

# VULNERABILITY TO FLOODING IN PERI-URBAN AREAS IN THE CONTEXT OF URBAN DEVELOPMENT AND CLIMATE CHANGE

Lessons from Study on Flooding Assessment in Hoa Tien and Hoa Chau  
communes, Hoa Vang district, Da Nang City<sup>1</sup>

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## STUDY BACKGROUND

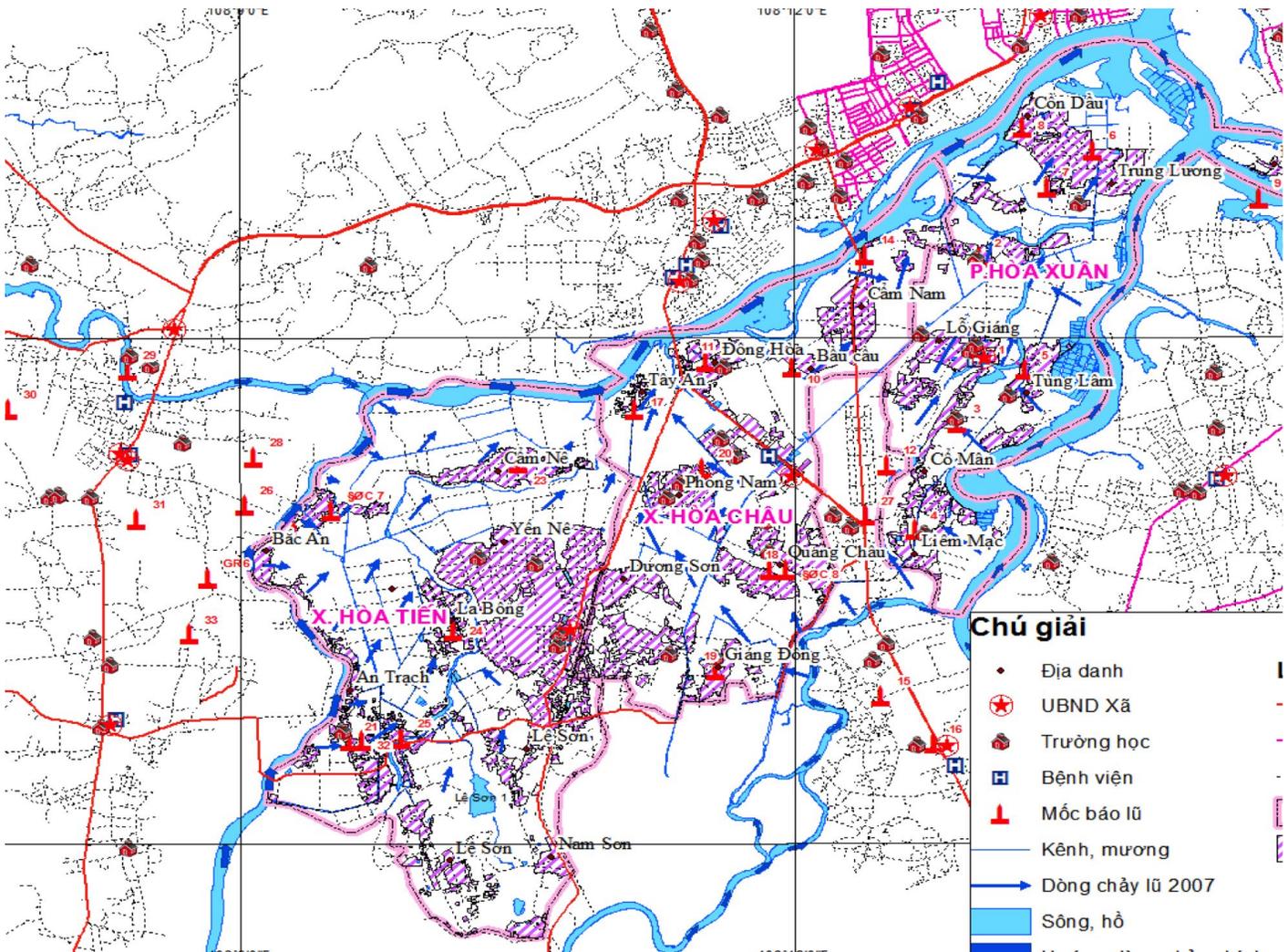
In recent years, Da Nang has developed strongly with the expansion of an urban area south of the city leading to the rapid development of infrastructure projects. This is also the area which suffered the flooding from the river basin from Quang Nam province.

Hoa Tien and Hoa Chau are typical areas in Da Nang city that experienced big changes in urban infrastructure in the period since 2008. Previously, the areas were predominantly agricultural but now they have become an interface area between urban and rural activities. Transport infrastructure has been significantly improved and paved roads now connect most households.

For years, these rural areas were frequently affected by flooding and residents considered a flood as a “regular event” and they had learned to “live with floods”. We found in our surveys that residents coped with the floods using traditional methods that are used in any rural region of Vietnam.

Urbanization has transformed the livelihoods and agricultural production of the residents. Most of the time, decent housing and paved roads have enabled more convenient responses to flooding. However, some respondents felt that residents should not underestimate the impact

**FIGURE 1: DIRECTION OF FLOODING FLOW OVER THE STUDY AREA (TOPOGRAPHY IN 2007)**



Source: CCCO, December of 2014

of future floods because the traditional way to cope with floods may no longer be relevant.

Heavy rain is a significant cause of flooding but there are also human factors that exacerbate the problem making it more difficult for local residents to quickly respond to flood hazards.

The purpose of the study conducted in Hoa Tien and Hoa Chau communes is to understand the

change in flooding in the urban development process. In addition to these two areas, the study includes analysis further downstream (Hoa Xuan ward) and upstream (Quang Nam province) to have a wider perspective to the research objects.

# METHOD OF STUDY

The methods are applied in stages:

1

## DATA COLLECTION

Most of the information related to flooding and records of flood levels has been collected in previous research. This information was presented to local communities in the preliminary meetings.

Socio-economic information was collected from previous researches and preliminary meetings with local communities. To assess the flooding impacts of several infrastructure projects since 2009, data on urban infrastructure was extracted from the dataset of Da Nang city. In order to prioritise the areas of this study, specific data on topography, structures and geomorphology, and flooding maps were taken from the Hydrology urban development simulation model (HUDSIM).

2

## MEETING WITH PEOPLE'S COMMITTEE IN HOA TIEN, HOA CHAU, AND HOA XUAN WARD; AND INTERVIEWING REPRESENTATIVES FROM COMMUNITIES

People who took part in the interviews represented several departments, including land management, traffic infrastructure management, water supply and sewage, drainage, agriculture, and disaster prevention. Representatives from affected hamlets were also interviewed.

3

## SITE VISITS

Site visits were undertaken in Cam Ne and Le Son 2 hamlet in Hoa Tien ward, and Tay An, Dong Hoa and Quan Chau hamlet in Hoa Chau ward. During the visits, several households were interviewed in depth including those working in agricultural production such as mushroom plantation and cereal planting.

4

## APPLYING THE HYDROLOGICAL MODEL AND SPATIAL ANALYSIS

The hydrological model developed in the HUDSIM project has been applied in this research to explore the impact of urbanization on flood patterns. The results attained from both simulation and interviews were analysed and compared.

5

## ANALYSIS

The results obtained from interviews and simulation can be used to identify the relationship between existing infrastructure and flood patterns. This provides the basis for flood prediction as the area continues to urbanise.

6

## REVIEWING OF EXPERTS AND LOCAL AUTHORITIES

The results of this research were shared and evaluated by local experts to ensure the reliability and usefulness for city planning in the future

# RESULTS OF STUDY

## 1. THE OBSERVABLE CAUSES OF INCREASE IN THE FLOODING FREQUENCY, FLOODING LEVEL, AND ISOLATED INUNDATION IN RESIDENTIAL AREAS

There has been an increase in the number of floods in two separate periods since 1964. From 1964 to 1998 (34 years), there were only two heavy floods in 1964 and 1998. Yet, between 1998 and 2013 (15 years) there were seven heavy floods (above the third level on the warning scale). The 1999 flood was as severe as the record flood of 1964 at Cam Le. Since 1999, there have been many floods. However, one flood in November 2007 and one flood in November 2013 are the focus of the analysis of the impact of rapid urbanization.

Many local residents confirmed that the direction of the floods across the province is consistent regardless of the type and duration of the flood; the flow direction is from west to east. Runoff overflows from Dien Ban District, Quang Nam Province flowing down due to descending terrain and rising river water. But locally, flooding has become deeper and lasts longer. To verify this, we conducted surveys near flooding meter HV22 in Bac An Hamlet, Hoa Tien commune and flooding meter HV17 in Tay An hamlet, Hoa Chau commune. The analysis implies that the flood in 2013 is smaller than the flood in 2007 but with some neighborhoods flooded more severely.

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### Flood in November 2007

River water started inundating Hoa Tien area from 10 pm on 14 November, reaching its peak at 5 am. It took more than one day for the flood to begin draining. It started receding from 10 am on 15 November. An Trach and Le Son 2 wards, which had just planted an experimental new rice variety in early November, were the first two hamlets flooded. Water levels remained high inside houses for 2 to 3 days and submerged the streets for up to 4 days. Flood waters drained slowly, resulting in inundation for 70-80 households. La Bong and Cam Ne hamlets were flooded about one hour after Le Son 2.

### Flood in November 2013

Heavy and long lasting rains increased the water level on all rivers within Da Nang and Quang Nam provinces. Water level at Ai Nghia station and Cam Le station reached a peak at 9.99m and 2.67m respectively on 16 November, exceeding 3rd warning level by 0.99m in the case of Ai Nghia and 0.17m at Cam Le. The flood lasted until 18 November 2013.

<sup>2</sup> 44 village leaders of 02 communes were interviewed directly, August of 2014.

## So, what causes led to flooding in the study area?

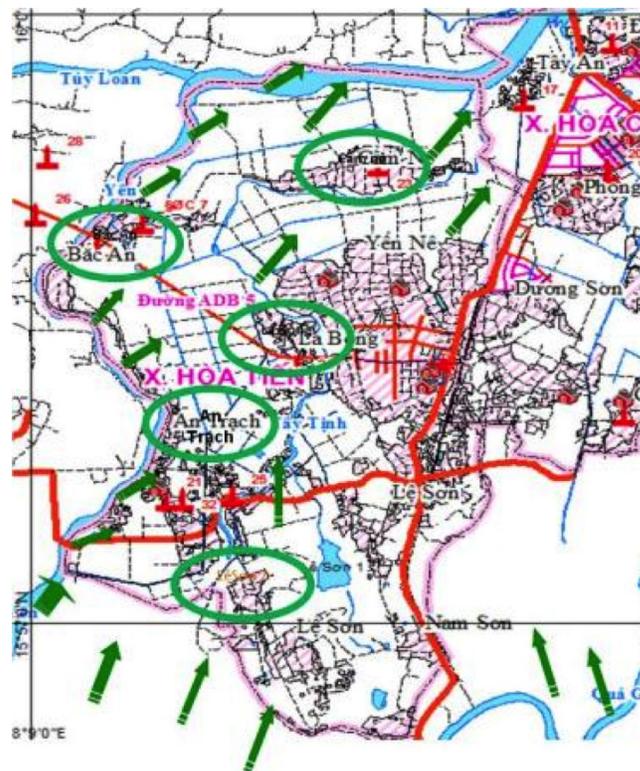
### Increasing elevation and lack of drainage items of traffic works

In 2009, the Ministry of Transport built a new road passing Hoa Tien commune which was funded by the Asian Development Bank (ADB) and is usually called ADB5 Road. Most of the interviewed people indicate that this construction closely relates to the change of flooding in the southern and northern villages of the commune. Road elevation is approximately 2.5 m higher than the surrounding terrain. The new facility connects the residents in three communes (Hoa Tien, Hoa Chau and Hoa Phuoc) to Hoa Vang District. However, after the roads were completed in 2013, villages located on the southern side of the road (La Bong, Bac An, An Trach and Le Son 2) suffered deeper inundation (flooding level in

some areas exceed the flooding level of 2007). The villages located in the north including Cam Ne, Thach Bo experienced less severe flooding.

After the flood in 2013, the ADB5 Road appears to hinder the flow of the flood. The water rose until it overflowed the road surface at the elevation of 2.5 m, and then flowed downstream to the village of Cam Ne. The upstream villages became low land where flood waters were retained. After the flood, the area still stores a very large amount of water due to the road and the limited drainage beneath the road. At the time the field survey was taken (August of 2014), the city was building 2 large culverts in this road to improve the drainage capacity. Previously, the drainage for the area mainly used 5 small culverts.

FIGURE 2: ADB5 ROAD AND INUNDATED AREAS IN HOA TIEN COMMUNE



Source: CCCO, December of 2014

In the study area, drainage and flood channels have been impacted by several urban development activities that have blocked overland water flow. These activities include the construction of new transport links which raise the surface level in new urban areas and build large structures in low-lying areas. Tay An village, Hoa Chau commune has been affected.

This can be seen in the impact of the 2007 flood which submerged Tay An under two meters of water. Flood water caused damage to crops, livestock and the environment. The flood lasted three days, disrupting daily life, study and production. But that year had less rainfall than in previous years. Local residents indicate that the flood was not caused by a storm and heavy rain but by the changes in local topography and drainage. The DT605 Road, located on the west, hindered overland flow into the area. After overflowing DT605, the flood water ran back to Cam Le River through the existing drains. The drainage system comprises a small number of culverts and drainage channels so water receded slowly. The upgrading of 1A National Highway (2003), the DT605 Road, roads

*“The flood pattern is very different than in the past. For example, though the flood in 2013 was smaller than previous floods, it lasted longer. The flood inundated the house for 2 days and it took 5 days for it to totally drain.”*

- Mr Phan Hoi in La Bong Village, Hoa Tien Commune, 68 years old -

along river banks and the South Cam Le resident area (2003-2004) also impeded flood drainage.

In previous floods, the surrounding areas, which were rice fields at that time, also served as retention areas where flood waters could spread out and quickly dissipate. However the improvement of transport links such as 1A Highway and the DT605 Road, and other construction activities such as the An Hai radio broadcast station appear to limit water flow and increase local flooding in existing villages.

**FIGURE 3: CURRENT IMPROVED DRAINAGE ON ADB5, HOA TIEN COMMUNE**



Source: CCCO, December of 2014

### **Operation of upstream hydropower plants cause flooding exacerbated the downstream areas**

Many people suggest that the operation of hydropower reservoirs was one of the factors causing flooding in downstream areas. In addition to interviews, we cite the results of the 2014 study “Flood discharge and reservoir filling of the hydropower plants in Vu Gia-Thu Bon system -From simulation to the reality” which was conducted by the Center for Social Development Studies (CSRSD) and had 350 respondents.

The reservoirs are supposed to be designed with excess flood capacity and play an important role in retaining floodwaters and slowing the speed of downstream flooding, especially during the rainy season. However, most of the hydropower plants on the Vu Gia - Thu Bon Basin have small reservoirs with limited flood retention capacity (except for A Vuong). So, in the flood season the hydropower plants are unable to buffer downstream inundation. Hydro power authorities have an incentive to operate their plants at maximum output levels. They are reluctant to reduce reservoir levels when rainfall is uncertain and they can be surprised by intense storms, as appears to have happened in 2013. The reservoir operators did not receive accurate forecasts with enough time to lower reservoir levels to create capacity for flood water. Heavy rains in the upper reaches of the watershed lasted for six hours while the lower reaches in Da Nang had almost no rain. Only two hours after rain started, the Dak Mi 4 hydropower reservoir was full. Several operators had to urgently implement emergency flood discharge to secure their reservoirs. The discharge led to rapid and large scale flooding for downstream areas, causing serious consequences.

*“The river water was still at a low level in the afternoon. However, it was very high at 8pm. So she didn’t have enough time to move her things. Many possessions were washed away. She noticed that the water rose very quickly but drained slowly because the road had blocked the waterways. The water flow became more aggressive and dangerous so that her family just stayed at home during the flood. She doesn’t want to move to another place but the risks induced by floods scare her family.”*

- Mrs Hiep (born 1971), Bac An Hamlet, Hoa Tien -

### **Raising the elevation of Hoa Xuan, part of Hoa Chau, and developing new buildings on the drainage corridor contributes to impeding the flow**

Activities that elevate areas include the construction of new transport links such as 1A Highway, DT 605 Highway, raising the surface level in new urban areas, and building large structures in low-lying areas. Dong Hoa Village, Tay An, and Hoa Chau are among the areas that have been affected.

The process of filling the low-lying areas in Hoa Xuan for construction has altered the natural drainage system in the area. The adjacent area (including Tay An and Dong Hoa in Chau Hoa commune), which has not been filled, has been impacted with large areas of standing water and waterlogged soils.

Assessment of individual construction projects will not clearly show the impact of that project on the flood pattern. However, assessment of many construction projects appear to limit water flow and increase local flooding in existing

**PICTURE 1: AN HOI BROADCAST STATION, TAY AN VILLAGE, HOA CHAU COMMUNE, HOA VANG**



Source: CCCO, August of 2014

**PICTURE 2: CAM NE VEGETABLE CROP, HOA TIEN COMMUNE, HOA VANG**



Source: CCCO, August of 2014

**FIGURE 4: FLOODED AREAS IN HOA CHAU COMMUNE, HOA VANG DISTRICT**



Source: CCCO, December of 2014

villages. To resolve this, more attention should be paid to drainage and flood retention sites.

**Other related problems in the study area**

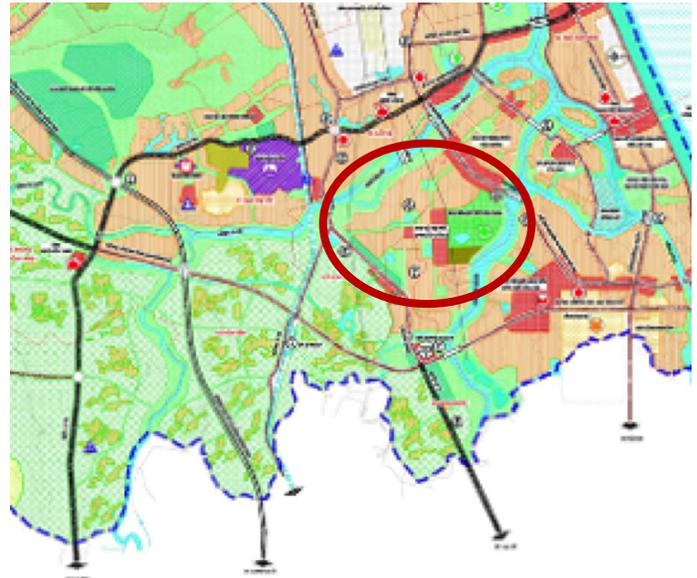
Another risk impacting people’s lives is the challenge of the transition from rural to urban livelihoods. The transition from a largely agricultural income base has changed the traditional occupations of the community. Local residents who have lost their farmland have received compensation but some can only find unskilled labor in urban areas. Low and unstable incomes mean that these poor households have become even poorer. Some high value agricultural activities continue in the area, such as organic vegetable and mushroom cultivation. Animal husbandry has also attracted some investment but the changing flood patterns create high and uncertain risks for livestock owners. Unless there is better planning and predictability for the management of seasonal floods across this area, farmers will be reluctant to invest in more productive agricultural technologies..

In addition, though there are still large areas of agricultural lands (mostly in Hoa Chau, Hoa Xuan, and Hoa Phuoc) that have not transitioned into urban area, they can not be used for agricultural production because surround projects have blocked the irrigation or drainage system.

**FIGURE 5: URBAN ZONING IN THE STUDY AREA (APPROVED IN 2002 AND 2013)**



Planning to 2020 (approved in 2002)



Planning to 2030 (approved in 2013)

Source: Decision no. 465/QĐ-TTg of 2002 and Decision no. 2357/QĐ-TTg of 2013.

## 2. ANALYZING THE UNDERLYING CAUSES OF THE IMPACTS OF URBAN PLANNING, DEVELOPMENT OF INFRASTRUCTURE, LIVELIHOODS TO FLOODING PROBLEMS IN THE STUDY AREA

Comparison of the two detailed plans for the study area, one approved in 2002 and the other in 2013, show a significant change in urban development. Earlier plans for Hoa Xuan ward and part of Hoa Chau showed large areas reserved for floodways and parks but in the 2013 plan, which reflects actual construction and fill ranging from +3.6m to +4.7m, most of the area is planned for development. Previously, this area was directly affected by floods from Cam Le, Vinh Dien and Qua Giang River. A historic flood level for floods with a probability of 5% is +3.7m.

The 2013 Master Plan for Da Nang shows strategic goals in socio-economic development towards regional linkages and sustainability. In the new plan, factors related to flooding and climate change adaptation have been considered in the following ways:

- Consider that climate change, increase in temperature, sea level rise will directly affect riverside and coastal areas. Therefore, ground level elevation must be considered and properly adjusted before development, especially in these areas.
- Specify standards of elevation corresponding to flood safety levels in certain areas:
  - + Select the minimum elevation for construction to be that of the river level during floods of probability 1 – 5%.
  - + According to national standards of urban planning QCXDVN 01:2008/BXD, ground

levels should be equal to the flooding level with frequency of 1-3%. However, for areas of new construction in Da Nang, the city suggests choosing the frequency at lower level (about 1-5%) to reduce the investment and to be consistent with the current resident areas in the city.

- Some built-up areas of the central city cannot be filled, so in these areas partial filling and elevation of streets and thresholds is recommended.
- The minimum elevation for the old urban areas can be attained from the adjusted general planning of Da Nang by 2020.
  - + The minimum elevation of construction in new urban areas of Lien Chieu, Cam Le, Ngu Hanh Son, Hoa Vang which is equal to the estimated flood water level corresponding to a flood frequency of 5%.
  - + The minimum steepness for construction ground is 0.1-0.2%.

***The above changes have had the following impacts:***

**Changes in the development density and construction in Hoa Xuan**

According to the master plan, approved in 2002, Hoa Xuan was to be a low-lying area allowing flood drainage. As such, it was flagged to be an eco-urban area with limited development and, essentially, maintain its existing elevation (from 1.5m to 2.0m). With this elevation, the area will be involved in flood drainage and any structures should be at least two storeys in order to allow flooding on the lower floor.

However, this plan was not used effectively to control development in Hoa Xuan. With strong interest from real estate developers, the city approved a land use plan and detailed development plans (see above) that made no reference to the limitations identified in the master plan. The area

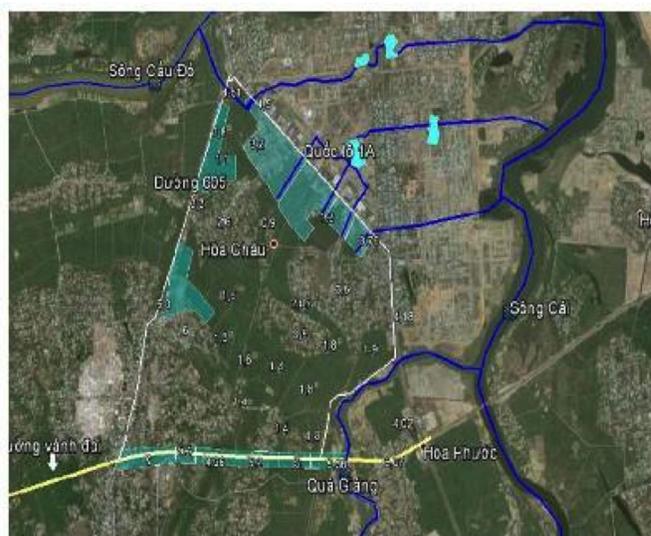
was attractive for luxury residential development because of the water features and its proximity to the central city and eastern beaches.

With the change in urban development, drainage plans in the area also changed. Major drainage culverts under National Route 1A connect to channels that cross the area from west to east to drain into Vinh Dien River. In addition, to handle the elevation of drainage and to support the drainage system, a number of artificial lakes for rainwater reservoirs, flood control and for landscape improvement were built in the new urban area.

Landfills and ground elevation are designed based on the elevation of National Route 1A and to match a historical flood return period of 20 years. The lowest elevation along Cam Le and Vinh Dien River is from 3.5m to 4.00m to protect against floods of the same magnitude experienced in 2009.

Raising these elevation levels for urban development in Hoa Xuan will increase the level of floodwater,

**FIGURE 6: SOLUTIONS FOR DRAINAGE IN HOA XUAN**



affecting the upstream area. This issue was considered by the consultant when designing the plan for ground elevation. They added 0.5m into the elevation in case of developing the urban areas in Hoa Xuan to make allowance for the increased water levels over historical flood values. In fact, the developer was not able to comprehensively complete leveling for such a large area. Dong Hoa neighborhood has maintained its previous elevation and become a relatively low-lying area. This area will be affected first by flooding and will be inundated for a longer time.

The consultants calculated that raising the elevation of 1000 ha in the low-lying area of Hoa Xuan is a relatively small area when compared to the entire flood plain and claimed that any local increase in flood level would not be high. Floodwater levels at Cam Le station increased by 0.42m. However, the problem is not about the increased water level in this area but, rather, the increased water level in the upstream area. So far, there have been no floods at the same size as the 2007 flood to be able to test the calculation of impacts of flooding and inundation advised by the consultants.

If there is further urban high density development in Hoa Tien and Hoa Chau, the flow in the river Cam Le will be 4,62m (results from the hydrological hydraulic model of HUDSIM project). Therefore, Da Nang city has modified its urban master plan that keep the low density development in the upstream communes to reduce the flood risks.

### **Some arterial roads were built without sufficient drainage**

As described in Section I, the new ADB5 route with a total length in the study site of about 5 km, running from National Route 14B (in front of administrative center of Hoa Vang district) to DT605 secondary highway is located to the North of Hoa Phuoc-Hoa Khuong. The lowest elevation of the roadway is 4.73 m, corresponding to a design flood probability of 20%.

Horizontal drainage system has a total of 16 horizontal drains with the smallest aperture D1000, the highest 2x (2000x2000); 02 bridges include: the Bridge over the River Yen (12 + 3x24 + 12)m, the bridge over the Tay Tinh River L = 24m. The total drainage area is 751m<sup>2</sup>.

The entire area is part of the flood drainage for Yen River. However, when designing the drainage system, the consultant calculated inadequate drainage aperture and unsuitable elevation of the center of the route so, under flooding conditions, the Vu Gia River overflows its banks upstream and water flows across the floodplain piling up behind the highway embankment which is at least 2m above the surrounding plains, and creating a deep impoundment in upstream areas.

By comparison, the Hoa Phuoc-Hoa Khuong road is about to be built in this area, connecting National Route 1A to Secondary road DT605 Route. Along this short connection, the road was built with a total of 18 horizontal drainage culverts with a total cross-sectional area of 1856m<sup>2</sup>. This road is designed for much better drainage than ADB5. Thus, the risk of flooding of the route is much higher than the ADB Route and 409 Route.

# CONCLUSION

## 1. CAUSES OF IMPACTS OF FLOODING AND INUNDATION HAVING INCREASED IN THE STUDY AREA

Flooding and inundation now have greater impact in the study area of southern Da Nang. The process of urban development in general, changes in urban features, and, in particular, expansion of infrastructure are factors that increase the impacts of flooding and inundation. Further, it is expected that climate change will increase the effects of extreme events and hydrological systems.

The transformation from a low density to high density urban form involves the planning and construction of infrastructure to minimize the impact of flooding. Unfortunately, these have become the root cause of risks in other neighboring areas. To minimize this effect, a "regional planning" process should be carefully considered. It is not sufficient to merely consider the safe ground elevation for the planning site. The planning process must specifically consider the impacts of the development on the surrounding areas.

In addition, the construction of secondary roads and highways cross the floodplain, such as the Hoa Tien - Hoa Phong secondary road, or construction of large projects within flood retention basins, interfere with overland flow in the floodplain. While this may reduce the flooding and inundation issues in the downstream area it makes flood levels in the upstream area rise and inundation in those areas deeper and longer lasting. Fixing these drainage problems after they occur will be extremely costly for the city.

Operation of hydroelectric reservoirs in the upstream area of Vu Gia - Thu Bon also leads to

exacerbating flooding problems in the study area. New studies are needed to recognize that extreme flood conditions will not only reflect higher intensities of precipitation in future, but may also be further impacted by emergency releases from overloaded reservoirs along the river basin at the same time.

## 2. URBAN PLANNING ADAPT TO FLOODING AND CLIMATE CHANGE SHOULD BE FURTHER INTEGRATED IN DANANG

Urban planning in Da Nang have considered flooding and climate change as a factor influencing development plans. However, there are a number of areas that should be considered for improvement:

- Limit the urban development in low-lying areas to avoid the need for infill or dikes to protect new urban construction. Large amounts of infill or new dikes in low-lying areas will restrict river flow and increase flood levels in other locations.
- Prioritize the preservation or expansion of floodway corridors, reducing structural impediments to surface flow in conditions of extreme water levels to speed drainage and reduce water levels.
- Revise estimates of flood levels based on historical data to account for issues of sea level rise, increasing intensity of precipitation, sea level rise and upstream reservoir operations in extreme events. Detailed planning needs to be consistent with the broader site and regional context, including developments upstream and downstream of the site.
- In the context of climate change and sea level rise becoming more complex, leading to the increase in rainfall and flood levels, new adaptation measures to protect human life and property in the face of more frequent and severe flood events are needed.

### 3. RECOMMENDATIONS IN IMPROVING THE URBAN DEVELOPMENT OF NATIONAL AND LOCAL LEVELS

Peri-urban development practices are affecting the frequency and intensity of floods in community life. Planning practices are improving with better knowledge of climate change and better modeling tools to assess potential future development options. In order to address the issues identified in this study, we propose a number of recommendations:

#### For Ministry of Construction

- Regional planning should become the basis for coordination and collaboration among different local government units, and between different cities and towns at various levels of development. Urban planning procedures and requirements should be harmonized so that lower level plans consider and respond to the guidelines and direction of higher level plans. In particular, urban master plans need to respond and follow the directions of higher-level regional plans.
- Improve the control of the implementation of general urban planning to ensure urban development is consistent with the approved scheme. If a problem arises, regional development needs was jointly handled promptly.

#### The city's People Committee

- Collaborate with other provinces in the region, especially with Quang Nam, in designing flood drainage and disaster risk reduction plans, to provide for the safety of communities in both upstream and downstream areas.
- Review and regularly adjust plans for urban development in low-lying areas before approving detailed construction plans. There should be specific regulations on limiting urban development in low-lying areas, and supporting flood drainage and emergency flood retention, especially in the southern part of the city.

- Focus on the implementation of a strategic environmental assessment for urban planning projects and environmental impact assessment for urban development projects. Planning should orientate towards increasing the green area, public area, forming the catchment area of natural flood along the river systems.
- Organize and approve the adjustment of building regulations in accordance with the requirements of coping with climate change. Review the possibility of flooding of urban areas of Hoa Xuan, Hoa Quy arrange appropriate adaptation options.

#### The city's construction department

- Develop a mechanism for coordination with other agencies involved in the appraisal of urban plans at different scales to verify design assumptions and context for assessing flooding and inundation and climate change adaptation.
- Undertake studies to develop criteria for land use planning in new urban areas, and feasibility studies for re-development in areas already built, to create or maintain floodway corridors (localities such as Hoa Vang District, Cam Le and Lien Chieu), and recommend regulations or construction restrictions in the area, then conduct activities of risk communications and awareness building to help residents understand and respect these restrictions.
- Undertake studies on flood and drainage planning, to develop new standards for ground elevation for changing hydrological conditions, considering risks of extreme rainfall, sea level rise, and reservoir management, as well as infrastructure design options. Apply the new construction standards for investors and residents building houses especially in Dong Hoa, Tay An of Hoa Chau Commune and Cam Ne, Bac An of Hoa Tien Commune.

- Undertake studies to create or maintain floodway corridors on rivers Yen, Qua Giang, Vinh Dien, Cau Do, Cam Le, Tuy Loan, Han while the unplanned drainage corridor should ensure no project planning, construction encroaching river dumps, riverbanks and riverbed.
- Strengthen the role of strategic environmental assessment and environmental impact assessment in urban planning.
- Continue to improve the planning of specialized technical infrastructure including: Feasibility studies for building flood retention lakes to reduce the pressure on water drainage system and river flows, particularly in Dong Hoa, Tay An of Hoa Chau, and Cam Ne, Bac An of Hoa Tien. Develop maps of elevation showing hydrological parameters, as the basis for flood maps of the city.
- Update and use the hydrological model from the HUDSIM project to use in the plan appraisal and approval process. Suggested uses for the model include recalculating the level of flooding for the city, especially as a result of changes in Hoa Xuan, Hoa Quy and development of new investment projects in Hoa Tien, Hoa Chau.

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Decision no.1349/QD-UBND on “actively respond to climate change, enhancing natural resource management and environmental protection in Da Nang”.

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