Outline of the Waterlog and Flood Prevention Solutions in Ho Chi Minh City

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Key words: *Waterlog, Flood prevention, Land deformation*

SUMMARY

Ho Chi Minh City has a great potential for developing industry, exports, tourism and services. At present, however, residents of the city must confront flooding every year during the rainy season. The city had 95 flooding-prone areas that may be caused by heavy rain, high tide, rain & tide, poor drainage, water release by hydroelectric dams and land subsidence combined with a global sea level rise.
Flood prevention has been one of the biggest preoccupations of HCM City authorities and many projects have been implemented but most of them are not effective. This paper will discuss current understanding of changes to flood regimes in urbanizing regions, their consequences for vulnerability of different social groups and what actions should be taken now to reduce risks of flood disasters in HCM. The information also provides interesting insights into future cooperation between Viet Nam National University and international organizations.

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1. INTRODUCTION

Ho Chi Minh City (former Sai Gon) is situated by the Sai Gon River in the centre of the Cuu Long delta and the Southeastern part of South Vietnam. HCM city has population 7 mil. people, 2095 km2 area and great potential for developing industry, exports, tourism and services. At present, however, residents of HCM City must confront flooding every year during the rainy season. Flooding may be caused by heavy rain, high tide, rain & tide, poor drainage, water release by hydroelectric dams and land subsidence combined with a global sea level rise. Flood prevention has been one of the biggest preoccupations of Ho Chi Minh City authorities and large-scale work are carrying out such as: construction of new sewers, repair of existing drainage systems, excavation of canals and reinforcement of the banks, demolition of housing built on piles,... Many projects have been implemented but in fact most of them are not effective, because city continues to suffer many serious floods. The city had 95 flooding-prone areas last year and the number of such sites is expected to be higher this year, because most of the previous solutions did not seem to be able to solve a problem that can prevent the circulation of surface water and cause new forms of flooding.

This paper will discuss current understanding of changes to flood regimes in urbanizing regions, their consequences for vulnerability of different social groups and what actions should be taken now to reduce risks of flood disasters in HCM City.

2. OVERVIEW OF WATERLOG PROBLEMS

a) Heavy rain caused floods: Ho Chi Minh City's tropical climate has two seasons: a rainy season (May to November) and a dry season. Rainfall is abundant, with annual rainfall exceeding 2,000mm of which about 80% is received during June and September, namely during the flood season. Rainfall max. is 200mm/day and maximum rainfall intensity is about 50mm/hr. Heavy rains flooded many streets causing traffic jam and environmental pollution. Hundreds of houses were flooded by 30- 40 cm and water receded after three or five hours. Rapid urbanization and infrastructure works are degrading, which leads to obstruction of the drainage system. Due to a lack of sewers in the new suburban district and many newly-built streets don't have drainage systems yet. Therefore, the flood waters are difficult to be released out of the central area of the city, which might easily cause the water logging.

Fig. 1 Flooding was caused by heavy rain

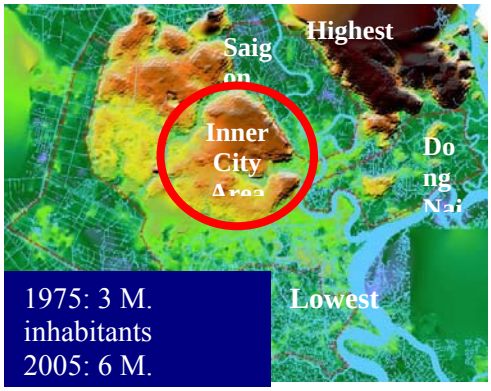

Fig. 2 Topology and population of HCM

The city natural land area is 2,095 km2 and the high land areas are mainly located at the north (highest elevation: +10 m) the plains is in the southwest parts and south parts (lowest: 0.5 m).The Saigon River and Dong Nai River are two major rivers encompassing the lowland with current max tide level: +1.48 m. The city's official population has increased from 3 million people in 1975 to 6 mil. people in the middle of 2005 and the plan to develop city until year 2020 (the population will reach 10 millions). Since 1985s the expansion of urban areas into flood plains and wetlands is one reason as it places additional people and infrastructure at flood risk. In addition to various problems including frequent floods were caused due to the lack of proper governance on infrastructure making, the widespread fill-up of branch of rivers and due to the existing shanties along the canal all over the city. Flooding in HCM City has become worse over the past five years, despite city's efforts to gradually solve the above issues for improving the urban drainage system.

b) Flood due to combined effect of tide and water release by upstream areas: A large number of urbanized zones are situated at a very low elevation and along the canals; the hydrographic system of HCM City is subjected to the influence of the semi-diurnal tidal flow regime, with considerable seasonal variations. In the event of dry season, flooding may be caused by the high tide, because City has 60% of area that ground elevation level is below +1.5m (max. tide level: +1.48m) and due to most of the outlying dykes and embankments are in poor condition. The heavy rain and freak tides flooded many streets, homes and schools,

and also damaged entire sections of retaining banks and walls along the river. Residents in many wards suffered water-logging of between 0.4-0.5m. On the other reason, flooding may be caused by water release by the Tri An and Dau Tieng reservoir on the upper Dong Nai and SaiGon river, where the water level reached 22.68m. The excess water was to be released at the rate of 300m^3/s. The HCM City make a proposal for a project to build the three embankments that are planned to be 200km in length and will be raised along the SaiGon river's banks. These measures will reduce the threat of future flooding as climate change causes sea levels to rise. In the case that climate change could cause sea levels to rise by 70 cm. Without dikes, about 300 km2 of land in the city could be flooded. The question rose that land subsidence combined with a global sea level rise creates a serious flood problem in HCM City?

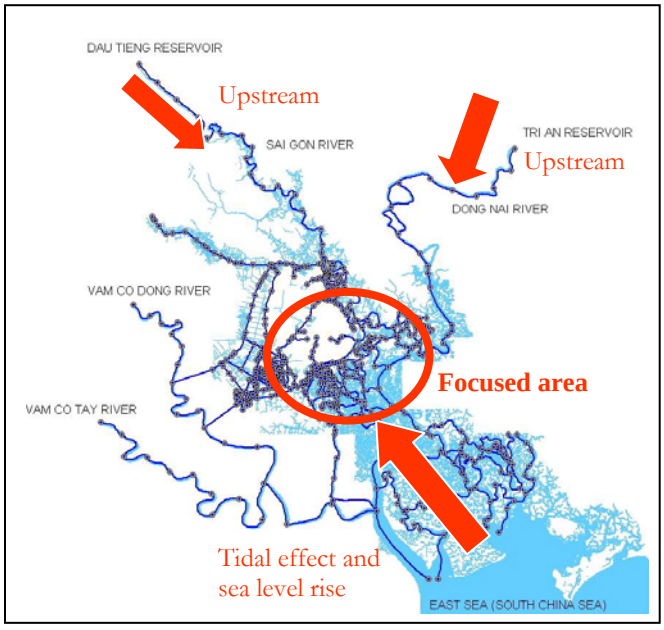

Fig. 3 Effect of tide and water release by upstream areas

c) Flood due to combined effect of tide and land subsidence:

Rapid increase of ground water use started in 1990 when HCM City were urbanized with some new districts, people and the industries used ground water as the main water resource. Ground water exploitation was estimated at about 650,000 m^3/day (in 2005) and the expansion of surface water works in city has not met this rapid increase. Besides, until now free of charge ground water and uncontrolled exploitation has increasingly augmented the exploitation rate. HCM City locates at the soft soil, the ground water use was in a large scale, ground water level decreasing (>20m from 1990 until now) caused deform of soil which makes the ground level goes down. The more ground water use the more land subsidence will happen and land deformation at the rate of few centimetres per year can be measured at the heavy

Fig. 4 Effect of tide and land subsidence

ground water pumping stations. Land subsidence (average velocity > 6mm/year) has resulted in tides moving into low-lying areas that were previously above high-tide levels. Each year, climate change could cause sea levels to rise by 3mm and in the mean high tide level, water level in rivers is higher than the ground level. Most of the river area in city becomes on-ground river and land subsidence makes the situation even worse.

Land subsidence made original leveling height lapse and deteriorates flood prevention situation through knocking down the ground elevation. This involved certain difficulties for tide line analysis, flood prevention plan and management.

On general we can clearly see that the land subsidence has caused so dangerous situation in flood prevention now in HCM City and the ground water still plays a non-replaceable role in water supply for the city. At present, however, the ground water is under threat due to salt water intrusion and the city really needs a suitable solution in flood prevention for sustainable urban development. Until now, no accurate researches on land subsidence monitoring have been done in HCM City.

3. SOLUTIONS FOR FLOOD PREVENTION

The city had 95 flooding-prone areas last year but the number of such sites is expected to be higher this year because:

- many newly-built streets don't have drainage systems yet.
- rapid urbanization over rice fields that once surrounded HCM City
- due to a lack of sewers in the new suburban district
- the widespread fill-up of rivers and canals all over the city
- ground level becomes lower because of land subsidence and tide level becomes higher and higher because of the climate changing.
- most of the outlying dykes and embankments are in poor condition

Owing to its location, HCM City is subjected to numerous climatic and geographic hazards and street waterlog often happens in rainy season in city. The sewer network has developed in a fragmentary fashion, without being coordinated at the level of the entire metropolitan territory.

At present, HCM City authority sets up the for center flood prevention with functions such as research, building of flood-tide control strategies and methods, plans of urban drainage, collection and analysis of a database relating to flood areas, and forecasting floods to advise prevention

Fig.5 Solutions based on the zoning concept.

measures. In addition, this center will make zoning and appraisal of the flood prevention and drainage programs, advise investors of flood prevention investment projects and check the process of carrying out the projects.

A group of local scientists proposes a three-phase plan, with the first phase to ease the chronic problem of flooding from high tides and heavy rain in the city's downtown and central areas. The second and last phases will lower the water levels in tributaries of the Saigon River that run through and around the city and complete the dike system. These measures will reduce the threat of future flooding as climate change causes sea levels to rise. The study, however, does not specify a time frame for the phases and now HCM City need a new assessment of land subsidence and sea level changes in flood prevention.

a) Application of Remote sensing and GISS for Monitoring riverbank changes:

Flooding in HCM City has become worse over the past five years despite efforts to reduce flooding. One of the reasons is the fast-growing urbanization process and the widespread fill-up of rivers and canals all over the city. Urban Upgrading Project is a new effort by the municipal People's Committee to battle the city's ongoing flooding problems. The main goal is to remove all the existing shanties along the canal, and gradually solve the environmental issues for more than 100 km of urban canals. Because sludge accumulates in the bed of the canals and the water is totally polluted. Each day, the canals are growing increasingly stagnant, which reduces their drainage capacity and causes to the present flooding situation.

Fig. 6 Existing shanties along the canal

In order to analysis of a database relating to flood areas, we proposed a tool for monitoring riverbank changes to serve the flood prediction based on the integration of Remote sensing and GIS.

Fig. 7 The widespread fill-up of rivers and canals

The main objective is to manage the widespread fill-up of rivers and canals all over the city and find out the regulation of standards, guidelines, policy and plans relating to using sewer systems and other facilities, conservation of rivers,… from the standpoint of environmental conservation. The preliminary results indicated that the tools for monitoring riverbank changes was suitable used for to serve the flood prediction. Thus, a suitable solution for developing a sustainable urban drainage system will be set up and what actions should be taken to reduce risks of flood disasters in HCM City.

b) Solution for land subsidence monitoring

There are many factors effecting land subsidence, but almost subsidence areas in many cities of the world are caused by human's activities, in which the groundwater large exploitation is the most important factor. HCM City locates at the soft soil and has the five aquifers, namely, (i) Holocene, (ii) Pleistocene, (iii) Upper Pliocene, (iv) Lower Pliocene and (v) Mesozoic. Three of five aquifers play an important role in water supply for this city: Pleistocene aquifer (20–50 m), upper Pliocene aquifer (50–100 m) and lower Pliocene aquifer (100–140 m). Until now, ground water level is decreasing (annual drawdown: 2m depth at the heavy ground water pumping stations) that may cause deform of soil due to ground water extraction. The ground level goes down at the rate of few milimetres per year that can be measured at the heavy ground water pumping stations. Land subsidence has resulted in tides moving into low-lying areas that were previously above high-tide levels. Each year, climate change could cause sea levels to rise by 3mm and in the mean high tide level, water level in rivers is higher than the ground level. Most of the river area in HCM city becomes on-ground river and land subsidence makes the situation even worse.

We proposed a project under the name "Measuring land surface deformation in HCM City using PSInSAR technique". This project conducted at the end of year 2008, the Envisat ASAR images (from 2003 to 2004) are used which cover central and the northern parts of the city. Evaluating the preliminary result of land subsidence from radar interferometry in HCM City showed that due to the strong groundwater extraction has led to the subsidence of some areas in the city. Ground deformation at the rate of 2cm/year can be measured at the heavy ground water pumping stations. The result also shows the flooding-prone areas that may be caused by high tide and rain & tide and land subsidence combined with a global sea level rise in Southwest region of HCM city.

Figure 8 shows the relationship connecting the flooding-prone areas that may be caused by high tide and land subsidence in the PSInSAR results in Southwest region.

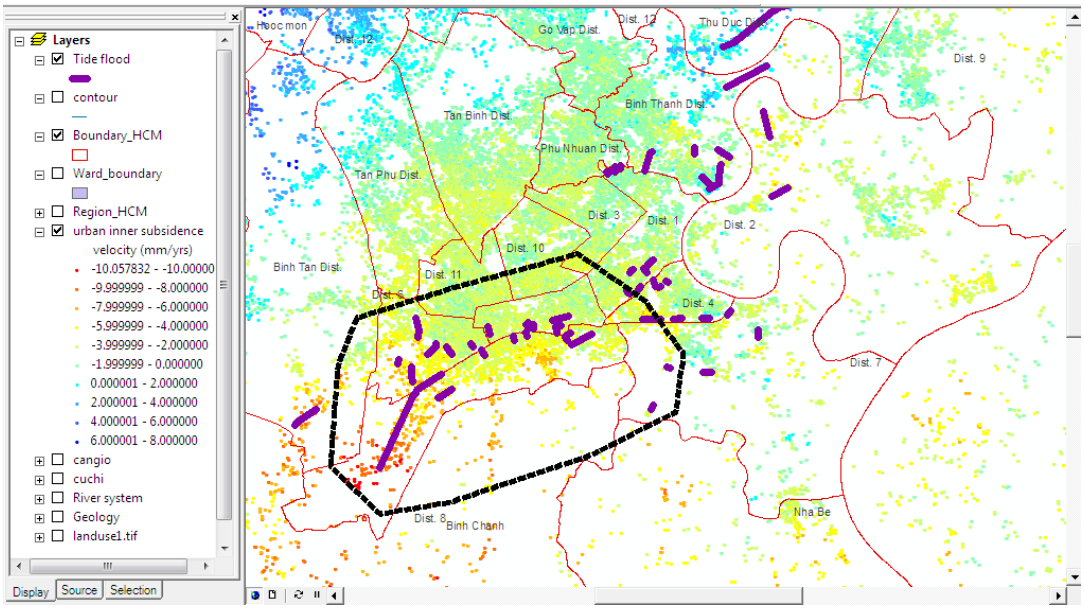

Figure 8: PSInSar results and tide flood sites

4. CONCLUSION

HCM City locates at the soft soil and the low elevation of the land, rivers and canals form a complex network that is affected by tide. Heavy rain, land subsidence combined with a global sea level rise creates a serious flood problem in the city. The city had 95 flooding-prone areas and many projects have been implemented, but most of them are not effective. Besides continued *hard traditional drainage engineering*, it is needed to pay attention to land subsidence made original leveling height lapse and deteriorates flood prevention situation through knocking down the ground elevation.
HCM City would like to invite scientists and experts to work out measures to deal with the problem to ensure sustainable development for the city.

- The tendency of land subsidence must be predicted and some suggestions should be given on how to solve this problem in the future?
- The comprehensive measure should be applied to prevent groundwater and control water quality.
- Flood due to combined effect of tide, storm water and river water coming from upstream area. What is a suitable solution for sustainable urban drainage system?

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