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Micro-Scale Flood Hazard Assessment in Phnom Penh City, Cambodia

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I. Introduction

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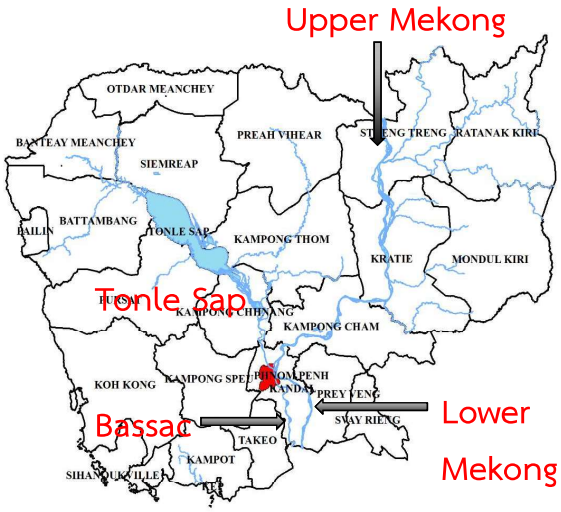
- **Phnom Penh** capital, located at the confluence of the Mekong River, Tonle Sap River and Bassac River, is the political, economic and cultural center of Cambodia.
- Area: 678.5 km^2
- Population ≈ 2.0 million (NIS, 2017)



I. Introduction

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Flood Problem in Phnom Penh

After heavy rainfall

Source: The Phnom Penh Post, Urban Voice

II. Objective

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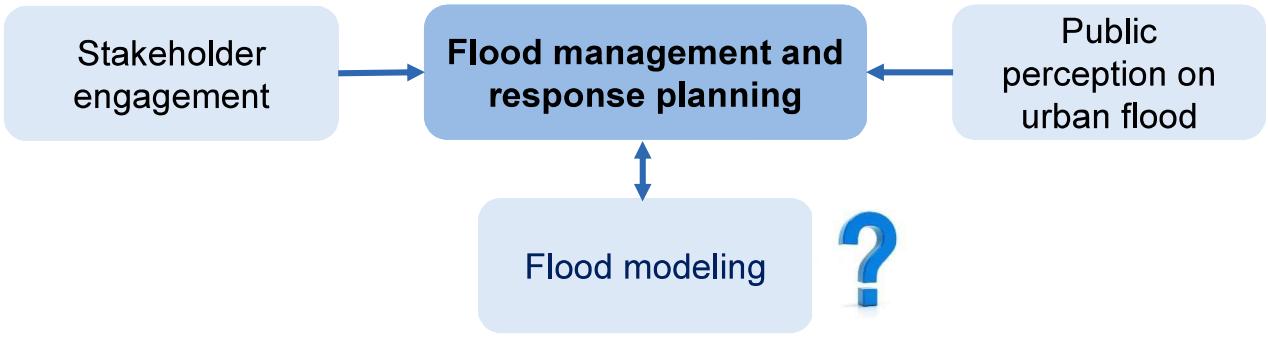
Research on urban flood management in Phnom Penh



Do : Visual representation of urban flood

Help : Making decision for land-use planning, limiting development in flood-prone areas

❖ The objective of this study is to simulate inundation situation in a downtown area with the complex storm drainage system in Phnom Penh using FLO-2D model.

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III. Methodology

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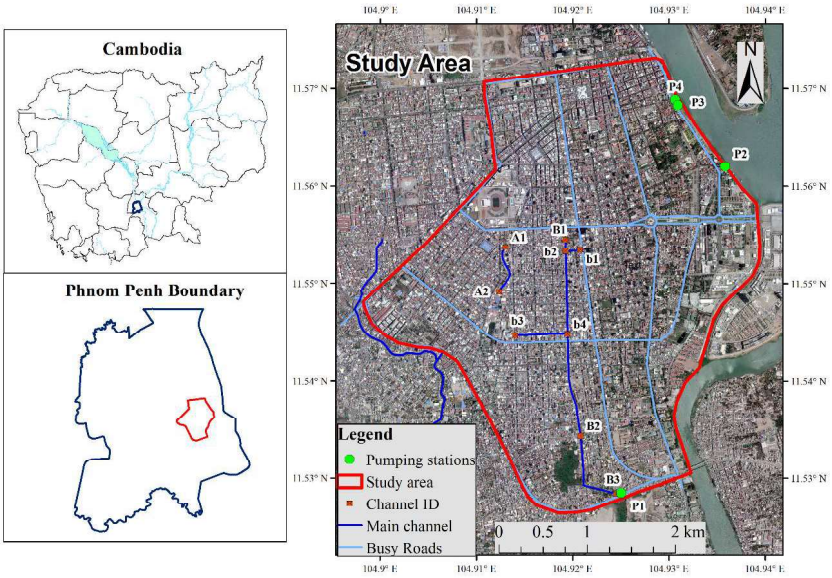
Study area: a small catchment in Phnom Penh

- Area: **12.5 km²**
- Mean precipitation: **1,200 – 1,500 mm/year**
- Elevation: **4 – 20 m amsl**
- Consists of **residences, commercial companies, busy roads** and **many municipal administrations**.
- **Frequently** having inundation during rainy season **(Sokchhay, Kimleng et al. 2017)**



- There are **4 pumping stations**
- Water drains from **north** to **south**
- Drainage system: closed conduit and open drainage

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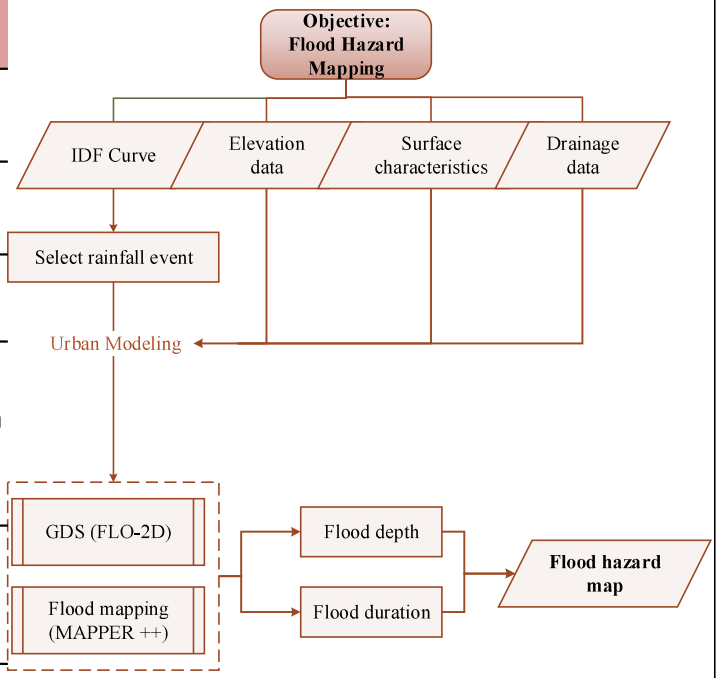
Available data

No	Data type	Time period	Frequency	Source
1	Rainfall	2010-2016	5 min	ITC
2	IDF curves	-	-	JICA
3	DEM	2016	2m x 2m	MRC
4	Drainage system	2010 & 2015	-	Phnom Penh Capital Hall
5	Phnom Penh Image	2016	2m x 2m	MRC

Overall framework



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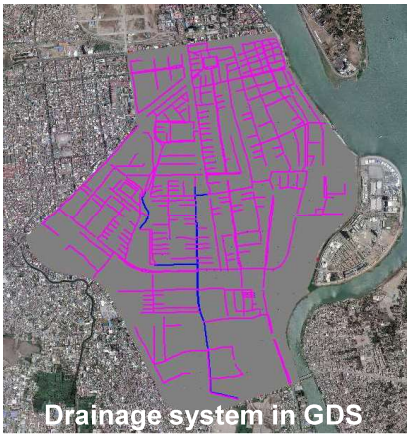
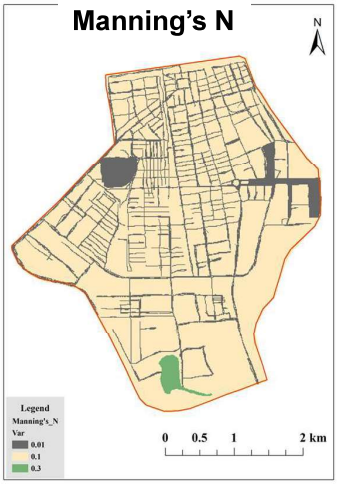
Flood simulation

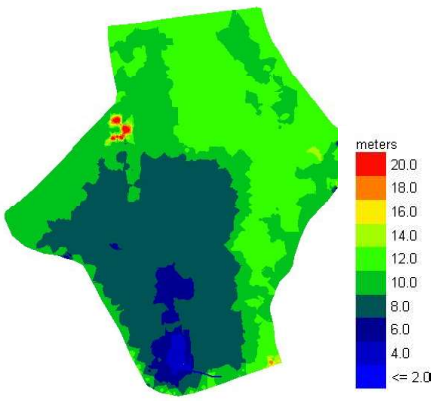
- Develop grid in GDS: 10 m x 10 m
- DEM => Grid element elevation
- Channel, street, building
- Assign n-values based on land-use
- Set up pump capacity
- Drainage system set up in SWMM

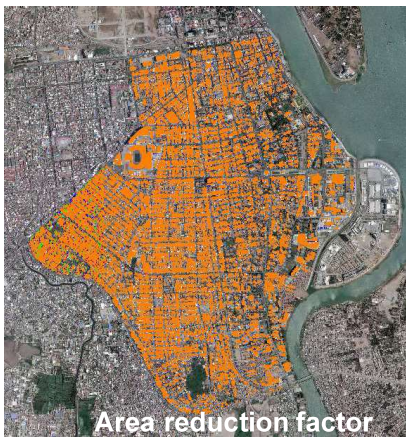


Manning's N



Ground surface elevation





Flood simulation

- Hazard index for depth of flooding

Depth (D) of flooding (m)	Flood depth category	Hazard index
D ≤ 0.3	Low	1
0.3 < D ≤ 0.6	Medium	2
D > 0.6	High	3

- Hazard index for duration of flooding

Duration of flooding	Flood duration category	Hazard index
Areas flooded in one of three inundation maps	Short	1
Areas flooded in two maps of three inundation maps	Medium	2
Areas flooded in three inundation maps	Long	3

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III. Methodology

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Flood hazard mapping

- Hazard index for combination of two parameters

No. Scenario	Function of flood depth and duration	Hazard index	Hazard category
1	D ≤ 0.3m and short	1	Low
2	D ≤ 0.3m and medium	1	Low
3	D ≤ 0.3 m and long	2	Medium
4	0.3m < D ≤ 0.6m and short	1	Low
5	0.3m < D ≤ 0.6m and medium	2	Medium
6	0.3m < D ≤ 0.6m and long	3	High
7	D > 0.6m and short	2	Medium
8	D > 0.6m and medium	3	High
9	D > 0.6m and long	3	High

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IV. Results and discussion

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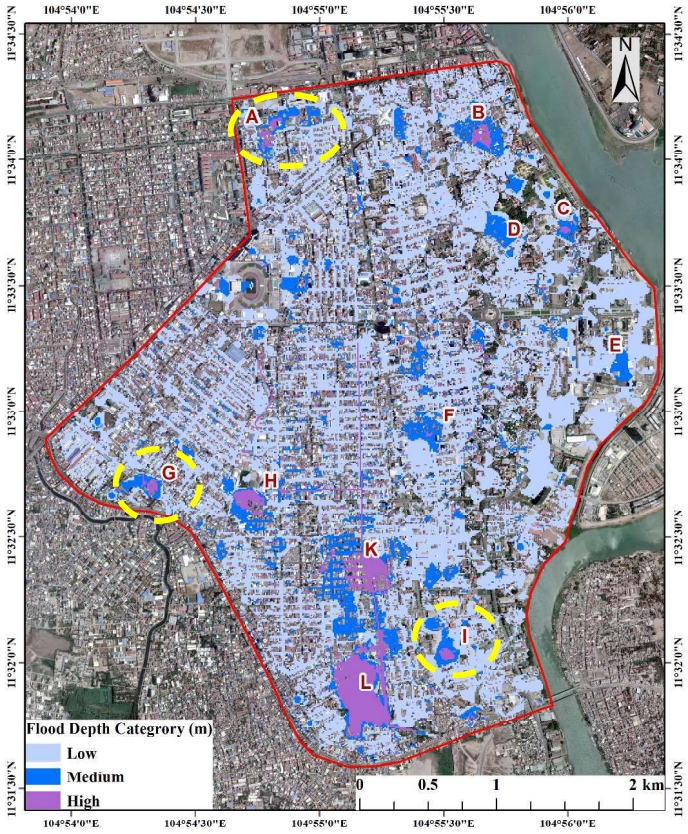
Hazard of flood depth



Flood depth category	Inundation area (km^2)	Percentage of flooded area (%)
Low	8.64	69.10
Medium	0.93	7.50
High	0.43	3.40

*Total area is 12.5 km^2

**Non-flooding area is 20.0%

- Almost the whole of study area is suffering from flood.
- Some uncertainty due to deficiency of drainage system data set up in the model.

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IV. Results and discussion

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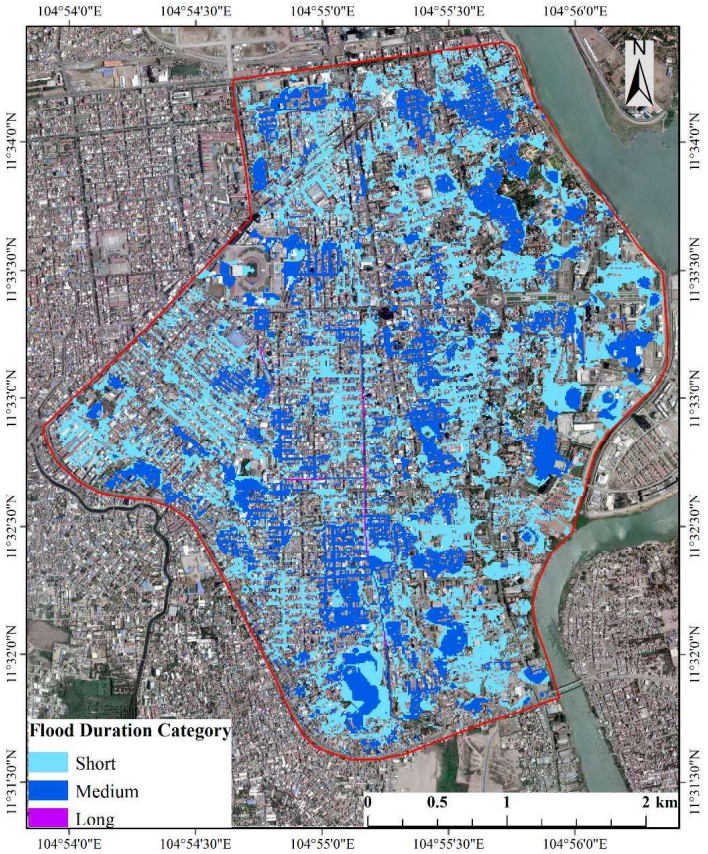
Hazard of flood duration



Flood duration category	Inundation area (km^2)	Percentage of flooded area (%)
Short	3.28	26.24
Medium	2.32	18.56
Long	0.14	1.12

*Total area is 12.5 km^2

**Insignificant effected area is 45.92%

- The map of flood duration is produced **with the receding flood map with 6 hours after rainfall has stopped.**
- Areas belonging to **short category** is completely drained **within no longer than 6 hours** after rain has stopped
- Flood of areas belonging to **medium category** is **longer than 6 hours** after rain has stopped.

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IV. Results and discussion

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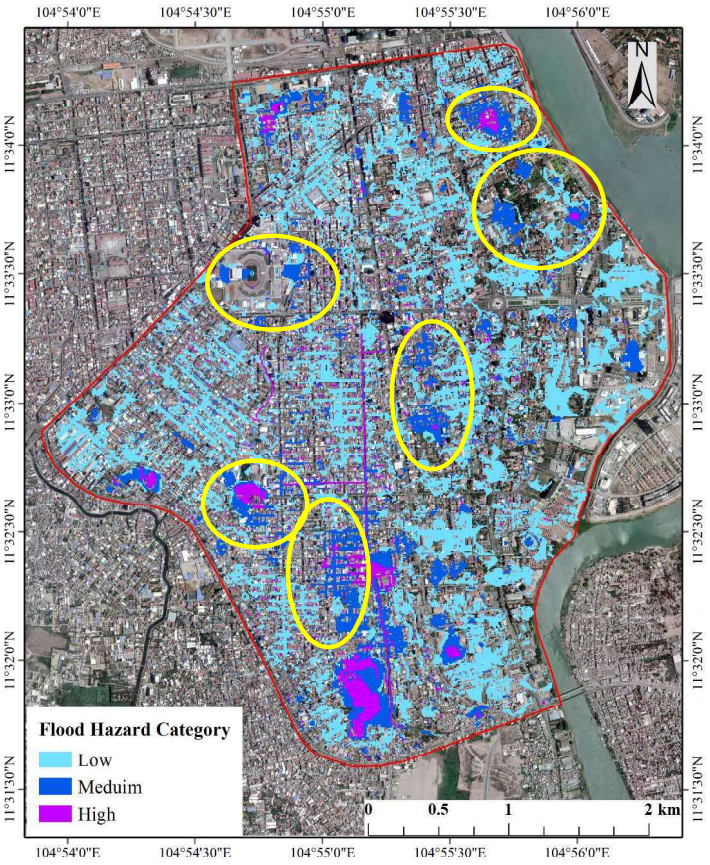
Hazard mapping



Flood hazard category	Hazard area (km^2)	Percentage of hazard area (%)
Low	3.20	25.60
Medium	1.03	8.24
High	0.34	2.72

*Total area is 12.5 km^2

Safe area is **36.56%

- The medium and high hazard areas are seen:
  - Kandal market
  - Around the Royal Palace
  - Olympic stadium
  - Boeung Trabek district, especially area along the canal

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V. Conclusions

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- Based on the results, there are some main locations (**3.40%**) in the study area which confront to the **high hazard with the depth higher than 0.6m**.
- Regarding to duration of flooding, the water of most study area can be completely drained within 6 hours after rainfall has stopped while flooding areas around **11%** of total area encounter **flooding longer than 6 hours**.
- This result is beneficial to the policy maker and the urban planner to consider on **renewal and maintenance of drainage system in some inundation areas**. Moreover, investing in structural measures such as constructing more **detention basin or ground storage** are able to reduce the water level in the inundation area.

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Thank You for Your Attention!