2 mm (4.21%). The highest levels of rainfall would likely occur in October (633 mm) and the lowest levels would occur in March (23 mm). In other words, the current pattern of seasonally intense rainfall

² http://en.wikipedia.org/wiki/Urban_heat_island

will increase, accompanied by increased drought during the dry season. For this reason, given projected population growth, no change in the agricultural system, and no water conservation measures, IMHEN has forecast water shortages in Quy Nhon as early 2020.

UNPREDICTABLE WEATHER PATTERNS

The El Nino Southern Oscillation (ENSO) phenomenon, a periodic shift in ocean temperatures and air pressure across the Pacific Ocean, plays an important role in global weather. The ENSO phenomenon, which historically has occurred irregularly once every 3-7 years, is becoming more frequent and more intense. Monitoring data at the Quy Nhon Hydrological-Meteorological station confirms this observation with increased ENSO years in the latter half of the 20th century as compared to the earlier half.

Climatologists believe that increased occurrences of the ENSO phenomenon are likely to be related to global warming but they are unsure of the effects. In Quy Nhon, both the maximum summer temperature and the annual mean temperature during the ENSO years of 1986, 1987, 1992, 1998, 2003, 2005 and 2007 were higher than non-ENSO years, rising 1-1.5^o C and 3.2-4.7^o C respectively. ENSO may also have an impact on rainfall patterns and the beginning of storm seasons. Rainfall patterns in Quy Nhon have fluctuated dramatically over the past 50 years. Compared to the overall average, rainfall was higher in the period of 1955-1964, then markedly decreased in 1965-1984 and increased again during the period of 1985-2004. In addition, floods due to tropical storms occurred very early in 2000 and 2005 and very late in 2001.

SEA LEVEL RISE

According to the medium emission scenario (B2), sea level would rise by 12, 17, 23 and 30 cm in 2020, 2030, 2040 and 2050 respectively. Due to prevailing winds and the rotation of the earth, the western Pacific, including Vietnam, would likely see this impact double. Rising sea levels would also affect the water balance of the lower Ha Thanh. In the dry season, when there is less fresh water underground, rising sea levels would push salt water further inland affecting fresh water wells, river systems, and agriculture.

Summary and Conclusions

Taking all this evidence together leads us to five general principles for the management of urbanization and climate change in the lower Ha Thanh river. We begin with an observation that we have repeated many times in this report: Whatever reduces the discharge rate of water into Thi Nai lagoon increases flooding. As typhoon Mirinae has illustrated, in an extreme storm, floodwater will rise to the height of roads and dikes within the flood plain. Reducing the number and impact of barriers in the floodplain and, at the same time, managing the flood protection and water management system to improve drainage is the only sustainable means of reducing threats associated with flooding both now and under the longer term influence of climate change. As we have noted frequently in this report, dikes alone cannot prevent floods. They can only displace them. In practice, therefore, climate change adaptation strategies that rely only on dikes are “risk redistribution” strategies rather than risk management strategies. The experience of Mirinae suggests to us that this approach will lead to the protection of new urban and industrial areas at the expense of existing settlements.

Second, we understand that uncontrolled flooding in extreme events is costly with respect to both lives and property. But, at the same time, seasonal flooding provides benefits to agriculture while recharging groundwater and holding salinization in check. In principle,

therefore, flood protection and water management infrastructure should allow for seasonal flooding while protecting people and property from life-threatening, extreme events.

Third, we recognize the importance of the lower Ha Thanh as a source of food for local and regional consumption. Energy prices are already playing a key role in food inflation in Vietnam. We expect this trend to continue. Ocean acidification is expected to reduce the productivity of coastal resources over the longer term. Maintaining local food sources is therefore a key requirement in maintaining access to affordable fruits, vegetables, meat, poultry, fish and shellfish.

Fourth, we expect that all the factors that currently play a role in the risk profile of Quy Nhon city – flooding, storm surges, water shortage, crop loss, and salinization – will become worse if the current master plans and project plans for the lower Ha Thanh are implemented without modification.

Fifth, we expect that climate change will increase all of these risks over time.

Based on these principles, we offer eleven policy actions that would reduce current environmental risks and prepare for potential risks associated with climate change. These actions are listed in order of priority, below.

1. Improve the disaster warning and response system.
2. Improve drainage in the lower Ha Thanh river system.
3. Limit new residential, industrial and infrastructure development in the floodplain of the Ha Thanh river. New development can be shifted to safer areas inland or on the Phuong Mai peninsula.
4. Gradually move residents of particularly hard hit areas into safer residential zones.
5. Encourage construction of safe areas within existing homes.
6. Cluster new settlements on smaller sites that allow floodwater to flow around them.
7. Maintain food sources in reserved floodways and coastal areas.
8. Use dikes, water gates, barrages, and roads to manage seasonal flooding.
9. Raise new housing above the ground in critical floodways in order to protect them from flooding and maintain drainage.

10. Provide enough drainage under new elevated roads so that, even in a severe storm, water does not crest over them.
11. Prepare to retreat from the coast of Thi Nai lagoon as the impacts of climate change become worse.

We have introduced most of these measures in previous sections of this report, in part through discussions with residents and in part through an assessment of master plans and project plans. In concluding this report, we offer a brief rationale and strategy for implementation.

IMPROVE THE DISASTER WARNING AND RESPONSE SYSTEM

From 4-5 pm, when flooding occurred in Van Canh, until 4 am the next morning, when people living on the shores of Thi Nai lagoon began to see water rising in their shrimp ponds, we see no evidence of any official warning regarding flooding in the mass media. Lack of warning was the key factor in many personal tragedies. Many people told us that, had they been warned in time, they would have responded to the flood more appropriately. Instead, they watched for local signs while listening to their radios for notice that a dam would be opened.

The hydrological stations, especially the station in Van Canh, should have been the first point in the warning system. Second, as water broke over dikes in Van Canh, notice should have been sent downstream to the mass media. The Dieu Tri bridge is marked with a flood gauge. This is the third line of defense. Then, at each stage of the flood, as floodwater spread from basin to basin, reports should have been sent to the mass media. None of this happened in 2009.

A system of flood gauges along the Ha Thanh and Kone rivers and their floodways needs to be set up to record and transmit rainfall, temperature, wind speed, humidity, barometric pressure, and river heights to a central source, such as the Department of Meteorology, Hydrology and the Environment and, at the same time, be made available for immediate use by citizens by SMS, online, and in the mass media.

IMPROVE DRAINAGE

From what we have seen, efforts to prevent flooding have, in fact, increased flooding by creating new and higher barriers to the discharge of floodwater in the lower Ha Thanh. Bridges are not wide enough, new roads limit surface flows, some new projects completely block floodways, and the raised foundations of project sites in the floodplain shifts the burden of flooding onto existing settlements. The

project-by-project approach is incoherent, incremental and based on the evidence of typhoon Mirinae, it does not work. If master plans and project plans are completed as proposed, the result will be increased flooding, and the loss of life and property.

Perhaps it is time to consider a different approach. Rather than trying to prevent flooding on a project-by-project basis, the leadership of Quy Nhon City and Binh Dinh Province needs to consider ways of improving drainage through Nhon Phu and Nhon Binh. This might include:

- Protecting floodways as agricultural zones
- Widening existing bridges or building new bridges along existing roads
- Preserving floodways to barrage No. 2 and No. 3 for the two seasonal branches of the Ha Thanh that pass through Nhon Phu into Nhon Binh
- Removing buildings that have encroached on the Dinh Market river
- Redesigning the site plan for Quang Trung University to restore the floodway through New bridge
- Removing the access road to the new wastewater treatment plant and replacing it with an elevated causeway.

There are many design possibilities. Listed above are just a few. Each of these options, and others we have not discovered, will require research, a means of engaging the public in a conversation regarding the costs and benefits, careful consideration of the hydrological implications, a long-term vision, and courage.

LIMIT NEW CONSTRUCTION IN THE FLOODPLAIN

Limiting new construction in the lower Ha Thanh is a difficult, but ultimately necessary, requirement. Every other potential option will increase flooding in Nhon Binh and Nhon Phu, displace flooding to Dieu Tri and Tuy Phuoc, or both. Limiting construction along with improving drainage will reduce and share risks more equitably.

The An Phu Thinh new urban area has to be scaled back. If constructed as planned, the narrowed channels within the site will restrict the flow of floodwater through Nhon Binh, causing increased flooding, and the loss of property and lives. In addition, over the longer term, public funding will likely be required to solve the problems this new urban area creates. We have seen this situation already in Danang where the Department of Construction is now trying to find solutions to flooding caused

by the 4.5 meter high foundation of Hoa Xuan “ecocity”. No solution is as easy as better planning, and in the case of An Phu Thinh, this means reducing the scale of the project in order to accommodate the flow of floodwater over the surface of fishponds, restored mangrove forests, and riverside parks within the urban design.

The same assessment applies to the new urban area planned for the eastern side of highway 19 (Dao Tan Street) and southern side of Tran Hung Dao Street. The project area east of highway 19 is too large and offers no means for floodwater to discharge into Thi Nai lagoon. If constructed, this residential area will effectively block the flow of floodwater through barrage No. 1, and force floodwater north to barrage No. 2. The area south of Tran Hung Dao Street is a critical floodway in the most seriously flooded area of the city. We strongly recommend keep this floodway free of new construction.¹

ENCOURAGE CONSTRUCTION OF SAFE AREAS WITHIN EXISTING HOMES

As barriers to the discharge of floodwater have been raised, people living in existing settlements in the floodplain of the Ha Thanh river are being forced to raise the foundations of their homes. Not everyone has the income or savings to do this. People who must remain in their current homes can be encouraged to build safe areas. We saw an example of this in Mr. Ngoc Son’s house. At the cost of a few hundred dollars, he removed the ceiling in one area of his house and replaced it with a loft high enough to provide refuge from a two-meter deep flood. This may not be high enough if construction in the floodplains takes place as planned. We therefore offer this recommendation with some caution. People should not be encouraged to build safe areas in older homes in existing settlements unless the master plan is modified to restore and improve drainage in the floodplains.

CLUSTER NEW RESIDENTIAL AREAS

Historically, settlements in the floodplain of the Ha Thanh river were clustered on ground slightly higher than nearby paddy fields. This gave the settlements some degree of protection from flooding, while also allowing seasonal floods to recharge groundwater, fertilize soils and kill pests. New construction in the floodplain should be limited. However, to accommodate growth, new construction should be clustered around existing settlements.

GRADUALLY MOVE RESIDENTS OF PARTICULARLY HARD HIT AREAS INTO SAFER RESIDENTIAL ZONES

When we were beginning this research in 2011, we found an interesting satellite flood map. The map uses radar to show the extent of floodwater on 05 November 2009,

¹ At the time of this writing, we have only recently become aware of a new project proposed for the recently diked area of Van Ha in Nhon Phu. At this point, our only comment is that this area is designated as “green space” in the master plan due to its vulnerability to flooding.



Map 16. Extent of flooding on 05 November 2009 ²⁶

three days after the flood. The map also shows something else. When we overlaid the radar map on a Google Earth image of Quy Nhon, in addition to showing the extent of flooding in Nhon Binh, Nhon Phu, Dieu Tri and Tuy Phuoc (green), the radar image also showed existing settlements in the floodplain (violet).

Many of these settlements are in critical floodways or areas where flooding was particularly deep. Alongside efforts to improve flood warning and response, restore and improve drainage, reduce flood risks, construct safe areas in existing houses, and cluster new residential construction, people will need to move out of particularly hard hit areas. These areas, evident in damage assessments from typhoon Mirinae, include much of southern and western Nhon Phu, and areas impacted by recent construction in Nhon Binh.

MAINTAIN FOOD SOURCES

Many of the people we talked to said they would agree to resettle in new urban areas if they could keep part of their farmland or fisheries land. For some, this was a lifecycle issue – they are simply beyond the age of employment in the city’s industrial zones. For others it was a lifestyle choice. Right now, Quy Nhon offers its residents the unique and positive possibility

of living on a small farm while one or more family members work in urban and industrial areas. This allows families to combine income from various sources, which keeps wages down while also providing families with food security. For us, the key benefits have to do with maintaining local food supply in the face of rising energy costs, and maintaining floodways as greenbelts within the city. Determining where and how to create the agricultural spaces will take time, public participation, and coordination between several city departments.

Ms. Truong Thi Thau offered us some suggestions on how a transition from village to city might take place.

Suppose the government cuts a part of my rice land to build a new urban area. In my example, ... everyone would sacrifice a little in order to consolidate land, so that we can all have a proper life together in that new urban area.

I am quite willing to live in a new urban area as long as some land is reserved for agriculture... This would be a consolidated area where we would be able to manage, to control diseases, to keep the environment clean – I would not raise animals in a residential area.

This option is good, clean and beautiful.

I have longed for that kind of life, and now that I am older, I still wish for that, because it is clean.

Ms. Thau's example is consistent with the needs we have identified in this report: keeping floodways open, maintaining local food sources, clustering new residential areas, gradually moving people out of dangerous areas, and using flood protection infrastructure to manage floodwater. Her solution also resolves employment problems for families composed of elderly grandparents, middle-aged parents, and young children. The income earners in families like these are not likely to find employment in industrial zones or other service sectors. Agriculture, or agriculture plus home-based non-agricultural employment, is their only viable option for employment.

USE SEASONAL FLOODING AS A RESOURCE

Seasonal flooding in the lower Ha Thanh was historically regarded as a resource due to its role in recharging groundwater, increasing fertility and killing pests. Climate change will make these critical services more important. Flood prevention needs to be linked to water management in ways that preserve the environmental services seasonal flooding provides.

ELEVATE HOUSING IN CRITICAL FLOODWAYS

In some areas, it will be impossible to move people or it will be impossible to prevent people from constructing homes and businesses. Along dikes and roads, for example, the common practice is to fill each lot to the level of the road or dike with sand. When done in critical floodways, this practice reduces the flow of floodwater. Elevating new housing on columns above the floodplain will improve drainage, protect housing from flooding, and prevent blockage of bridges and culverts. This is now a common practice, globally. Areas under houses are not wasted space. They can be used for many purposes, including relaxation, small businesses and livestock raising.

ELEVATE NEW ROADWAYS IN THE FLOODPLAIN

Like the construction of housing in critical floodways, road construction has also restricted the discharge of floodwater. In general, roads serve as benchmarks for expected flood levels. As part of an integrated flood management effort, improving drainage under and over roads can reduce the level of flooding. This can be done by the construction of “drifts” – dips in the road in critical floodways as well as through improved venting through culverts and bridges.

PREPARE TO RETREAT FROM THE COAST

Implementing the ideas laid out in this report will also make it possible to retreat from the coast of Thi Nai lagoon with no regrets as mangrove forests, fishponds, paddy fields, and city parks, rather than homes and businesses, are sacrificed to rising tides.

FINAL WORDS

This is the preliminary report in a larger process. In future studies, we will develop a hydrological model of the lower Ha Thanh that can be used to assess the implications of different climate change scenarios. We will then use this hydrological model in a build out analysis to estimate potential impacts of climate change on current master plans and project plans in the lower Ha Thanh. Finally, through a collaborative process, we will develop an alternative development strategy based on what we have learned through this process in accordance with the Prime Minister's directive to build climate resilient cities. The recommendations we have offered offer direction to a much broader and longer conversation between public officials and the citizens of Quy Nhon city. That collaborative process, like the methodology used for this report, is key to developing and implementing plans that make Quy Nhon Vietnam's first climate resilient city.

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