Engineering Solutions for Management of Water and Land Subsidence in Ho Chi Minh City
HCMC is facing the following water problems:

- Flooding due to storm water, upstream water, tidal rising, climate change, natural conditions, deforestation, rapid urban development and population growth.

- Land subsidence due to groundwater lowering, consolidation settlement of a soft clay and construction of new projects.
Abstract

- Contamination of water, soil and air from activities of people, low quality of wastewater treatment systems and lack of infrastructure facilities.

- Erosion and collapse of river banks and instability of a dike due to the increase in water velocity, water volume, water level of rivers and soft soil conditions.
Abstract

The proposals and recommendations for water and land management in HCMC:

- Available engineering solutions to enable the mitigation of floodings and reduction of land subsidence.

- The adaptation of innovated engineering solutions and green technologies to HCMC conditions.
Abstract

- Integrated solutions, combining existing and new ones.

- Proposed pilot projects using new engineering solutions and technologies.

- International cooperation to make the best combination of knowledge, skills, expertise for sustainable development and for a better quality of life with environmental ethics.
1. Introduction

1.1. Water is the most important element of our life.

The Cycle of water and 5 basics materials according to our philosophy:

- Water => Trees => Fire => Earth => Gold => Water
- Love => Courtesy => Appreciation => Intelligent => Confidence
1. Introduction

The volume of water and cycles of water

1. The sun heats the ocean.
2. Ocean water evaporates and rises into the air.
3. The water vapor cools and condenses to become droplets, which form clouds.
4. If enough water condenses, the drops become heavy enough to fall to the ground as rain and snow.
5. Some rain collects in groundwells. The rest flows through rivers back into the ocean.
1. Introduction

Shows the life and behavior of the water after the earthquake Hanshin-Awaji occurred and three months later (by Dr. Masaru Emoto)
1.2. Causes of Flooding

**Natural causes**
- High rainfall
- Flooding often occurs in low-lying lands
- Snowmelt
- Coastal flooding

**Human causes**
- Deforestation
- Poor farming
- Overgrazing
- Over-cultivation
- Hydropower plant
- Poor water management
- Population growth and other causes
1. Introduction

1.3. Causes of Land subsidence

- Ground water lowering due to water pumping.
- Construction of embankment, roads, and buildings.
- Consolidation settlement of a soft clay.
1. Introduction

In honor of Dr. Poland’s 40 years of research on land subsidence
2. Natural conditions and water problem of HCMC

Map of Geology conditions
Map of Geological and Geotechnical Conditions
2. Natural conditions and water problem of HCMC

Map of Geological and Geotechnical Conditions
2. Natural conditions and water problem of HCMC

Map of Environmental and Geology Conditions
2. Natural conditions and water problem of HCMC

Prediction of sea water rising due to climate change A
Prediction of Land subsidence due ground water lowering

Tidal level after 47 years

Land subsidence due to ground water lowering after 47 years
47 years \times 15\text{mm/\text{year}} = 700\text{mm}
3. Engineering solution and integrated solution to reduce flooding and land subsidence.

3.1. Recovery of groundwater of stormwater using Wils system

*Project Spreewald, Thermal Burg. Client Hochtief Construction AG Cot bus*
3.1. Recovery of groundwater of stormwater using Wils system

Procedure of Hydraulic pressure
3.1. Recovery of groundwater of stormwater using Wils system

Sample of Infiltration of water with injection technology.
Total Area: 500 m²
3.2. Storage of storm water underground

- Infiltration basin
- Detention basin
- Harvesting Cistern

Storm water infiltrates into the underlying soils (percolation).

Peak flows are attenuated using an outlet control structure.

Rainwater is filtered and stored for later use such as irrigation and non-potable water usage (e.g., toilet flushing, laundry, fire suppression).

Applications Subsurface storm water infiltration/Detention/Harvesting
3.2. Storage of storm water underground

Storage of rain water for secondary use
/RainWater Harvesting
3.2. Storage of storm water underground

- With Rainwater Harvesting/Stormwater Detention System in High Rise Building with water reuse
- With Rainwater Harvesting with water reuse for flushing the toilet
- With Rainwater Harvesting/Stormwater Detention system in Flattened Factory
- With Rainwater Harvesting with water reuse for gardening

Applications
3.3. Waste water treatment using Hofmann, Klaro UTP system

KLARO system
3.3. Waste water treatment using Hofmann, Klaro UTP system

Công nghệ hoàn toàn sinh học. Chuyên xử lý nước thải sinh hoạt

Thiết kế mở đun linh hoạt. Áp dụng cho các khu dân cư, đô thị, nhà hàng,...

Chi phí đầu tư và vận hành thấp, Hiệu quả tối đa

Làm sạch 98%
Trong 6 tiếng

Rất ít tiếng ồn,
Tương đương 01 tủ lạnh

Không hóa chất, cơ học, điện,
bơm và màng lọc. Không dây tác
Dụng phụ tới môi trường

Tiết kiệm năng lượng tiêu thụ
Tối 75% so với các hệ thống khác
3.3. Waste water treatment using Hofmann, Klaro UTP system

Thải nước đã xử lý và chuyển bùn lắng về ngăn đąu

Chu trình phản ứng mè

1. Bom nước
2. Phản ứng dùng khí nén
3. Lắng Đông
4. Thái nước đã xử lý và chuyển bùn lắng về ngăn đąu
3.4. Smart tunnel for water drain

The water flow and road for cars.

The Smart tunnel can be used for water drain system and transportation system
Cross section of smart tunnel of KL, Malaysia
When the flooding is occurring, the tunnel is used only for water drain to prevent flooding
3.4. Smart tunnel for water drain

Three alternative to use smart tunnel, depending on the volume of stormwater

- **For flood discharge recedes to 70 cumecs**
  - 2 motorways open
  - 1 deck = 1 traffic sense
  - 1 stormwater open

- **For flood discharge between 70 to 150 cumecs**
  - 1 motorway open
  - 1 deck = 2 traffic sense
  - 2 stormwaters open

- **For flood discharge exceeds 150 cumecs**
  - The full stormwater operation of the SMART, which is expected once or twice a year
3.4. Smart tunnel for water drain

Underground floodway in the city of Tokyo to prevent damage
(Ministry of Land Infrastructure and Transport, 2005)
3.5. Other solution to make the reduction of storm water run off

**Engineering solutions and technologies for design and construction of a new dike system**

a. Soil improvement using
   - Cement columns or
   - Sand compaction pile or
   - Vertical band drain
   - Mini piles
   To prevent or reduce the settlement of a dike or embankment and increase the bearing capacity of soft clay as well as stability of a slope.

b. Compacted soil
c. Reinforced soil using geotextiles
d. Protection of water and strengthening of the bearing capacity for traffic
   - Consolid + cement + soil
   - Protection of erosion impact

*Design and construction of a dike system*
3.6. Water management

- Returning water to living with nature
- Monitoring of water
- Control of water pumping
- Control of floods
- Control of waste water
- Control of water quality
- Reuse, recycling of water
- Education
3.7. Integrated Solutions for management of water and Land subsidence

Integrated solutions for mitigation of storm water and reduction of the land subsidence
3.8. Pilot Projects

a) Objectives

Comprehensive Reports on:

- Causes of flooding and land subsidence.
- Data Bank for monitoring of land subsidence due to ground water lowering.
- Prediction of land subsidence and rise in level of river water.
- Integrated solutions for mitigation of flooding and land subsidence.
3.8. Pilot Projects

b) Pilot Projects for

- Improvement of existing water drains system.
- Storm water storage and infiltration to increase ground water table.
- Design and construction of dike or improvement of existing dike in soft clays.
- Adaptation of a new technology from Germany and other countries to Vietnam.
3.8. Pilot Projects

- Monitoring system: settlement, stability, discharge capacity, ground water lowering and other.
- Investment in the quality of human resources.
- Improvement of water and land management.
- Participation of social society, professional engineers, public and private sector.
c) Plan of actions and methodology

- Collection of all existing data.
- Additional investigation.
- Establishment of a monitoring system
- Modeling and analysis.
- Selection of different solutions.
- Conduction of a feasibility study.
- Seminar, workshop, courses, publication..
3.8. Pilot Projects

- Design and construction
- Observation
- Evaluation
- Lessons learned
- Reports and recommendations
3.8. Pilot Projects

d) International Cooperation

- Preparation of a proposal project
- Time schedule
- Estimated cost
- Supports from Governments
- Participation of: Universities, Organization, institutions, Companies, and other
- Contributions
3.8. Pilot Projects

- Expected results.
- Key persons.
- Key words for cooperation
  - RESPECT
  - COMBINATION
  - ADAPTATION
  - FLEXIBLE
  - OPEN
  - LOVE
  - VALUE
  - FRIENDSHIP
  - APPRECIATION
4. Conclusions

4.1. Flooding in HCMC is increasing with time, due to the following causes

- Land subsidence due to groundwater lowering, land reclamation, land filling, constructions of new projects and consolidation settlement of a soft clay.
- Low land lying level, about 60% of the land area is less than +2.0.
- Increasing the maximum level of tide to +1.58 meters.
- Upstream flow water from reservoirs.
4. Conclusions

- Overloaded water drain system
- Reduction of the volume and discharge capacity of rivers, lakes, canals.
- Rapid urbanization, increased concrete area.
- Increase in the intensity and frequency of storm water.
- Lack of good tools for water and land management.
4. Conclusions

4.2.
- Land subsidence with the rate from 10mm to 30mm/year and rise in tidal level or river water level with the rate 3mm-10mm/year are occurring at the same time.

- Land subsidence will create more risks, losses, damage and environmental impact than water level rise.

- Further studies needed to obtain reliable data and monitor results for a better understanding, analysis, evaluation and predictions.
4.3. Conclusions

• The existing solutions for mitigation of flooding, storm water are concentrated on the construction of new dike system, water gate, new drain water system or improvement of existing drain water system.
• The new dike system in soft clay will produce high value of settlement and need to be improved, restored or protect the erosion and slope stability.
• Studies on the reduction of discharge capacity of storm water from the city to river due to dikes need to be carried out.
4. Conclusions

4.4. The water and land management related to flooding, land subsidence, usage of land and water, waste water, storm-water is controlled and implemented by many organizations, authorities, ministries. Therefore, it is rather difficult to have integrated solutions and administrations.

4.5. There are not yet national and international projects or research works with comprehensive reports and reliable data for a better understanding, analysis, prediction and comparison between different alternative solutions.
4. Conclusions

4.6. Lack of a new technology for design and construction of dike, water drain system, waste water treatment, storage of storm water,.... and monitoring system for mitigation of water and land subsidence.

4.7. Limitation in the reuse, recycling of water

4.8. Lack of education and training course on water and land management, as well as conservation of water

4.9. Lack of environmental ethics and professional consulting services for water management.
5. Recommendations

5.1. The Management of water and land need to take into account:
- Climate change
- Land subsidence
- Ground water pumping
- Shortage of water and energy
- Health
- Prediction of Challenges and Risks
5. Recommendations

5.2. It is recommended to establish the research project for monitoring of ground water, flooding and land subsidence:
- To establish the well system to observe the ground water lowering.
- To establish the benchmark and stations for the monitoring of the land subsidence.
- To make the monitoring of settlement in new construction and land reclamations.
- To establish the monitoring system of flooding.
- To make the prediction of land subsidence and rise in water levels of rivers.
5. Recommendations

5.3. To carefully design and construct a new dike system. It is not recommended to focus on this solution. It is important to consider the settlement and slope stability of a new dike as well as the water flow in natural conditions.

5.4. It is not recommended to develop cities in the South, East and areas where the thickness of soft clay is great.

5.5. It is recommended to conduct cleaning of rivers, lakes and open canals in order to increase the capacity of discharge.
5. Recommendations

5.6. It is important to make the regulation of flow water from upstream reservoirs.

5.7. It is important to increase green areas in city.

5.8. It is recommended to build Pilot Projects using combined engineering solutions.

5.9. It is recommended to build Pilot Projects using underground storage and infiltration of rainfall in order to increase the levels of groundwater, to reduce the land subsidence. The technology from Germany can be adapted to Vietnamese conditions.
5. Recommendations

- Filter 1
- Filter 2 for pretreatment
- Deposit of remained mud
- Flow of water
- Storage tank
- Well
- Pump
- Air pressure to accelerate water speed
- Sand layer

Rain Spot for collect storm water, storage of water and recharge of water to increase ground water table
5. Recommendations

5.10. It is recommended to make the adaptation of other engineering solutions to mitigate flooding such as:
- Smart tunnel for water and transportation (Experiences from Malaysia and Japan)
- New dikes system using new engineering solutions and technologies.

5.11. It is recommended to use Hofmann-Klaro-UTP (Germany) and other technologies for treatment of waste water. It is recommended to build mini plants of waste water treatment. It is not recommended to build a large waste water plants as planned.
5.12. It is recommended to make the separation of storm water and waste water drain system.

5.13. It is recommended to have new research projects for integrated solution.

5.14. The international Cooperation plays a very important role for engineering solutions, technology and innovative ideas or water and land managements. The proposal from our friends and colleagues from Germany are carefully prepared and of great value for our development. The knowledge, expertise, skill, engineering solutions and technology from Germany are very valuable for our sustainable development.
5. Recommendations

5.15. To introduce new programs for education and training on water and land management. We need to build up environmental ethics and strengthen the responsibility of our people on usage of water and land for sustainable development.

5.16. It is recommended to promote the participation of social organizations, societies, experts in this important Project. The government, Ministries and People Committee of HCMC can assign the tasks and/or research Project to Professional Societies and private sectors as well as individuals with innovative ideas. Vietnam Society for Soil Mechanics and Geotechnical wishes to take part in this important Project.
Thank You!