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EXPERIENCE OF URBAN DEVELOPMENT AND CLIMATE CHANGE ADAPTATION IN DA NANG CITY

Lessons from the urbanization process of Hoa Tien and Hoa Chau communes, Hoa Vang district

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Lessons from the urbanization process of Hoa Tien and Hoa Chau communes, Hoa Vang district

(From research by Institute for Social and Environment Transition (ISET) and Da Nang Climate Change Coordination Office (CCCO))

AUTHOR

ISET-VIETNAM
Phong Tran
Stephen Tyler

DA NANG CITY ASSOCIATION OF SCIENCE AND TECHNOLOGY UNIONS
Thanh Huynh

CLIMATE CHANGE COORDINATION OFFICE OF DA NANG CITY
Ha Nguyen

Tran Viet Dung MA, Research Associate

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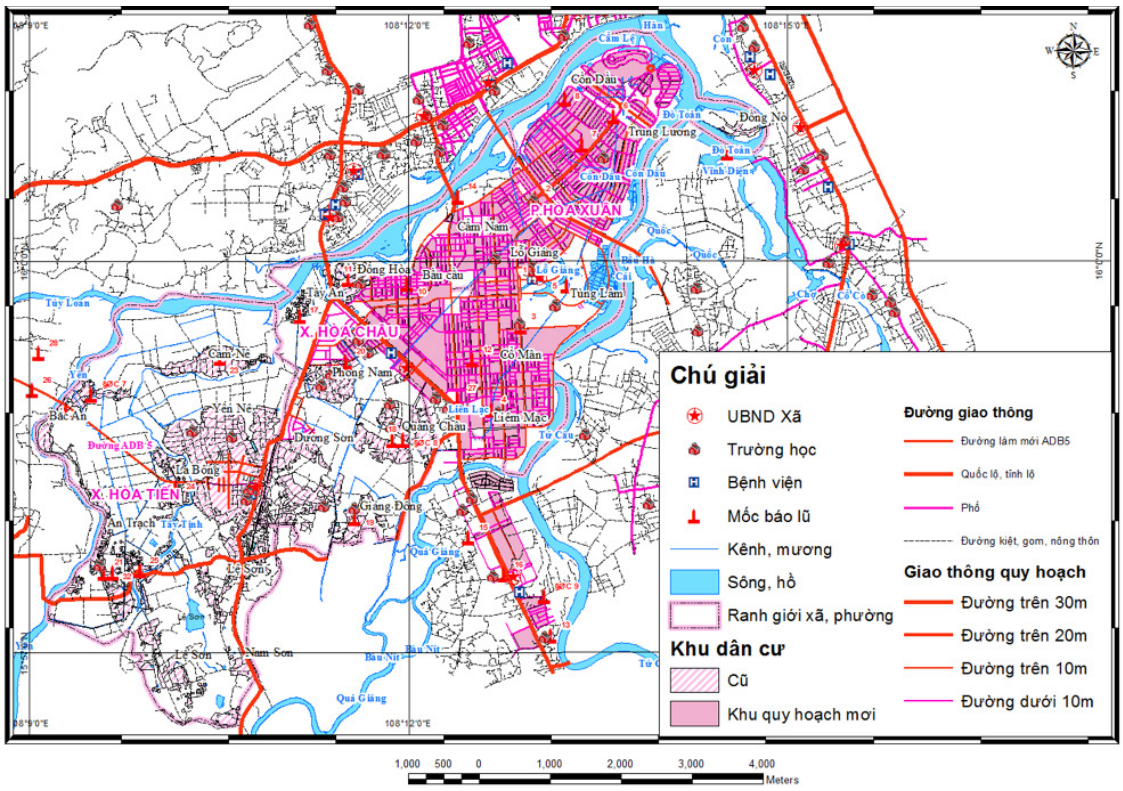
ABSTRACT

This report is the synthesis of relevant studies in Da Nang conducted by the Institute for Social and Environmental Transition (ISET) and the Climate Change Coordination Office of Da Nang (CCCO) in collaboration with relevant organizations and agencies in Da Nang. The research demonstrates that with the prospect of climate change, the intensity and frequency extreme rainfall events is likely to increase in Da Nang and surrounding areas. Meanwhile, urban development in floodway and low-lying areas has worsened flooding in areas already susceptible to flooding in Da Nang and Quang Nam. Flooding will affect Da Nang's reputation and future land price, at the same time posing major costs to the local government for urban infrastructure damage restoration. Local businesses and people living in floodplains will also suffer increases in flood damages and recovery costs. Traditional practices in urban planning, infrastructure design and the use of filling standards that are based on historical flood experience and data will pose major challenges in the face of future hazards. Therefore, it is critical to restore natural ecosystems, and preserve and protect low-lying areas and buffer zones along rivers for emergency flood retention. These areas can have the flexibility of being used for recreational or agriculture purposes. It is unsustainable to promote urban development in floodway and low-lying areas in the context of climate change.

FIGURE 1. 2013 CURRENT MAP OF RESEARCH AREA



CONTEXT

Over the past years, Da Nang has experience a period of robust urban development with expansion towards the southern area of the city, accompanied by rapid development of infrastructure. Hoa Tien and Hoa Chau are typical areas of undergoing major changes in urban infrastructure. Road infrastructure has been improved significantly, with concrete roads built in all villages and hamlets, reaching most families.

However, serious localized flooding in residential neighbourhoods of Hoa Tien and Hoa Chau has been increasing. The question is, *what are the causes of these changes?*

INCREASED ELEVATION AND INSUFFICIENT DRAINAGE FEATURES OF ROAD INFRASTRUCTURES

A new road running through Hoa Tien commune was built in 2009, with the Ministry of Construction (MoC) as the project owner, and the Asian Development Bank (ABD) as the funding agency. Local people called it the ADB5 road. Most of the people interviewed attributed the construction of this road to changes in flooding patterns in hamlets in the northern and southern areas of the commune. The elevation of the road was 2.5 m higher than surrounding areas. The road was built to

make it more convenient for people in Hoa Tien, Hoa Chau and Hoa Phuoc villages to travel to Hoa Vang district. However, after the road was built, hamlets to the north of the road (La Bong, Bac An, An Trach and Le Son 2) started to experience deeper flood levels. The 2013 flood revealed that the ADB5 road was blocking the flood flows, causing floodwater to keep building up until in reached the elevation of the road (2.5 m) and overflowed, turning upper hamlets into flood-containing cells. After the flood had retreated, there was still a large volume of water trapped in these hamlets due to the high elevation of the road and the very low capacity of the road's drainage system.

Besides, other elevated roads, residential areas built on filled land, and new constructions in low-lying areas, especially those right on the floodway, led to increased localized flooding levels in areas such as Tay An village of Hoa Chau commune.

The construction of DT605 road to the west of Tay An led to delays in flood transference into this area. But after overflowing the DT605, floodwater drained back into the Cam Le River through road culverts (including box culverts such as Cua Dinh and Dong Hoa), which are too few and small, therefore the water took a long time to drain. The renovation of National Highway (NH) 1A in 2003 and riverside roads and the South Cam Le residential area in 2003-2004, and the construction of An Hai Broadcasting station also led to obstruction of flood drainage. These, along with other future infrastructures, will certainly interrupt flood drainage and increase localized flooding in nearby neighbourhoods.

UPSTREAM HYDROPOWER OPERATION WORSENED FLOODING DOWNSTREAM

In principle, hydropower reservoirs are designed with part of their capacity for flood control, thus assume the role of reducing and slowing down flood flows into downstream areas. However, most hydropower reservoirs in the Vu Gia – Thu Bon system have either no or very negligible flood control capacity (except for A Vuong reservoir). Therefore, these reservoirs hardly play any role in mitigating flooding downstream during the flood season. Even the operation of these reservoirs according to the inter-reservoir operating mechanism in the flood season faced plenty difficulties because of the short time of advance alert of incoming flood flows, and so they cannot take early initiative to release part of their existing water for the expected flood volume, and if they decide to release the water when alerted, it might already be too late because of the rapid incoming flood. On the other hand, all these reservoirs have very little capacity, thus their flood release capacity is also limited. Particularly, in the 2013 flood, there was prolonged heavy rainfall for six hours upstream, but hardly any rain downstream, and after only 2 hours, the Dak Mi 4 Hydropower reservoir was filled. This amount of rain was unexpected, so the reservoir had not release the water to make space for the coming flood—it had to open its floodgates for an emergency release. This resulted in rapid and severe flood progression, causing serious damages downstream.

FLOOD FLOW OBSTRUCTION CAUSED BY GROUND LEVELLING IN HOA XUAN AND PART OF HOA CHAU, AND INFRASTRUCTURE DEVELOPMENT IN FLOODWAY AREAS

Elevated roads such as NH 1A and DT605, residential areas built on filled land, and new constructions in low-lying areas contributed to the shrinkage of the floodway. Construction in low-lying areas for urban development had altered the natural topography of flood drainage in the entire area. Adjacent areas that are not raised, such as Tay An and Dong Hoa villages of Hoa Chau commune, became hotspots of localized flooding.

Over the years, the renovation of NH 1A (in 2003), DT605 road, riverside roads, and the South Cam Le residential area (in 2003-2004) led to obstruction of flood drainage. In the 2007 event, Tay An was 2 m flooded. Swift flows from upstream caused damages to cash crops, livestock, poultry, and the environment. The flood prolonged for three days, disrupting people's lives, school activities, and production. Precipitation during this flood was lower than in previous years. According to local people, the flood was caused not by heavy rain and typhoon impacts, but by changes in the elevation profile of the area. The construction of DT605 road to the west led to delays in flood transference into this area. But after overflowing the DT605, floodwater drained back into the Cam Le River through road culverts (including box culverts such as Cua Dinh and Dong Hoa), which are too few and small, therefore the water took a long time to drain. Before, all surrounding areas were rice fields, which functioned as flood storage areas during flood seasons.

It is very difficult to highlight the underlying cause of increased flooding in the area by assessing each building or infrastructure separately. Putting together, the massive change caused by a series of infrastructures in the area—including NH 1A, DT605 road, An Hai Broadcasting Station, along with other future infrastructures—will certainly interrupt flood drainage and increase localized flooding in nearby residential areas if no further engineering and drainage measures are implemented.

OTHER EMERGENT ISSUES IN THE RESEARCH AREA

Another social risk to the local community is the existing gaps between urban development and socio-economic development. The conversion of large agricultural land areas for urban development disrupted the traditional livelihoods of many communities. People who lost access to traditional agricultural livelihoods had to turn to other urban livelihoods, mostly with unstable income, with the poorest households usually bearing the brunt. There are investments in agricultural production—such as vegetable growing, mushroom growing and livestock keeping—despite high flood risks in the area. This high flood exposure profile is not integrated into the detailed plan for the area. Therefore, gains

FIGURE 2. MAP DEMONSTRATING FLOW DIRECTION AND VILLAGES OF HOA CHAU COMMUNE THAT SUFFER HEAVY FLOOD

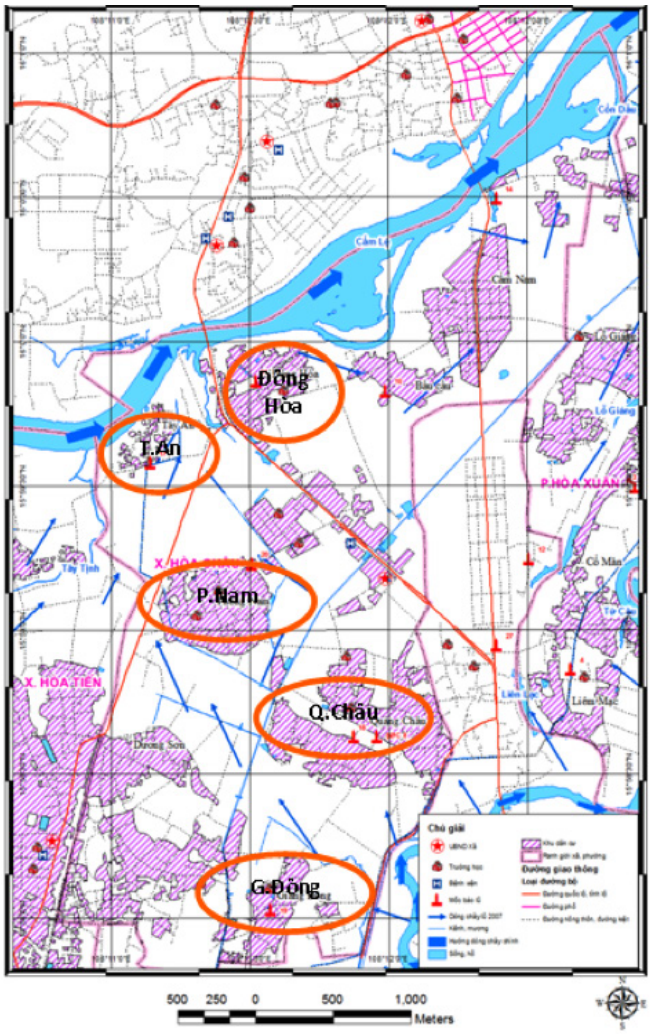


FIGURE 3. AN HAI BROADCASTING STATION, TAY AN HAMLET, HOA CHAU, HOA VANG*

FIGURE 4. CAM NE VEGETABLE FIELD, HOA TIEN, HOA VANG*

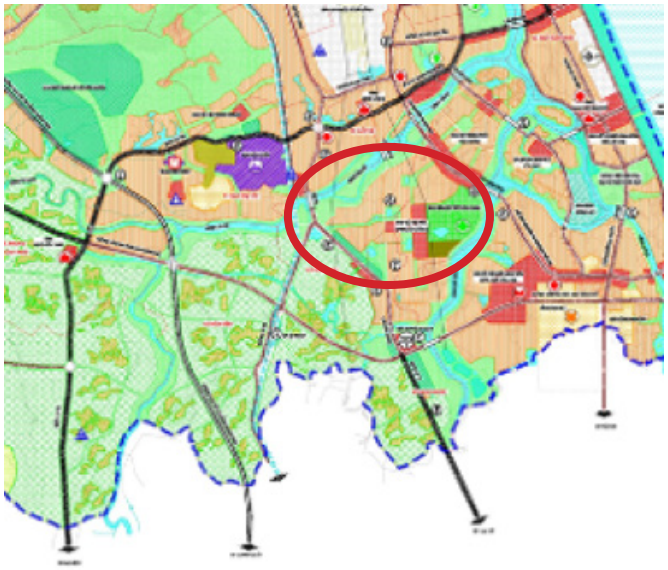
**Source: CCCO, August 2014*

from agricultural production will be low, if any, and there is a high risk of losses caused by unusual and unpredictable flood events.

Besides, fairly large areas of agriculture land (mostly in Hoa Chau, Hoa Xuan and Hoa Phuoc communes)—though have not been converted into urban land—are being affected by construction projects in their adjacent, and can no longer be used for agriculture production because there are no more irrigation and drainage channels.

FIGURE 5. DEVELOPMENT PLAN UNTIL 2020 (APPROVED IN 2002)

FIGURE 6. DEVELOPMENT PLAN UNTIL 2030 (APPROVED IN 2013)



UNDERLYING CAUSES – IMPACTS OF URBAN PLANNING, INFRASTRUCTURE DEVELOPMENT AND RESIDENTIAL CONSTRUCTION ON FLOODING

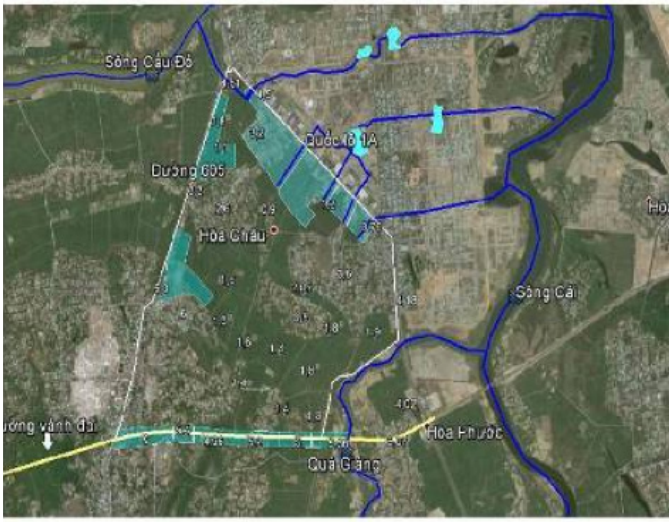
URBAN DEVELOPMENT PLAN IN THE RESEARCH AREA (APPROVED IN 2002 AND 2013)[1]

The urban development plan approved in 2013 was built upon the former plan approved in 2002, on the basis of assessment of advantages and disadvantages in the implementation of this plan. The modified plan integrated considerations of adaptation to flooding and climate change, specifically:

- Pointing to issues posed by weather pattern change and climate change, global warming, and sea level rise, which have various implications on construction elevation in the planning of riverine and coastal areas, and making adjustments as appropriate.
- Providing specifications on appropriate construction elevation for flood safety and for specific areas:
  - + Select minimum ground elevation equal to river level during floods of P=1-5%.
  - + According to the urban planning standard QCXDVN 01:2008/BXD, ground elevation of

1 Decision no. 465/QĐ-TTg in 2002 and Decisio no. 2357/QĐ-TTg in 2013.

FIGURE 7. MAP OF DRAINAGE PLANNING OF HOA XUAN



construction must be equivalent to 1% flood level. However, during recent years when infrastructures were being constructed in residential areas and new urban areas, it was recommended that construction elevation should be selected so as to ensure maximum flood protection (resisting 20-100 year floods), at the same time being well coordinated with existing elevation profile of the city.

+ For the centre area of the city, in developed areas in which elevation cannot be raised, ground levelling and elevation raising need to be done for each new construction project individually.
+ Minimum construction elevation for the existing urban area is based on the adjusted urban master plan of Da Nang until 2020.
+ Minimum construction elevation in new urban areas in Lien Chieu, Cam Le, Ngu Hanh Son and Hoa Vang districts must be equivalent to 5% flood level.
+ Elevation slope of the plan is from 0.1-0.2%.

However, there are still impacts caused by the following changes:

a. Major changes in construction density

According to the plan approved in 2002, because Hoa Xuan was a low-lying floodplain with a role in flood drainage, it was to be reserved to develop an ecological urban area in harmony with existing elevation, technical and social infrastructure. The ground elevation provided was low at 1.5-2.0 m, which means the area will play a role in flood drainage. New infrastructures were to be at least 2-story tall, with the ground floor serving the function of flood drainage. However, in reality Hoa Xuan did not become an ecological urban area. There are new residential quarters and riverside premises in between public facilities, parks, regulating lakes, sports complex and green areas, which create an image of a modern urban area. This is an attractive urban space with water surfaces (the junction of the Han, Vinh Dien and Co Co rivers), convenient roads and waterways, and proximity to the sea.

With these changes in the nature of the urban area, drainage measures must also change accordingly. Flood drainage culverts on NH 1A were connected to the Vinh Dien River to ensure clear drainage in all culverts on NA 1A and drainage basins. In addition, to adjust the elevation for drainage and reduce pressure on the drainage system, many lakes were created for rainwater regulation, flood regulation, landscape creation and climatic regulation. Elevation for ground levelling was determined based on the elevation of NH 1A and for resistance of floods at P=5%. Areas with lowest elevation along Cam Le and Vinh Dien rivers are

at 3.5-4.0 m, which can resist floods at P=5% and the 2009 flood equivalents.

Drainage measures for Hoa Xuan

Raising elevation for urban development in a natural floodplain area that used to play a role in flood drainage led to increases in flood levels and affected upstream areas. The planning consultants did anticipate this problem adding 0.5 m (instead of 0.3 m according to standard) to the elevation as a flood buffer when designing the ground elevation level of the urban area in Hoa Xuan. In reality, ground levelling could not be done for the entire area. For instance, the elevation of Dong Hoa village was kept unchanged, so it became a low area. When the drainage system is not improved, this area will be the first to be affected by flooding and for more prolonged periods of time.

Although according to calculations by the planning consultants, land levelling for the 1,000 ha in Hoa Xuan will only have minimal impacts given its relative size to the entire southern area of the city, and that the increase in flood levels is small (flood level at Cam Le increased by 0.42 m). However, the main impacts were not in this area itself, but in its upstream areas. Notably, flood damage has a quadratic relation to the level of flood, therefore the level of flood risk and flood damage in the area would increase considerably. So far, there has not been any flood event equivalent to the 2007 flood to allow verification of the flood impact calculations for this area.

Evidence shows that if urban development leads to a significant increase in population and construction density in Hoa Tien and Hoa Chau, the risk is that water level in the Cam Le River could reach 4.62 m (according to HUDSIM project results – [Tran & Tran, 2014]). Therefore, in the approved city master plan, adjustments were made to allow these areas to remain as they are and reduce the risk of increased water level in the river.

b. Some transport infrastructures and constructions built without consideration of flooding and flood drainage

The ADB5 road is about 5 km in length, connecting NH 14B (in front of Hoa Vang district administrative centre) with the DT605 road, and is in the north of the Hoa Phuoc-Hoa Khuong road (downstream to the Yen River bridge). The minimum elevation of this road on its centreline is 4.73 m at the Yen and Tay Tinh river bridge, equivalent to the level of 20% floods. This elevation is mostly kept equivalent to existing elevation of the road and houses by its sides. The current elevation at the Yen River Bridge is 8.5 m, and Tay Tinh River Bridge 6.21 m. The culvert system across the road includes 16 culverts with minimum opening at D=1000 m, and maximum opening at 2x(2000x2000); two slab bridges: Yen River Bridge with opening of (12+3x24+12) m, and Tay Tinh River Bridge with L=24m. Total drainage area is 751 m2.

This entire area participates in flood drainage of the Yen River. However, when designing the drainage culverts across the road, the planning consultant did not provide enough opening for drainage, and did not get an appropriate elevation for the centreline. This is the main cause of increased and prolonged flooding in upstream areas when water level increased on the Vu Gia.

Also in this area, the construction of Hoa Phuoc-Hoa Khuong road was about to start. On the section of the road connecting NH 1A and DT605 road, there are in total 18 culverts with minimum opening of D=1,500 m and maximum opening of 3x(3500x3000) m. There are four bridges: one west of the Yen River Bridge at 9x(5000x3500) m and 4x(5000x3500) m, Yen River Bridge at L=200m, and Tay Tinh Bridge at 6x(5000x6000) m. Total drainage area is 1,856 m2. Thus, the drainage capacity of the road is much higher than that of the ADB and the 409 roads.

CONCLUSION

CAUSES OF FLOODING

There is a tendency of more severe flooding and inundation impacts in the research areas. Urban development, along with the changes in typical characteristics of urban areas and the development of new infrastructure and houses are factors that worsened flooding impacts, which were already increasing due to climate change.

Transforming the nature and functions of urban areas in urban planning without comprehensive considerations of all factors will lead to negative consequences. While it might help to mitigate the impacts of flooding in some areas, it might also be the underlying cause for increased flooding in the surrounding areas. Therefore, calculation of ground elevation considering only the area of interest is not enough.

Construction of roads across the floodway (such as the Hoa Tien – Hoa Phong road), or infrastructure in the floodplain without thorough consideration of flood drainage direction, elevation and flows in a number of years can lead to a situation where flooding is reduced in areas downstream of the new road, but increased in areas on the opposite side. An arising issue is the considerable cost of fixing the drainage problems when flooding happens. It is necessary to consider flood drainage capacity while designing urban infrastructure, looking at both the impacts of natural flooding and of flood discharge from hydropower dams.

PROJECTION OF FLOODING

Climate change will continue to cause increased urban flooding. In the coming years, there should be more consideration of flood risks caused by the concurrence of storm surges and extreme rainfall, and management of upstream reservoirs, regulating lakes, and urban drainage channels.

IMPROVEMENT OF URBAN PLANNING FOR FLOODING AND CLIMATE CHANGE ADAPTATION

Urban planning needs to have clear integration of flooding and climate change factors. Especially, there are a few aspects that need further considerations and improvements:

- Urban development in low-lying locations should be limited to avoid raising the elevation of these areas, so that they can continue to act as buffer zones for river floods. Raising elevation of the floodway will lead to higher risks when future climate tends to become more extreme and impacts of upstream hydropower plant operation more challenging to control.
- Priority should be given to the expansion of floodway and buffer zones, the conservation of natural flood retention areas, and the restriction of structural measures that interfere with the flow of rivers.
- It is risky to identify ground elevation on the basis of historical flood survey data. Better methods should be investigated. The dynamics of regional interactions—including those between an urban core and its satellite areas—should be taken into account when identifying ground elevation level in detailed planning. Emphasis should be on suitable phasing of investment to prevent development in urban core area to negatively affect satellite areas.
- In the face of worsening climate change and sea level rise and increasing precipitation, flood levels will continue to increase. There must be proper measures to protect human lives and assets in this prospect.

RECOMMENDATIONS FOR BETTER URBAN DEVELOPMENT AT THE NATIONAL AND CITY LEVELS

There is a tendency of increased flooding, affecting the lives of communities, especially in peri-urban areas. Urban planning and urban development procedures need to be further improved and integrated with proper technical measures. Based on the research results, we propose the following recommendations to government authorities across levels:

MINISTRY OF CONSTRUCTION

- The ministry should explore and start the development and approval of regional plans, which will provide the basis for cities within the region to develop their plans, review and implement these plans in accordance with the regional plan. At the same time, there should be a mechanism for managing approved regional plans to facilitate the coordination and mutual support of provinces and cities in all areas of socio-economic development and urban development.
- There should be a mechanism to control the implementation of urban master plans to prevent diversion of implementation from the approved

plans or failure to meet revision timeline, etc. Issues emerging in the development process need to be resolved in a collaborative process and in a timely manner.

DA NANG CITY PEOPLE'S COMMITTEE

- Collaborate with provinces in the region, especially Quang Nam province, in developing a plan for flood drainage, to protect the safety of downstream communities.
- Provide detailed regulations to limit urban development in low-lying areas, floodway areas, especially in the southern area of the city.
- Focus on conducting strategic environment assessment for master urban plans, and environment impact assessment for urban development plans. Review urban plans to increase green coverage, public spaces, and create new natural flood storage areas.
- Consider and adjust the ground elevation requirements for construction in urban areas to reflect the requirements of climate change adaptation, reassess flood risks of Hoa Xuan and Hoa Quy urban areas to devise suitable adaptive measures.

DA NANG DEPARTMENT OF CONSTRUCTION

- Develop a mechanism for the coordination between relevant agencies and organizations in the appraisal of plans, evaluation of construction design for consideration of flooding and climate change adaptation.
- Investigate and propose reviews of development plans of new and renovated urban areas to create a corridor for flood drainage (for areas such as Hoa Vang, Cam Le, Ngu Hanh Son and Lien Chieu districts); propose regulations to prohibit or limit construction in these areas; and share with the communities so that they are aware of and follow the regulations.
- Research urban drainage and flood drainage plans and use the information as the basis to propose new standards of ground elevation to take climate change into account, and to provide instructions to investors and local people in building their houses and facilities, with a focus on Dong Hoa and Tay An hamlets of Hoa Chau commune, and Cam Ne and Bac An hamlets of Hoa Tien commune.
- Investigate and develop the plan for flood drainage corridors along the city's main rivers: Yen, Qua Giang, Vinh Dien, Cau Do, Cam Le, Tuy Loan and Han, and flood drainage for small but critical areas such as Hoa Trung and Phu Loc. While the flood drainage corridor plan is not yet available, it is important to make sure no new projects or plans interfere with existing floodplain, riverbank and river bed areas.
- Focus on conducting strategic environment assessment and environment impact assessment for urban development planning and implementation.
- Continue to finalize technical infrastructure plans to (1) explore and plan new regulating

lakes to reduce the pressure on the drainage infrastructures and rivers, specifically in Hoa Xuan ward of Cam Le district and Dong Hoa hamlet of Hoa Chau commune; (2) explore and propose standard for ground elevation combined with drainage infrastructures, dykes, and reservoirs; (3) explore house designs suitable for the existing residential areas in the flood zone, specifically for Dong Hoa and Tay An hamlets of Hoa Chau commune and Cam Ne and Bac An hamlets of Hoa Tien commune; and (4) update and use the hydrological model for consultation in the appraisal and approval of urban architectural space plans and urban infrastructure plans. It is necessary to use the model to recalculate flood levels in the city, especially considering new infrastructures and alternative infrastructures located in between existing infrastructures and areas.

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