



HPC and Applications for Mekong Delta

Nam Thoai

namthoai@hcmut.edu.vn

Faculty of Computer Science and Engineering

HCMC University of Technology

<http://www.hcmut.edu.vn/>





Contents

- HPC at HCMUT
- Traffic analytics
- HCMC urban flooding
- Problems of Mekong delta



Ho Chi Minh City University of Technology



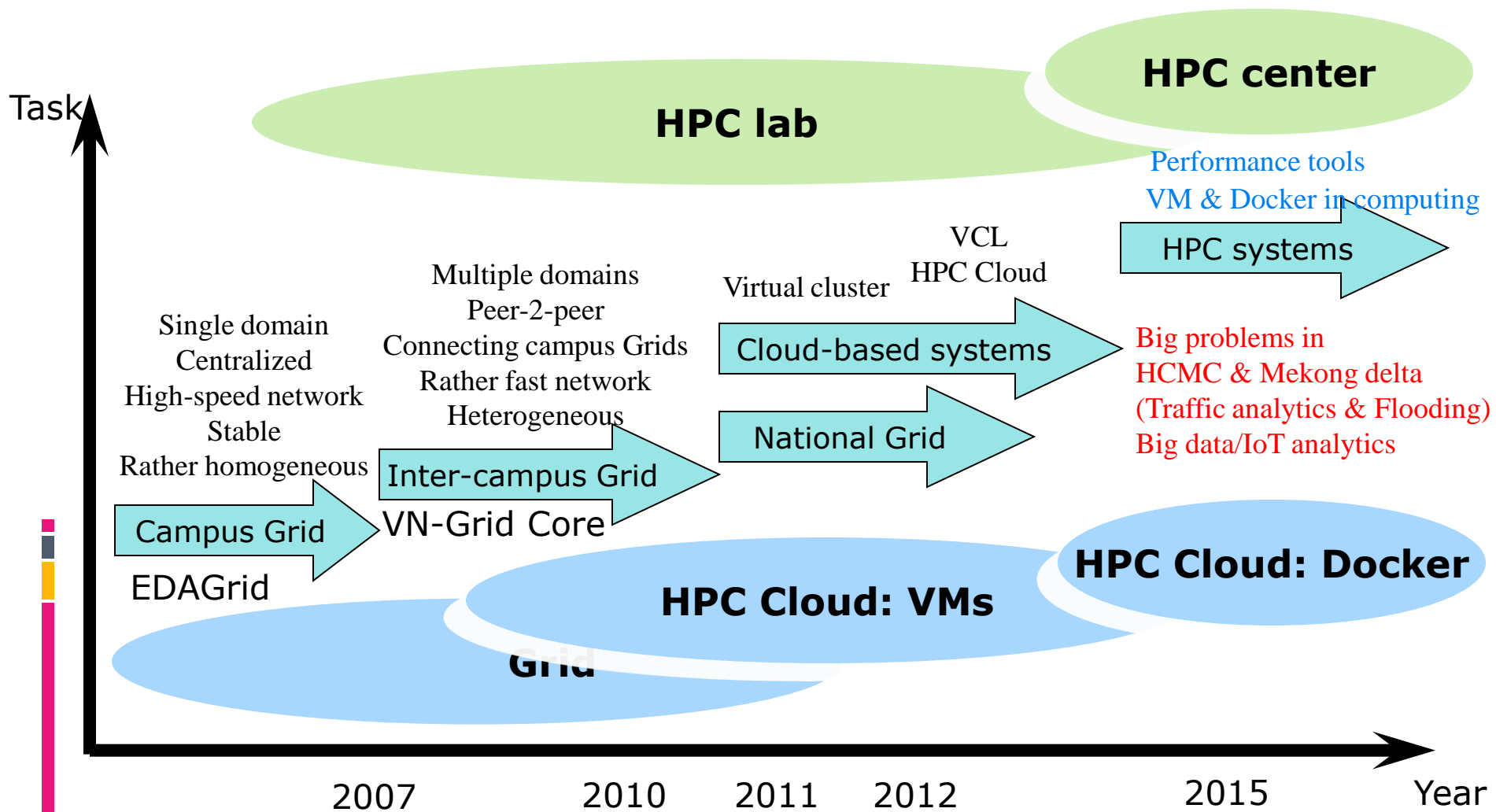
- ❑ From 1957
- ❑ 27,000 students
- ❑ 1,500 staffs
- ❑ 11 faculties
- ❑ One of the most prestigious universities of technology in Vietnam and the largest university of technology in Southern Vietnam



HPC Center



High performance computing (HPC)



HPC center

■ Partners

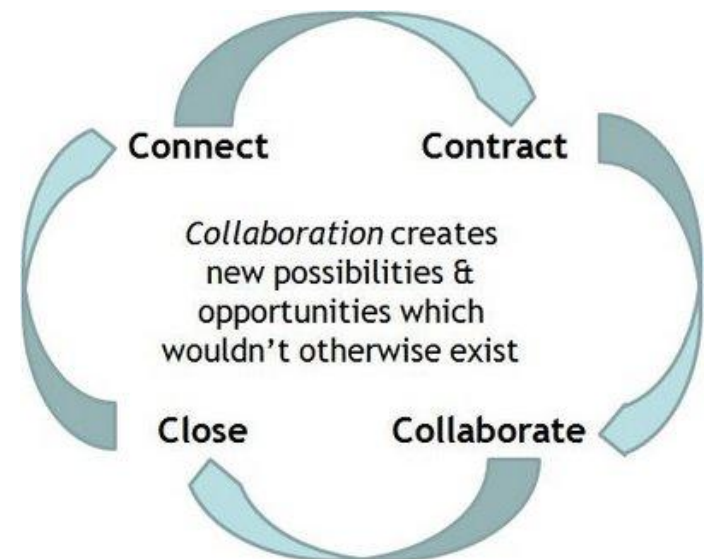
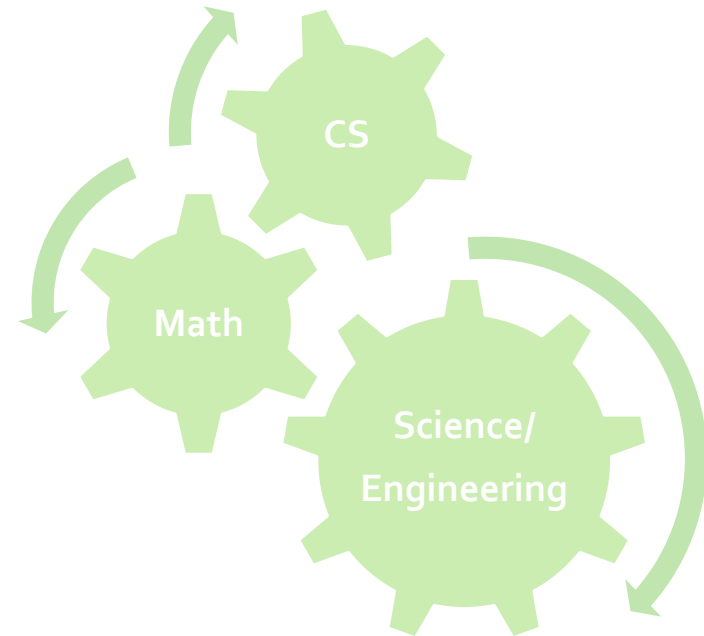
- HCMUT - VNUHCM
- Intel
- Ho Chi Minh city

■ Plan: 2012-2022

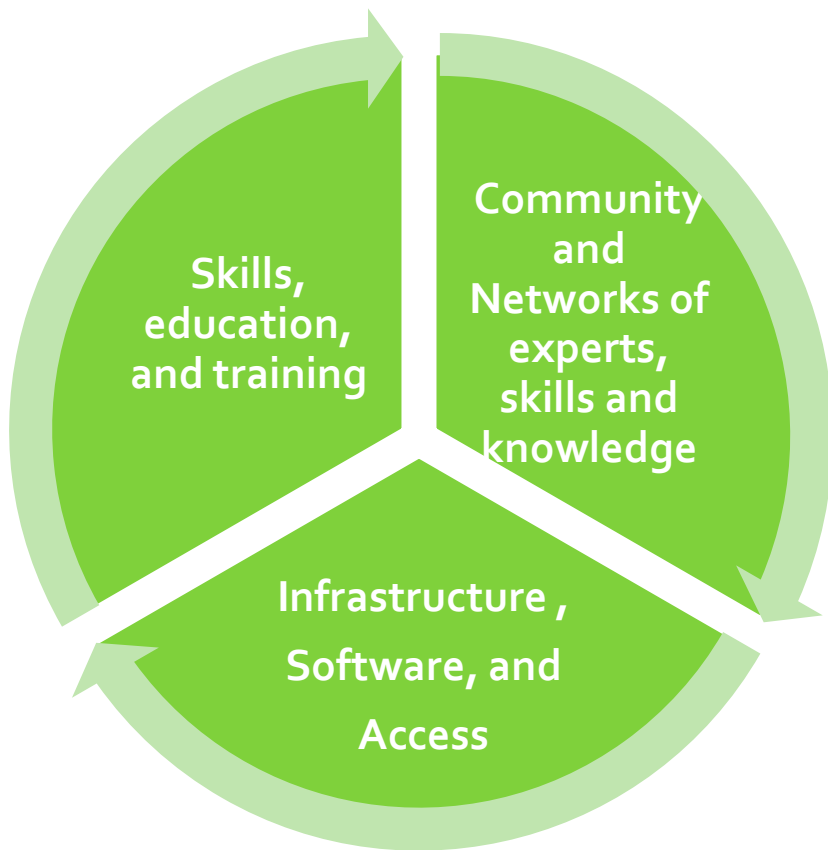
- HPC Research Center: Set up in 2013
- Strengthen HPC in Vietnam
- Solving big problems

■ Key applications

- HCMC traffic analytics
- HCMC urban flooding
- Problems of Mekong delta
- Big data/IoT analytics



How to close the adoption gap: a pathway for Vietnam



- *Develop the talent pipeline*
- *Create community and knowledge transfer through global and national networks*
- *Provide access to leading edge infrastructure*

Machines

- A new Intel & HP system
 - ~50 TFlops
 - Xeon Phi
 - 54 Gbps Infiniband
 - 40 TB storage
- A cluster donated by Intel
 - 1.7 TFlops
 - 80 cores
 - 40 Gbps Infiniband



Training

- **Short course: 2013**
 - Parallel programming
 - HPC applications
 - Administration/Networking
- **Master program: 2013**
 - HPC major in CS
 - Research oriented
- **PhD program: 2016**

Xeon
Phi &
GPUs

Network

HPC
system

Traffic
analytics
(ITS lab)

Big
data

Urban
Flooding

Science &
Engineering
problems

IoT
(IoT lab)



Traffic analytics

Prof. Pham Tran Vu



Traffic in HCMC



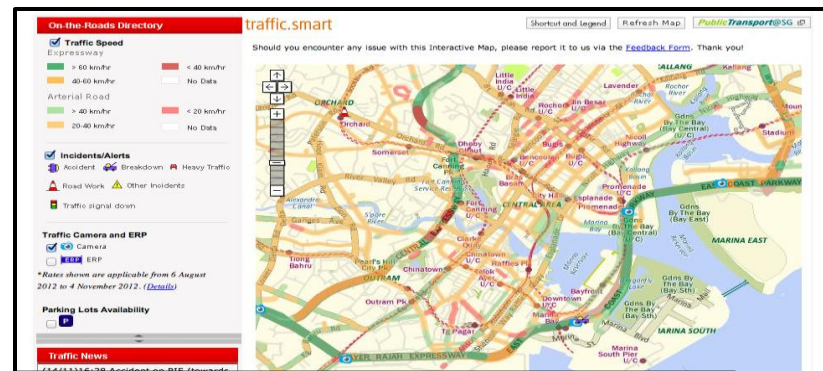
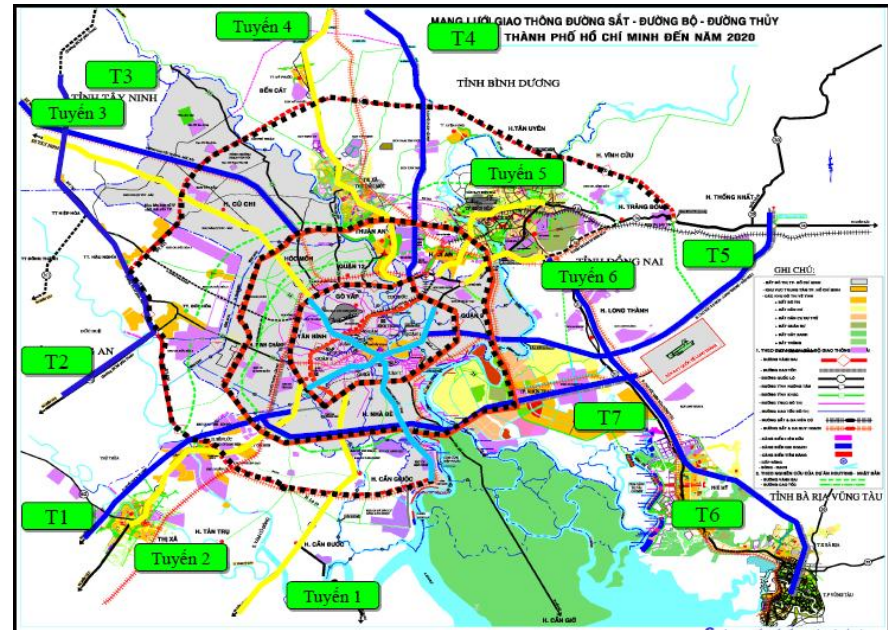
Big problem

■ Big data

- Motorbike: 5M
- Car: 800K
- 3.800 roads with the total length of 3.670km
- Realtime simulation, analytics???

■ Complexity

- Many motorbike
- Safety space
- Traffic coming from small routes



Singapore
(<http://interactivemap.onemotoring.com.sg/mapapp/index.html>)



Traffic analytics

- Analyse and extract traffic information from realtime/offline GPS data
- Extract traffic information from video camera in realtime
- Microsimulation for traffic analysis
- Large and efficient storage system for realtime GPS/traffic data

ITS system

Data Collection

GPS from mobile devices



GPS from bus



Camera

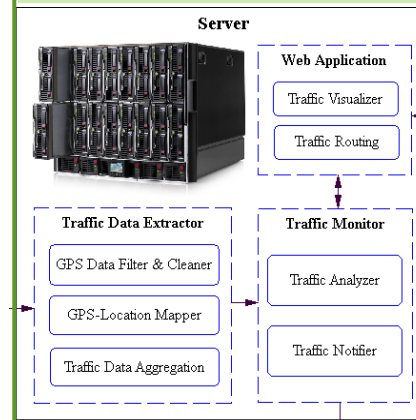


VOV, VOH transportation channel



Store and integrate data in real time

Data integration from multi-source



Display and guide in real time

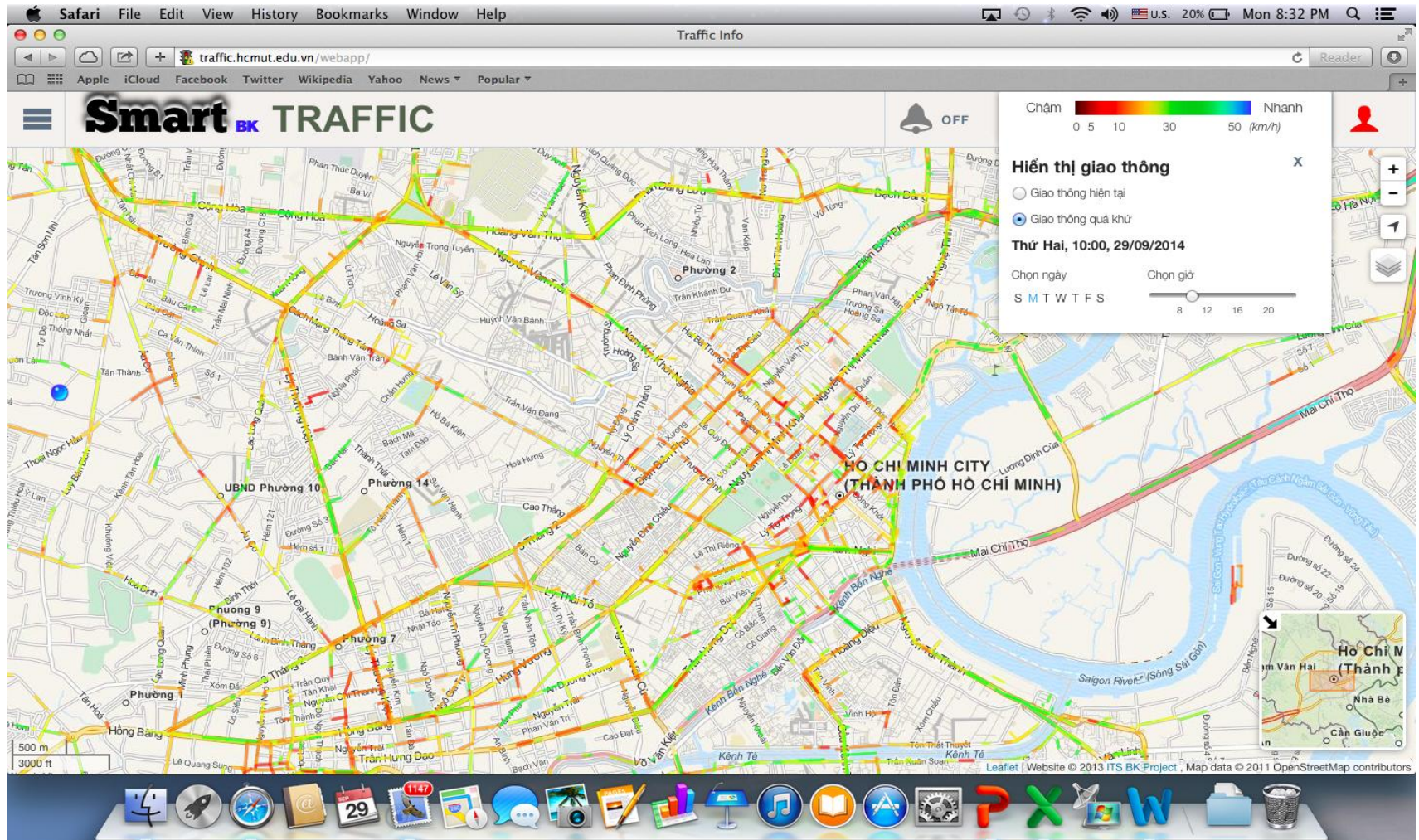
Display in smartphone, web



Guide

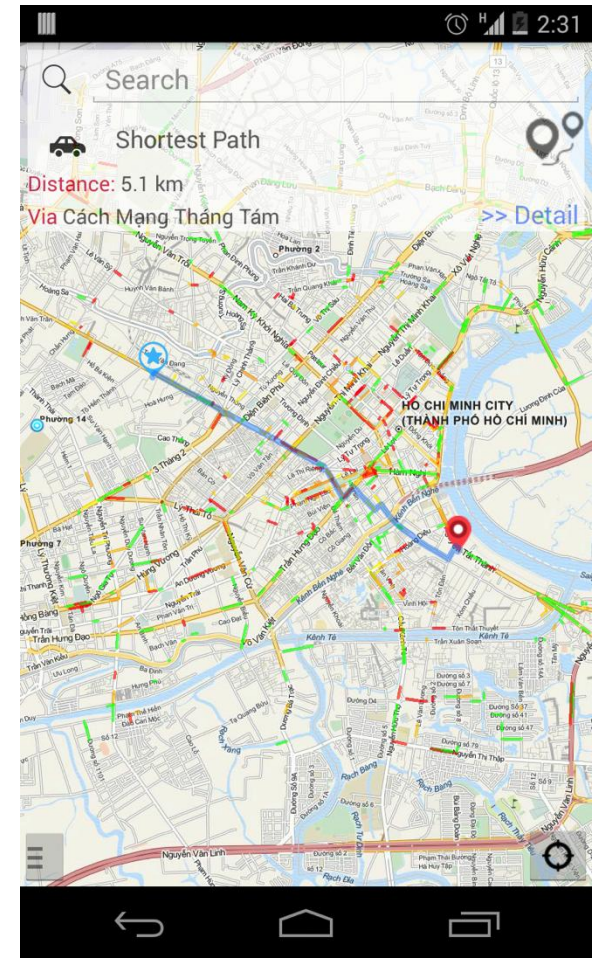
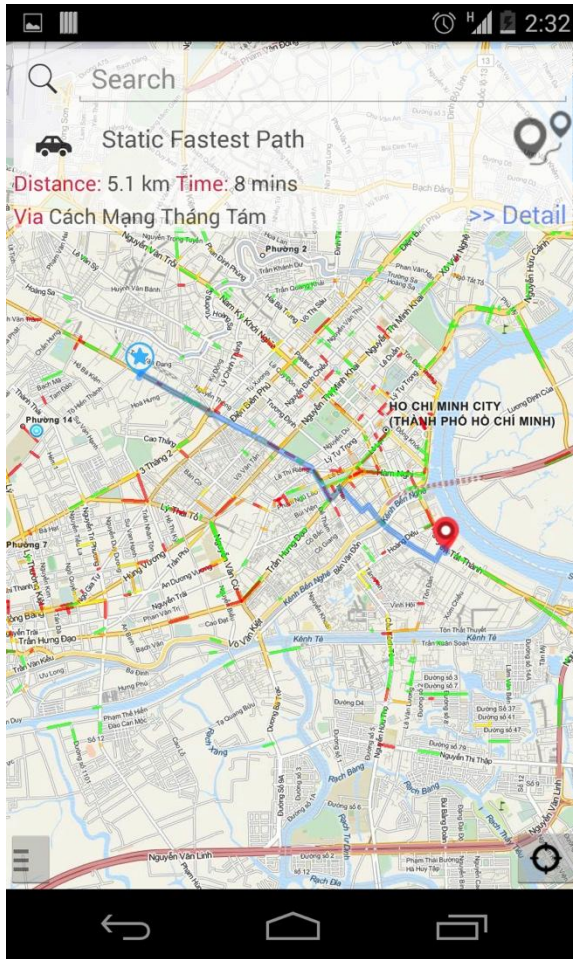


Http://traffic.hcmut.edu.vn

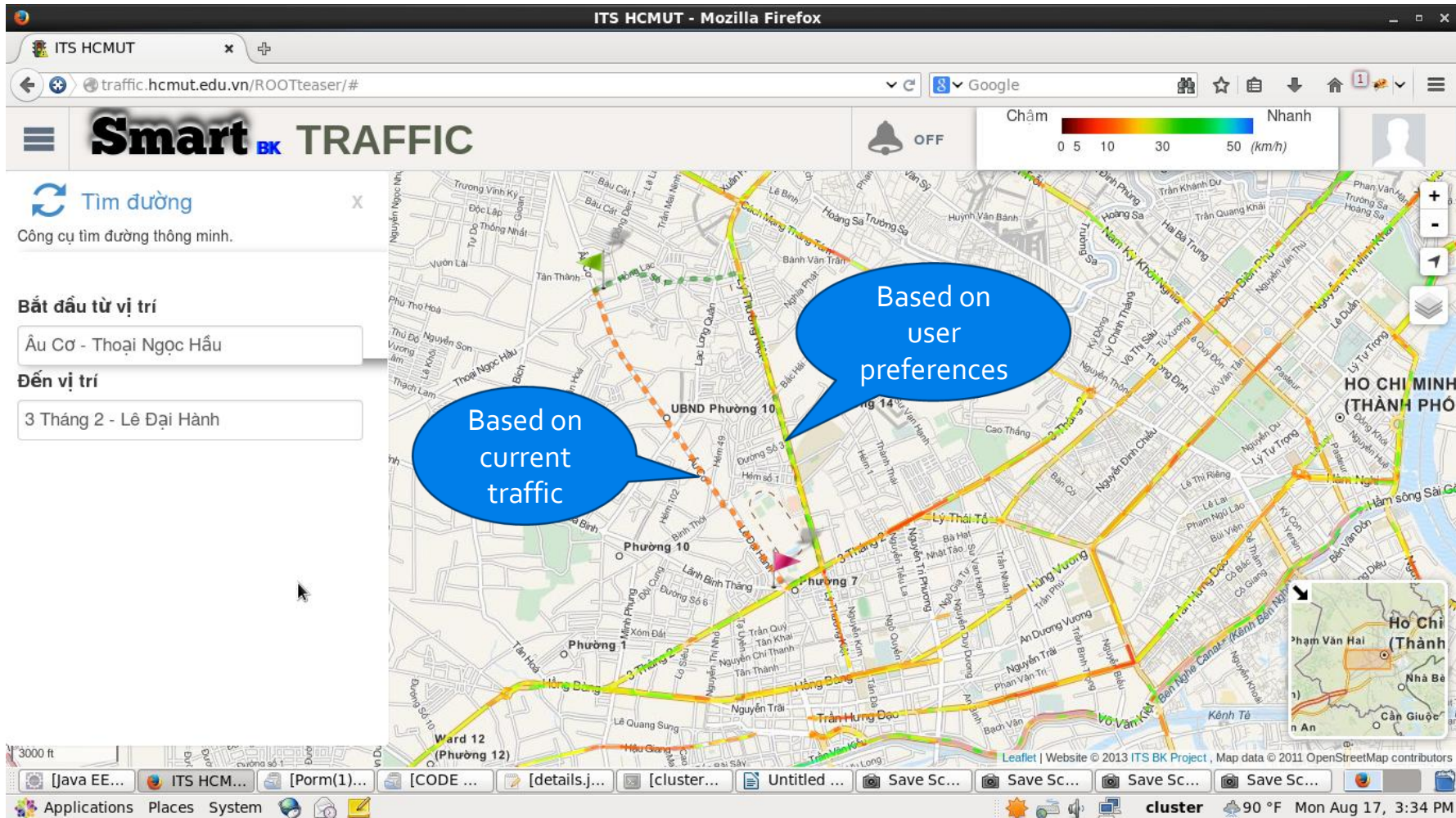


Navigation Application: Road Maester

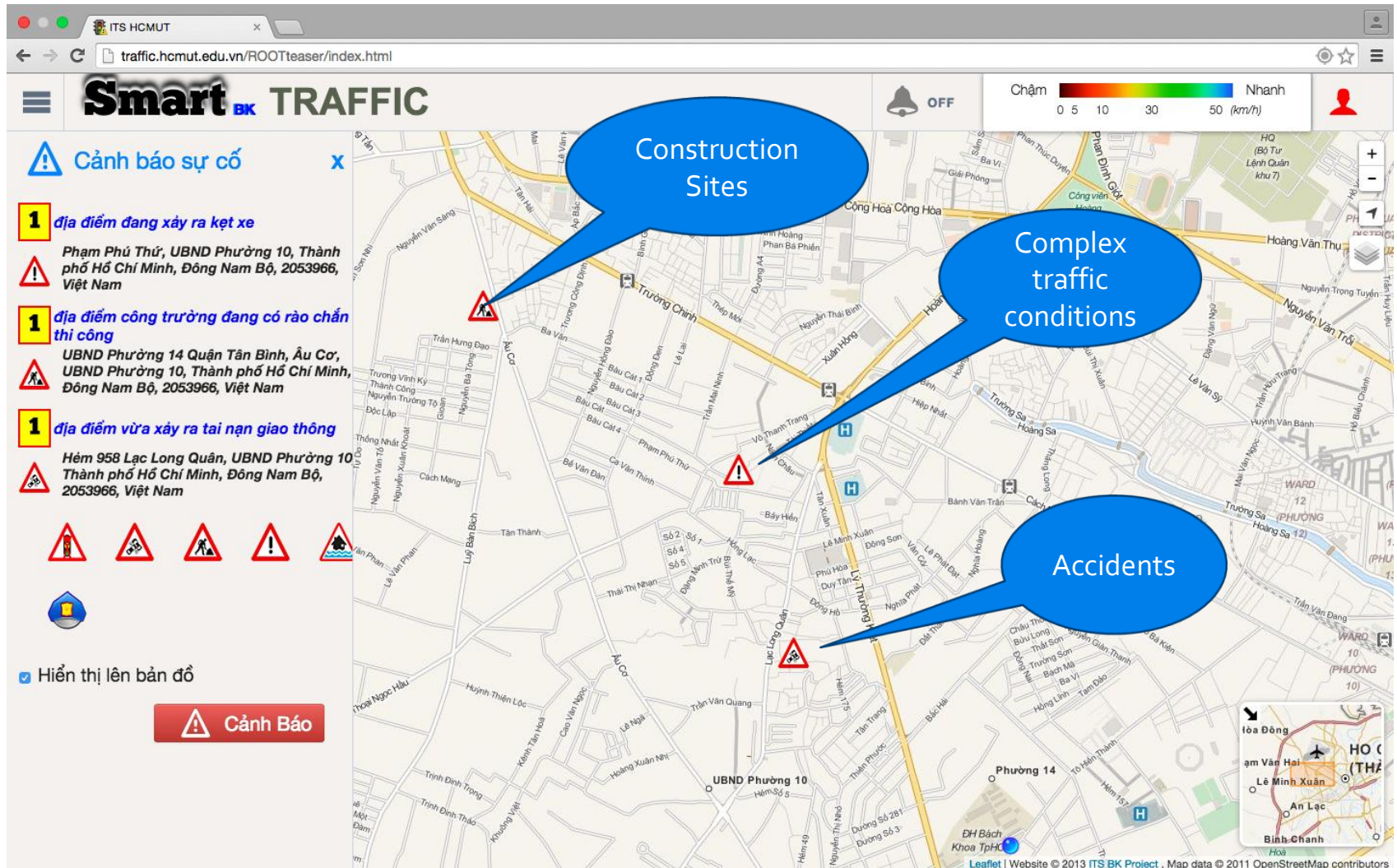
<https://play.google.com/store/apps/details?id=cse.its.routing>



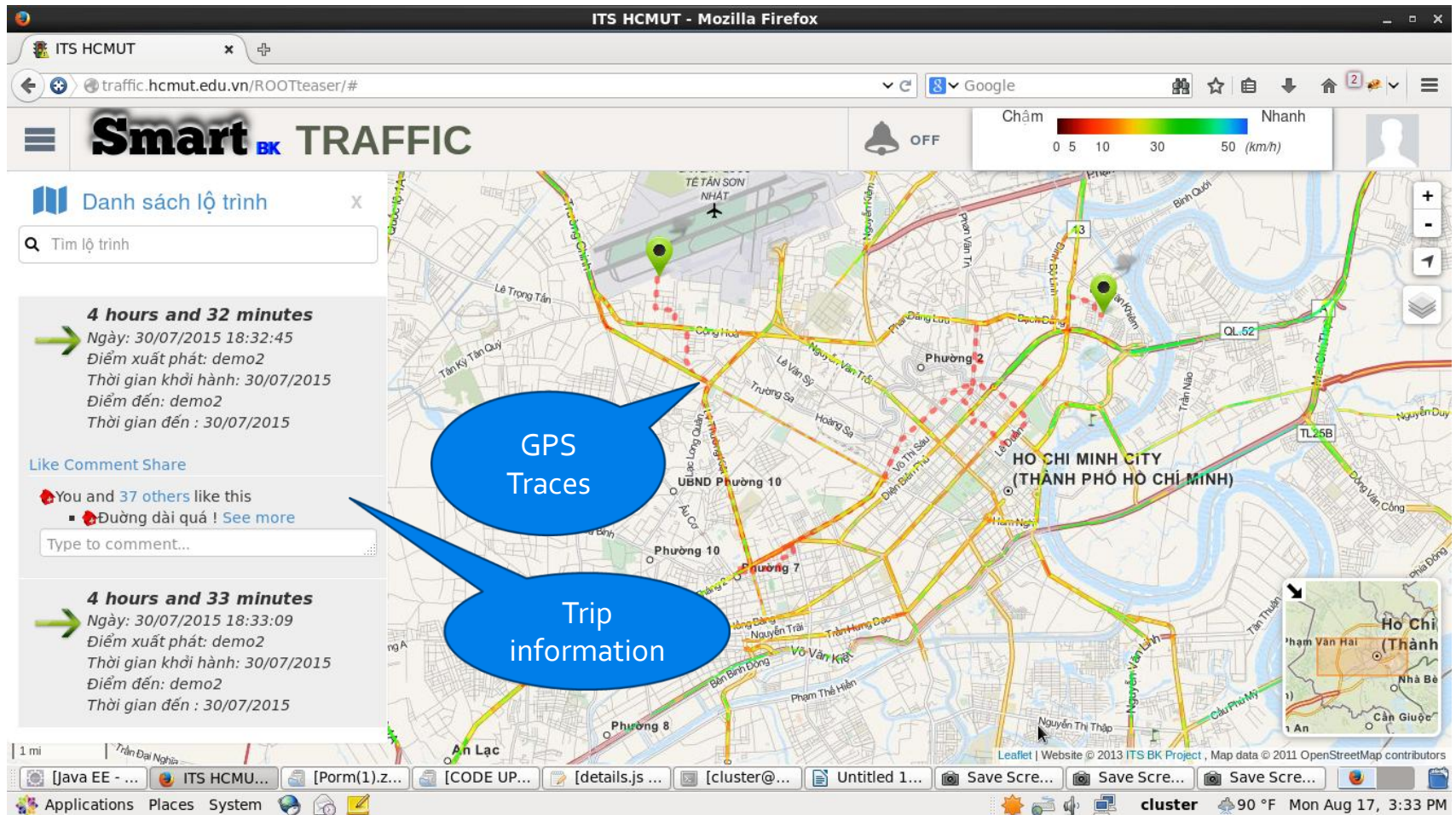
Routing Algorithms on Web Application



Sharing Traffic Incidents on Web Application



Sharing Trip on Web Application





HCMC urban flooding

WACC & HPC Center

Prof. Ho Long Phi

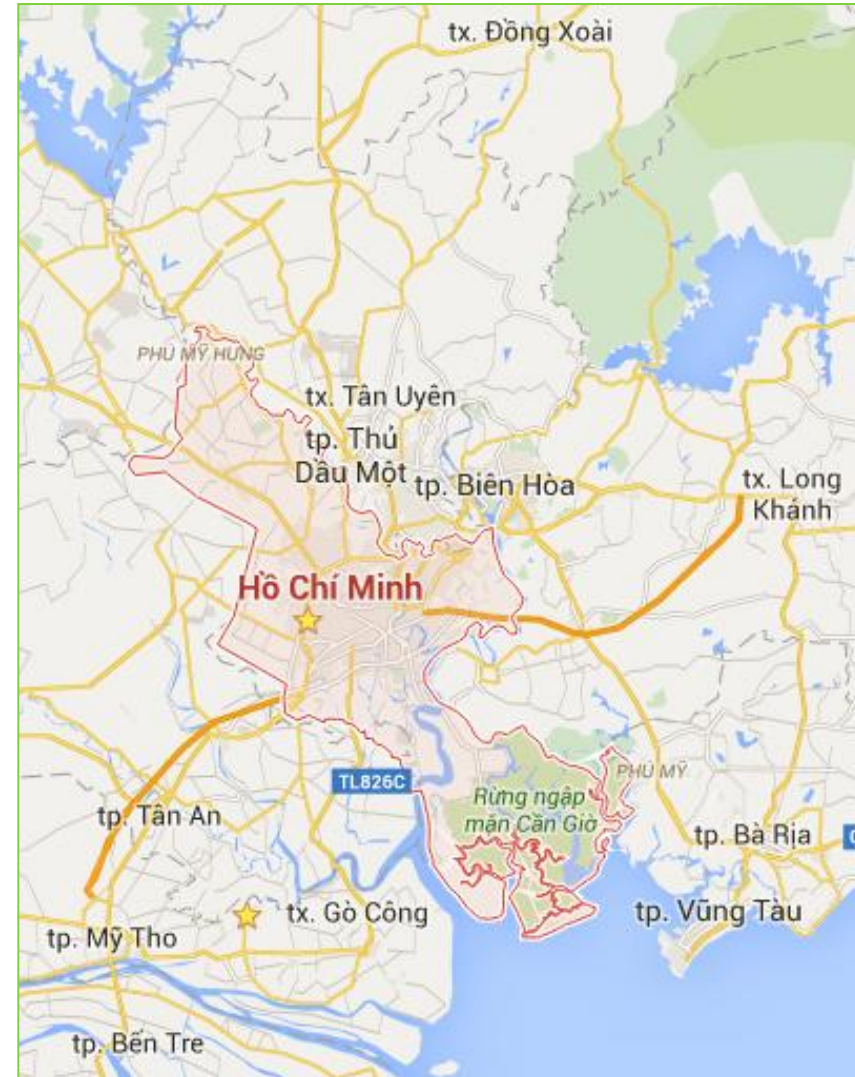
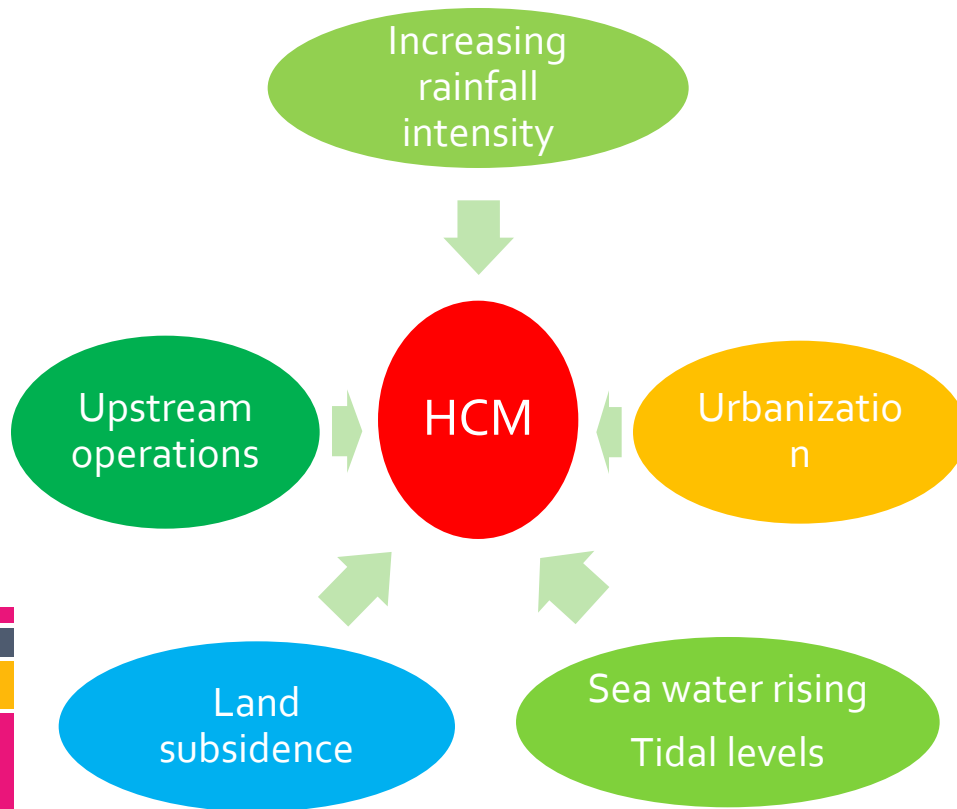


Flooding in HCMC

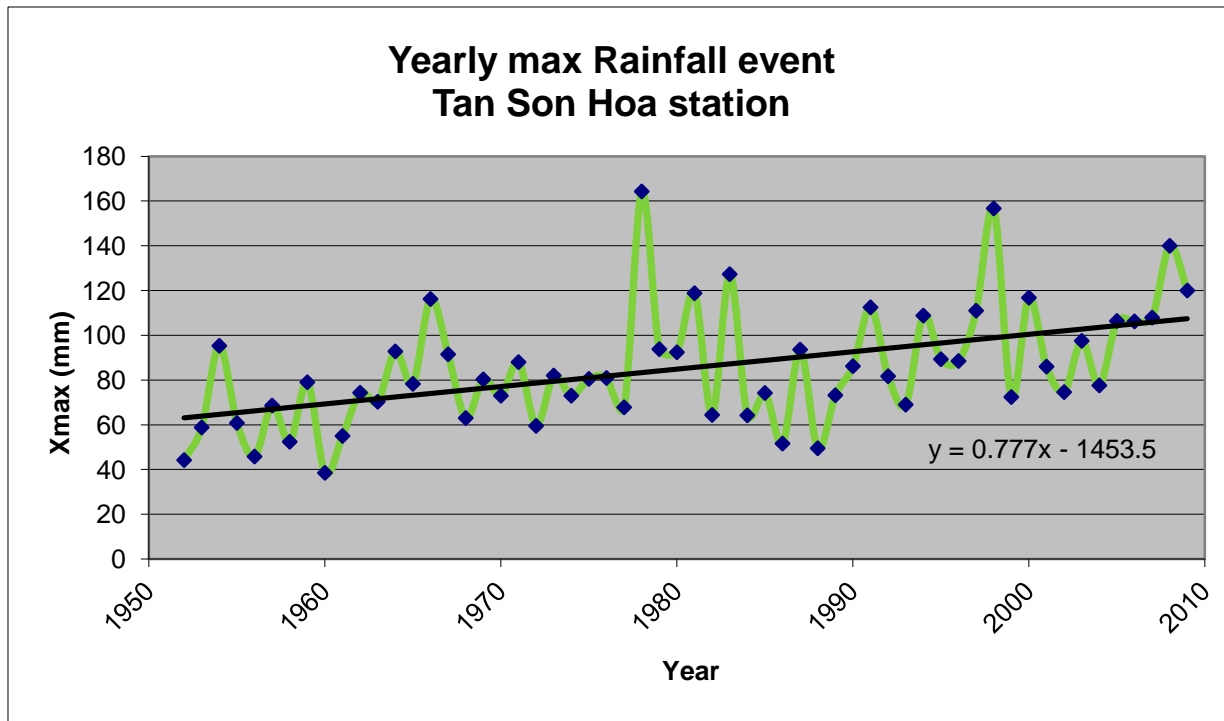
- Dongnai, Saigon rivers
- Others???



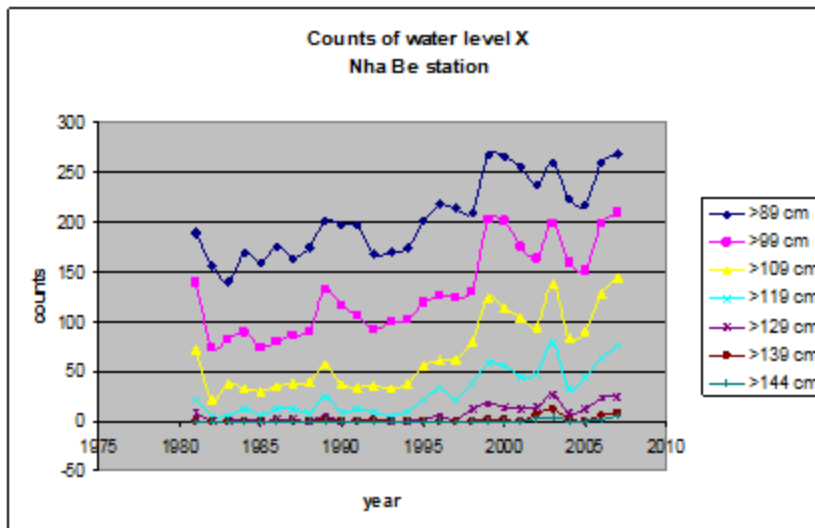
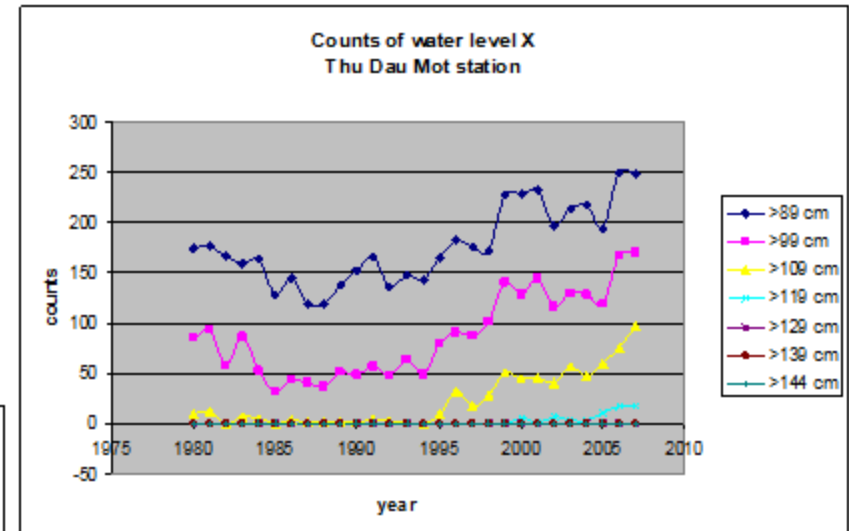
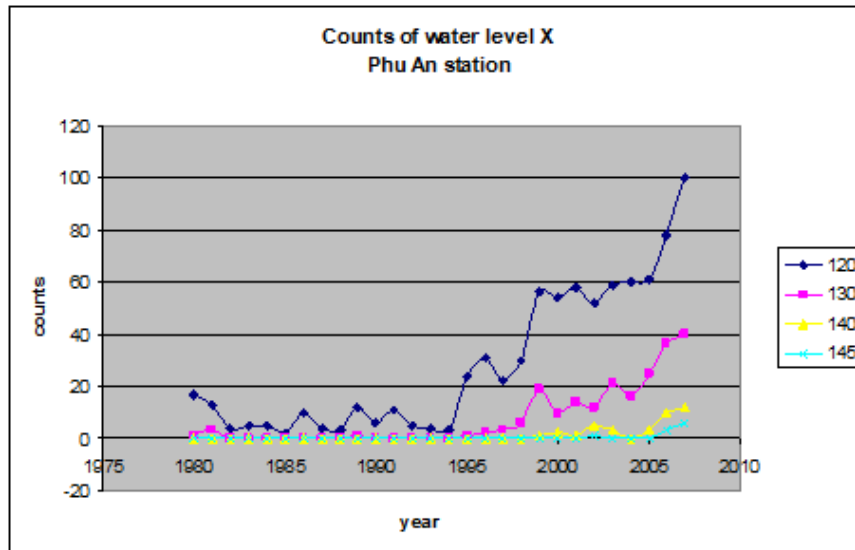
Flooding in HCMC



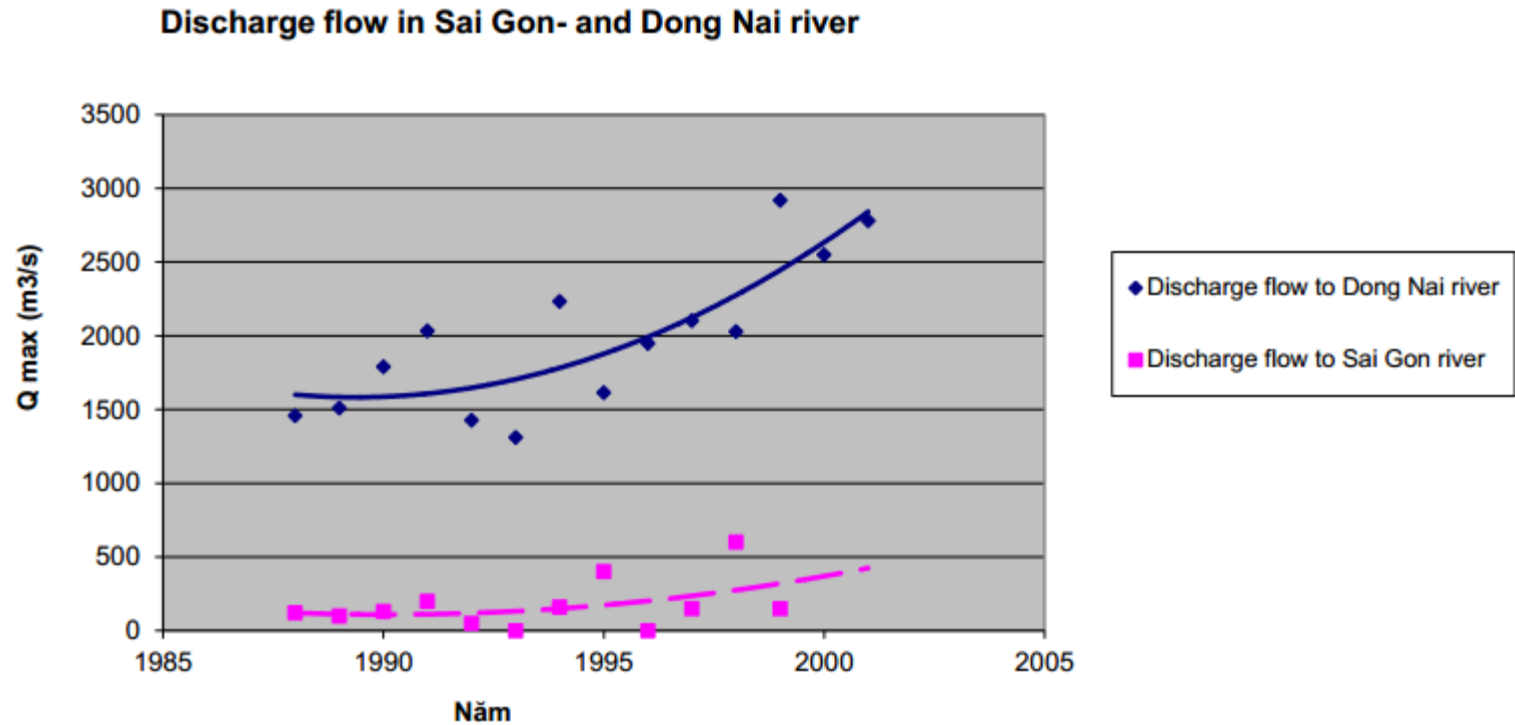
Rainfall



Water level rise

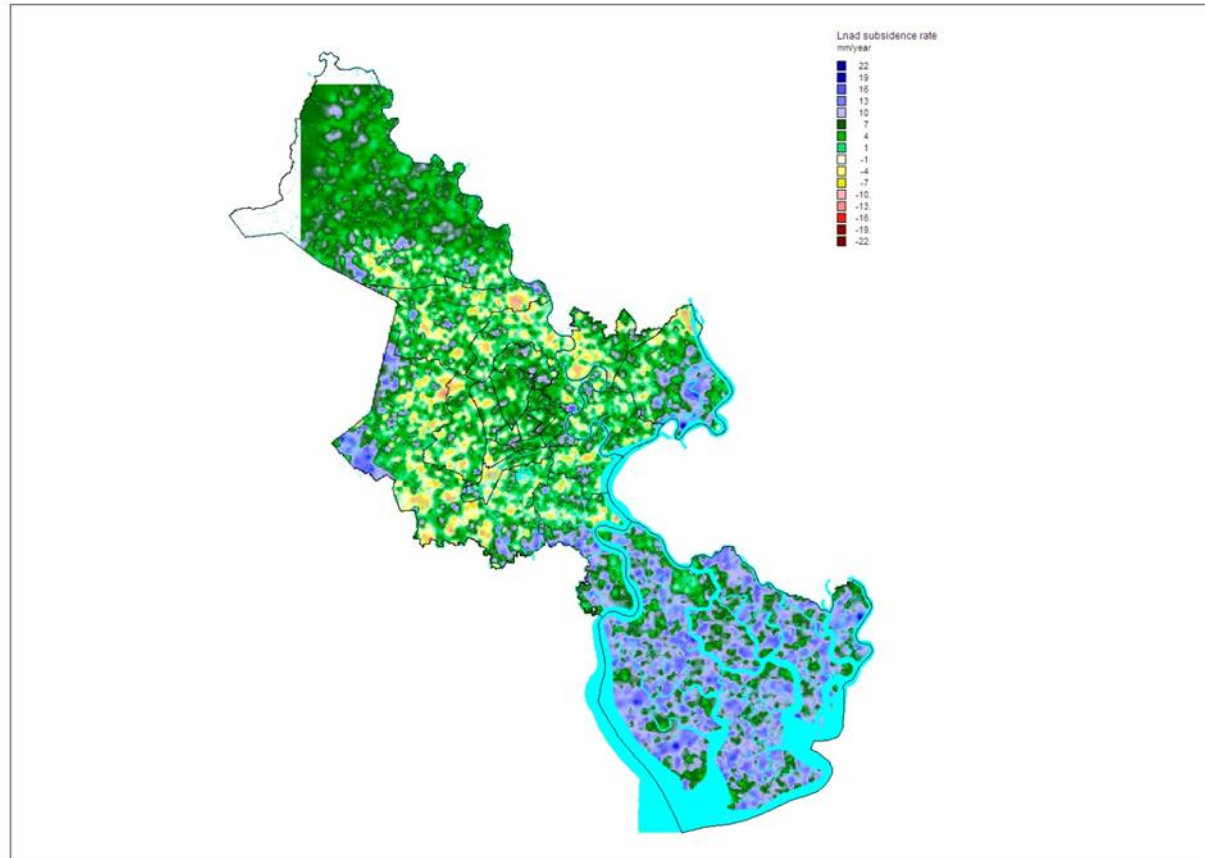


River flood



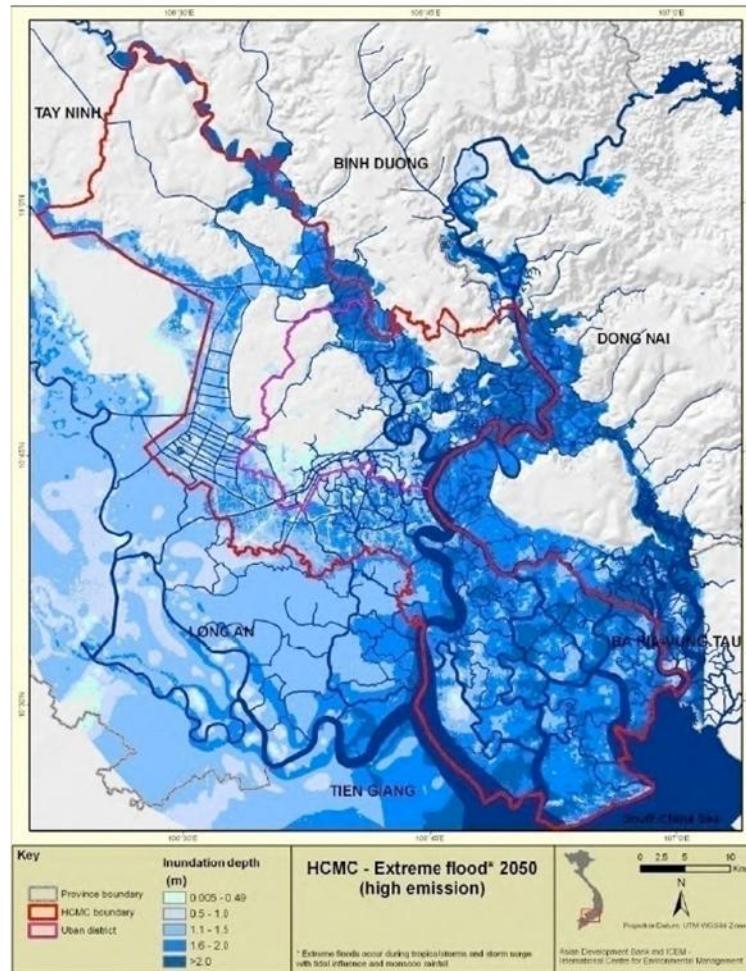
Ground subsidence (1996-2009)

- In wide area: 2.5cm/year



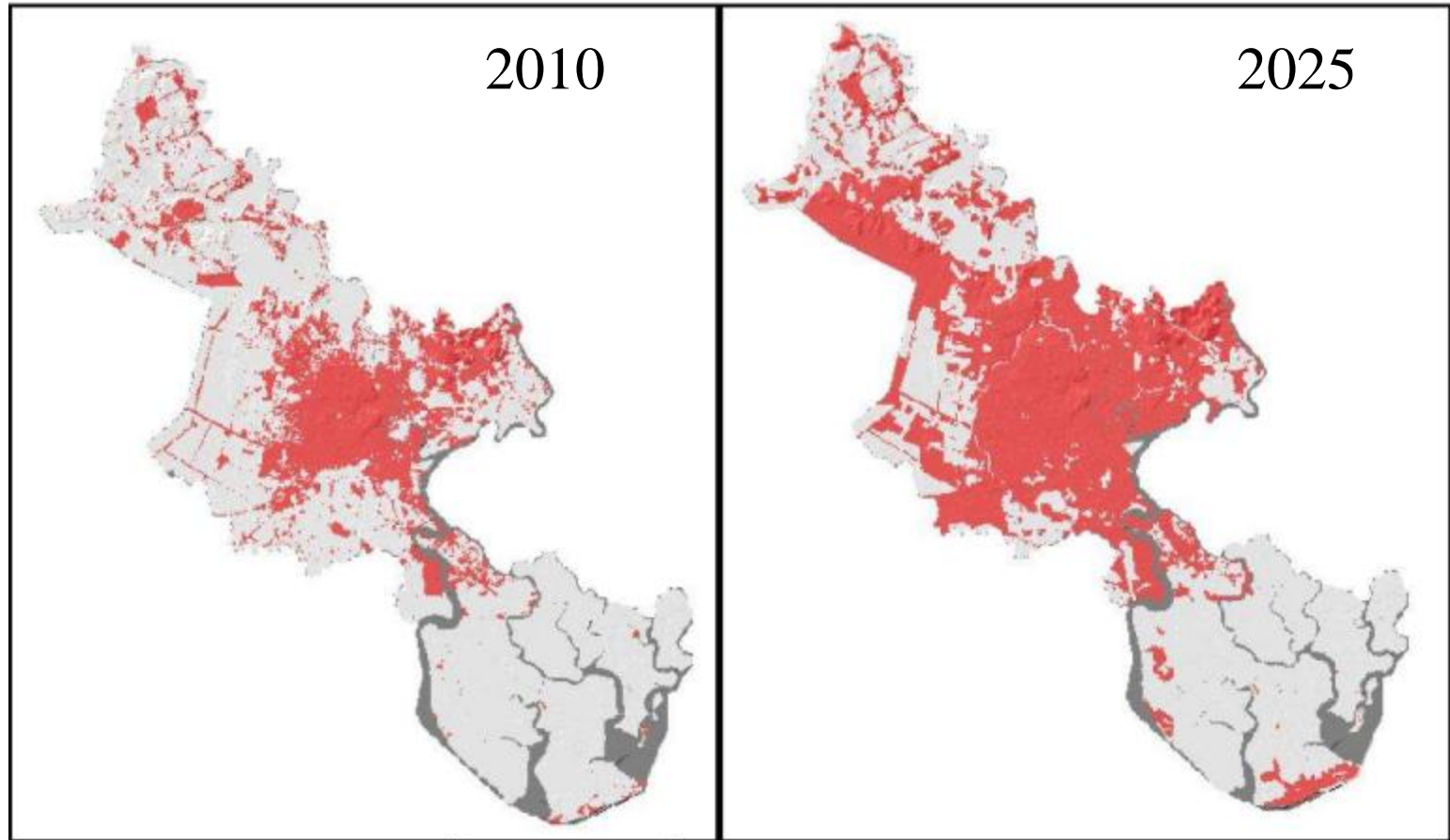
Sea level rise

- Rising 0.3-1cm/year



ICEM source

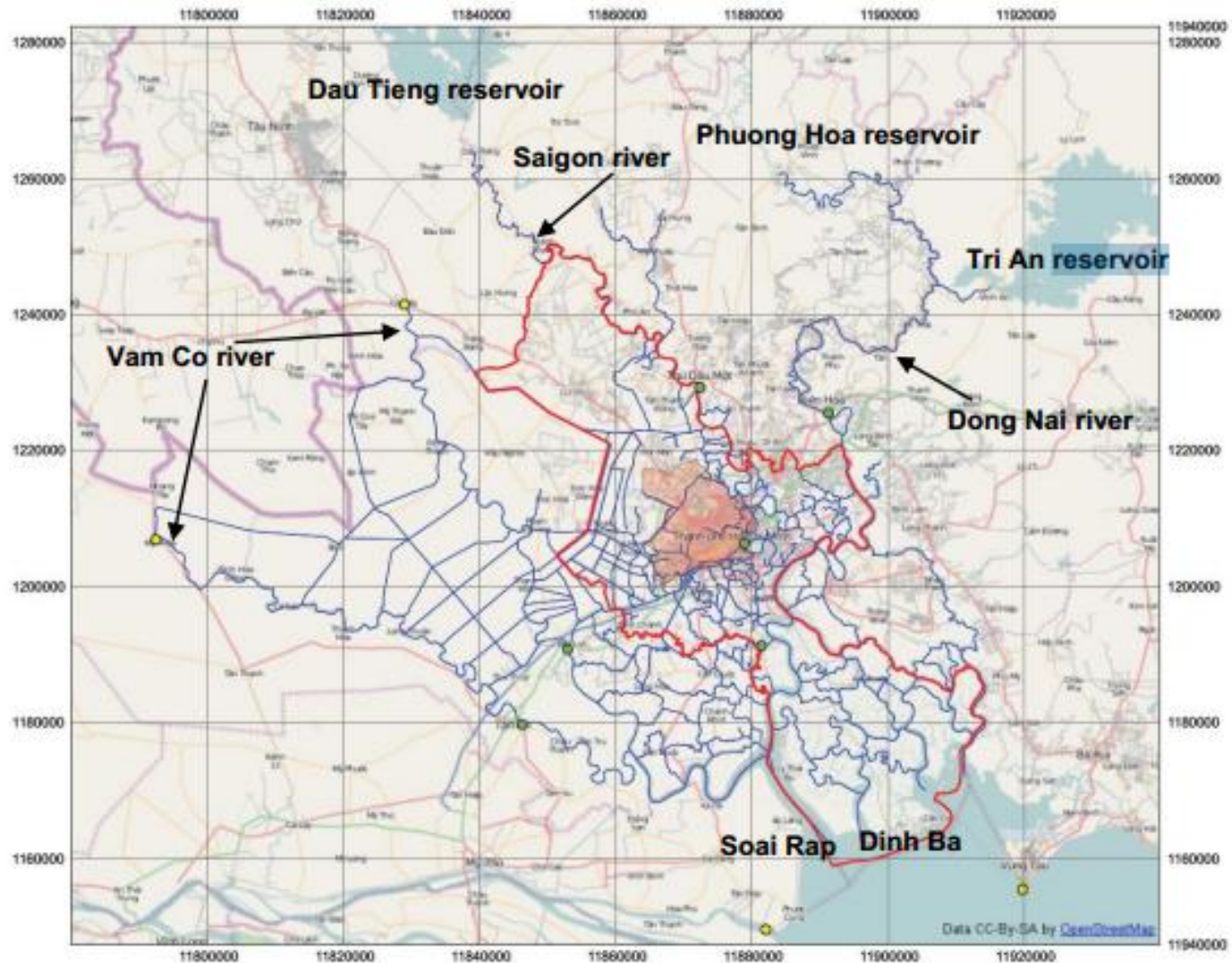
Urbanization



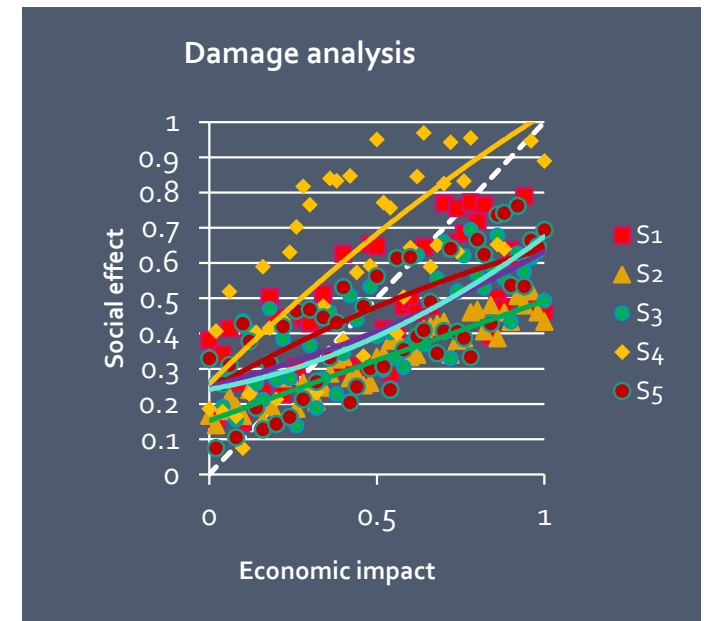
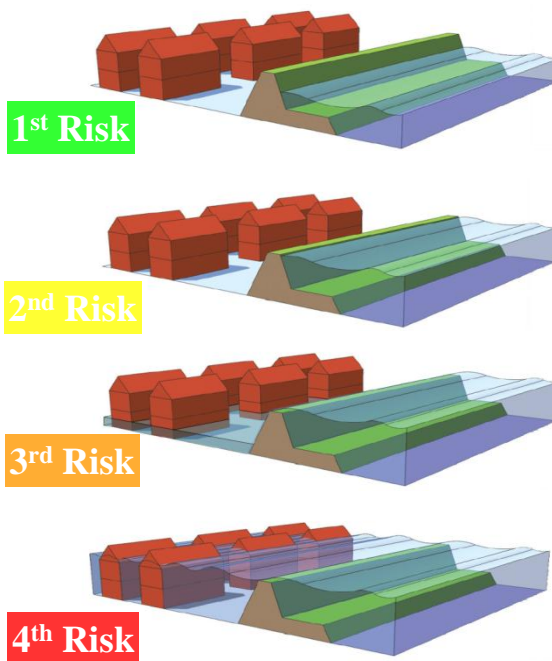
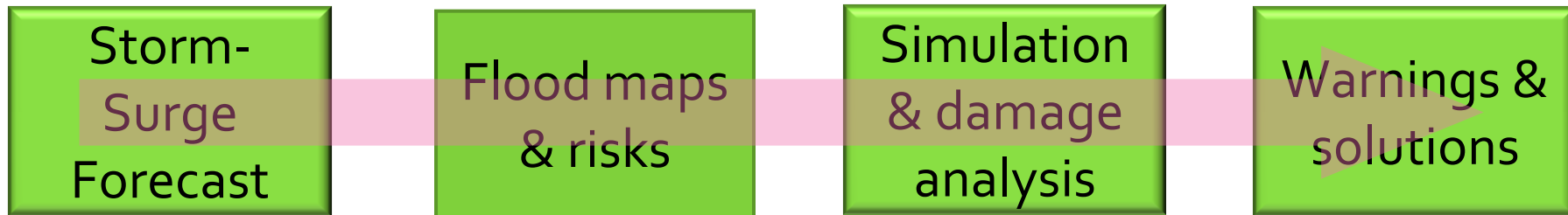
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Risk



Forecast system





Mekong Delta

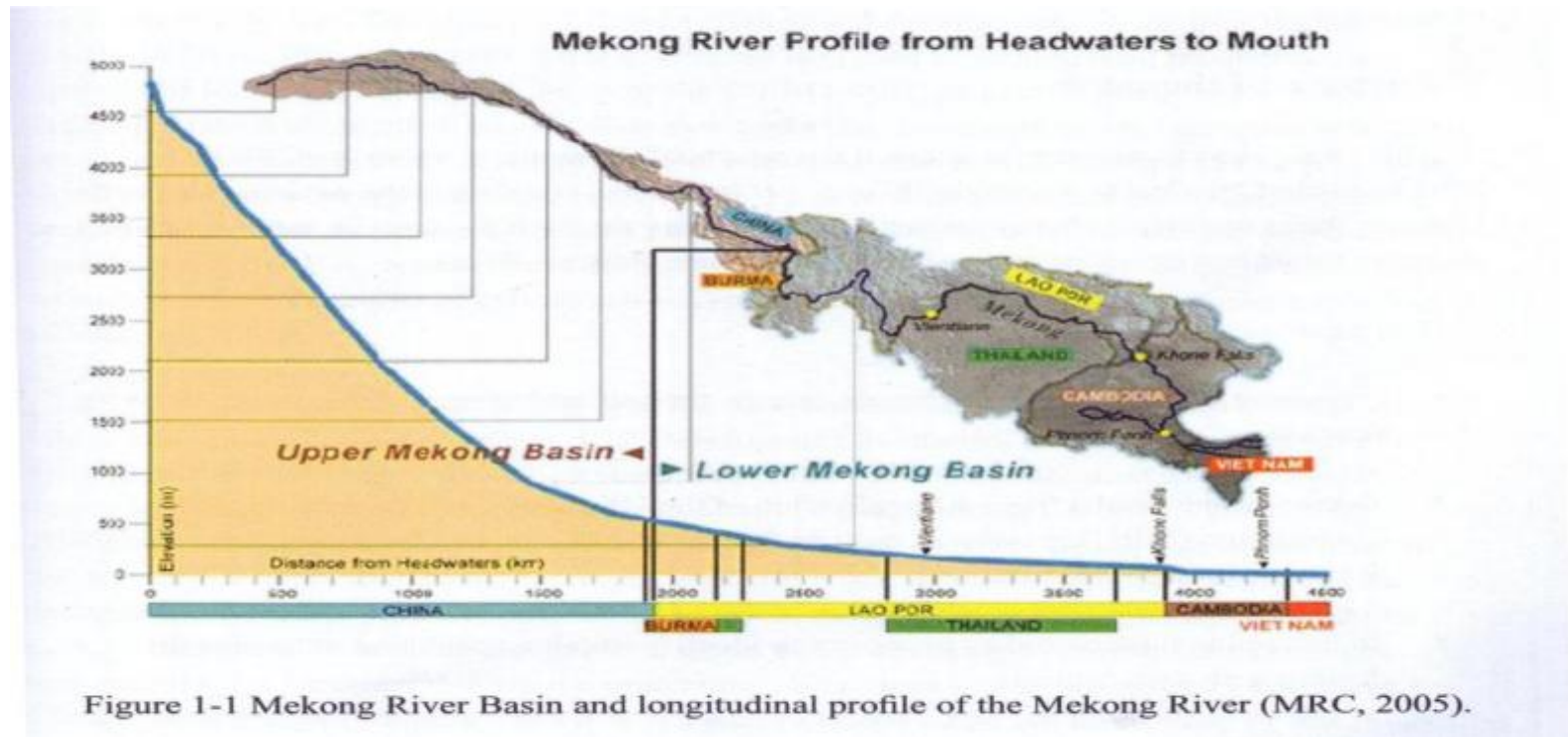
FCE & HPCC

Prof. Nguyen Thong



The Mekong

- Upper Mekong basin – China (22%)
- Lower Mekong basin: Myanmar (3%), Lao PDR (25%), Thailand (23%), Cambodia (19%), Vietnam (8%)
- Mean annual discharge 457 km³ (#8 in the world)



The Mekong delta



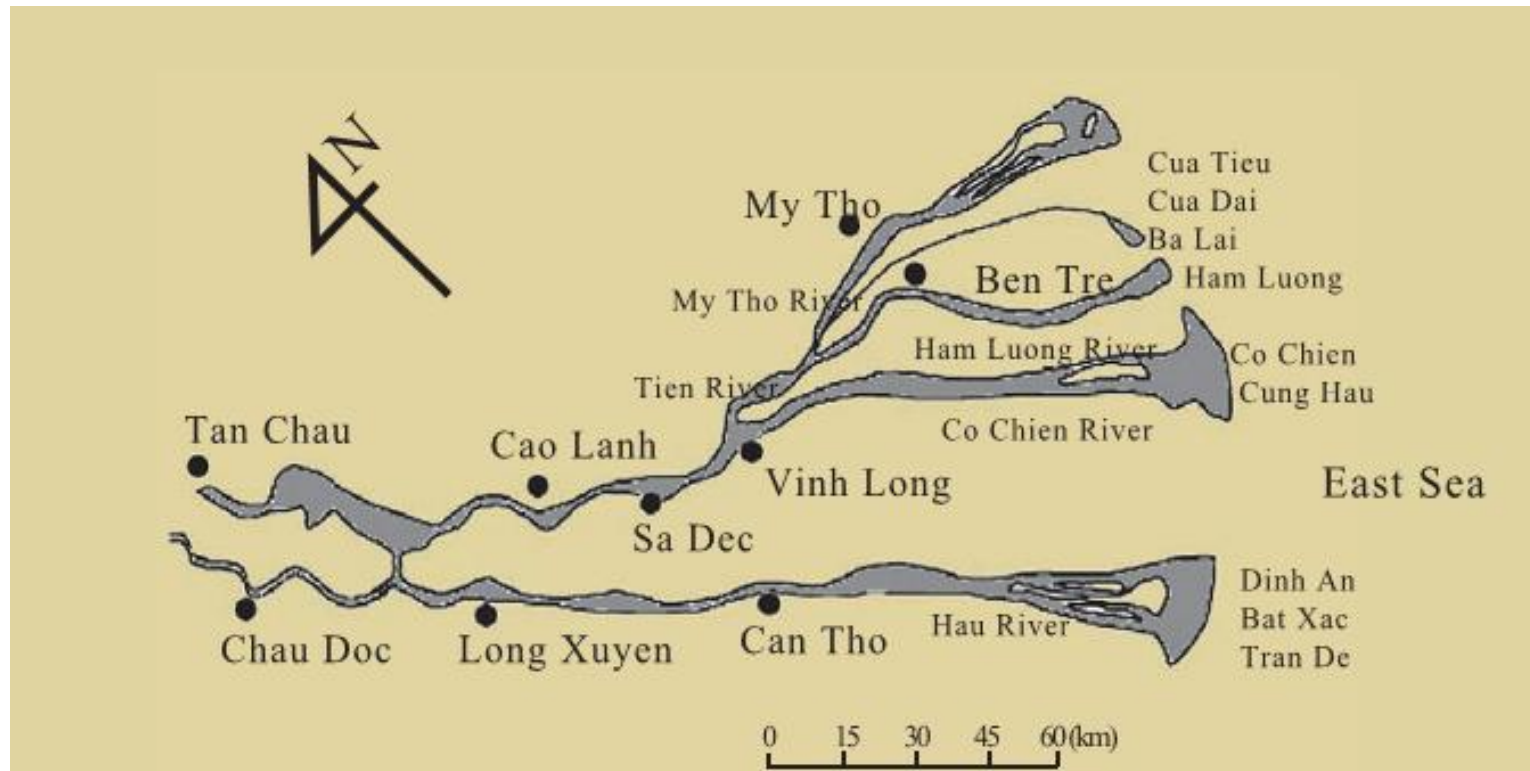
- 5.9 million ha of which Vietnam cover 3.9 million ha
- Population of 18.6M people (i.e. 22% of national population)
- Predominantly agriculture – 80 percent lives in rural area and 76 percent of its population engaged in agriculture
- Economic importance – 40 percent of the country's agriculture production, more than 50 percent of agriculture exports, 52 percent of national rice production (and nearly all rice exports), 65 percent of fruit production, and 60 percent of its combined fisheries and aquaculture outputs

Crops patterns

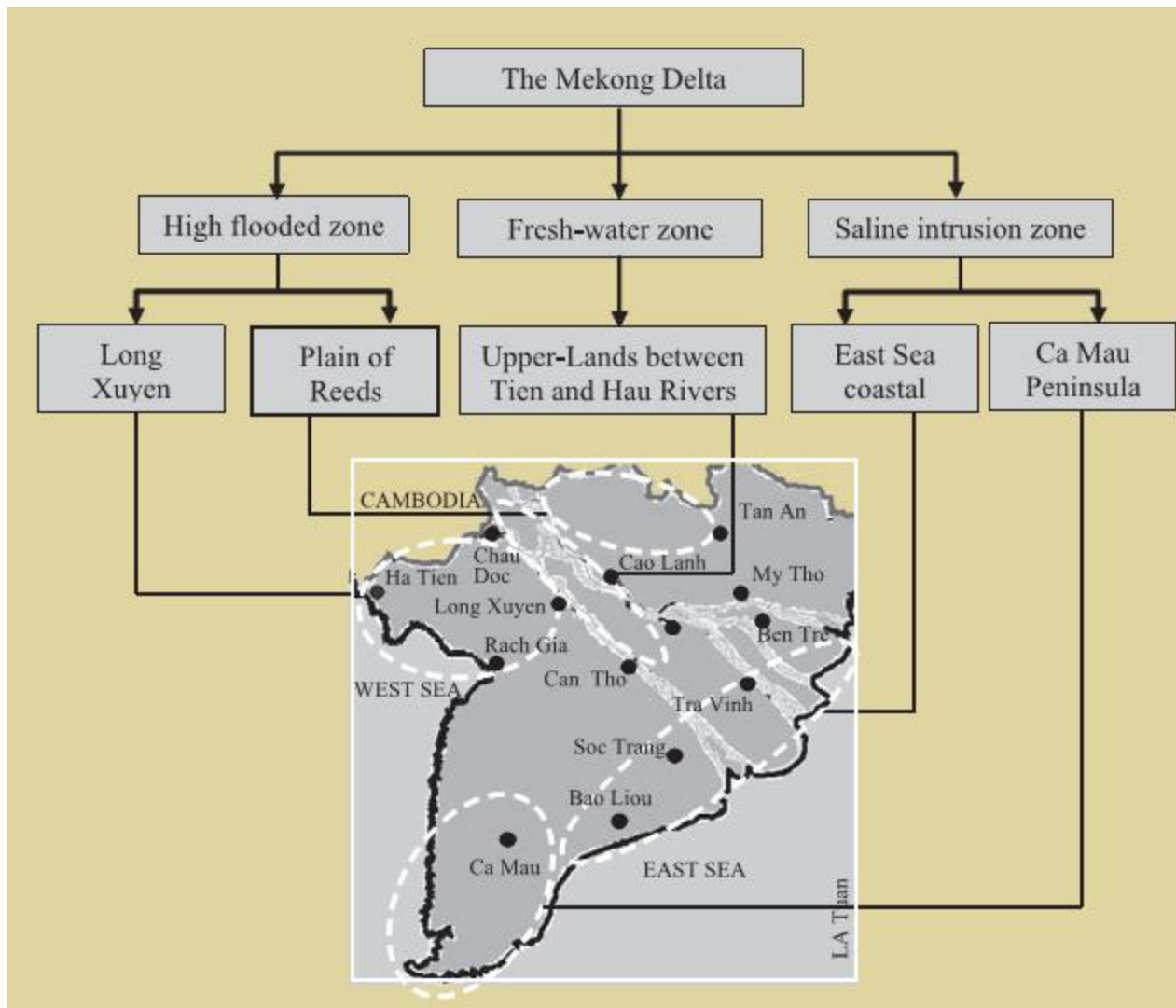
	1975	1990	2000	2009
Crop patterns (ha)				
Rice land	2,040,000	2,080,000	2,070,000	1,920,000
Traditional (One) Crop	1,860,000	470,000	545,300	414,000
Double Crop Rice	180,000	963,000	1,724,000	1,963,000
Triple Crop Rice	-	140,000	158,000	430,000
Orchards and Vegetable	-	145,000	537,000	750,000
Aquaculture	-	241,000	357,800	737,600
Coastal shrimp	-	110,000	338,000	703,000
Rice and Shrimp	-	-	40,000	130,000
Rice Production (ton)	6,000,000	9,400,000	16,520,000	20,483,000
Aquaculture production (ton)	-	126,400	365,200	1,869,500
Shrimp production			68,700	309,800
Average rice Yields (ton per hectare)	2.00	3.30	4.19	5.30

<http://www.fao.org>

The Mekong River in Vietnam and its nine branches



Three major water resource zones



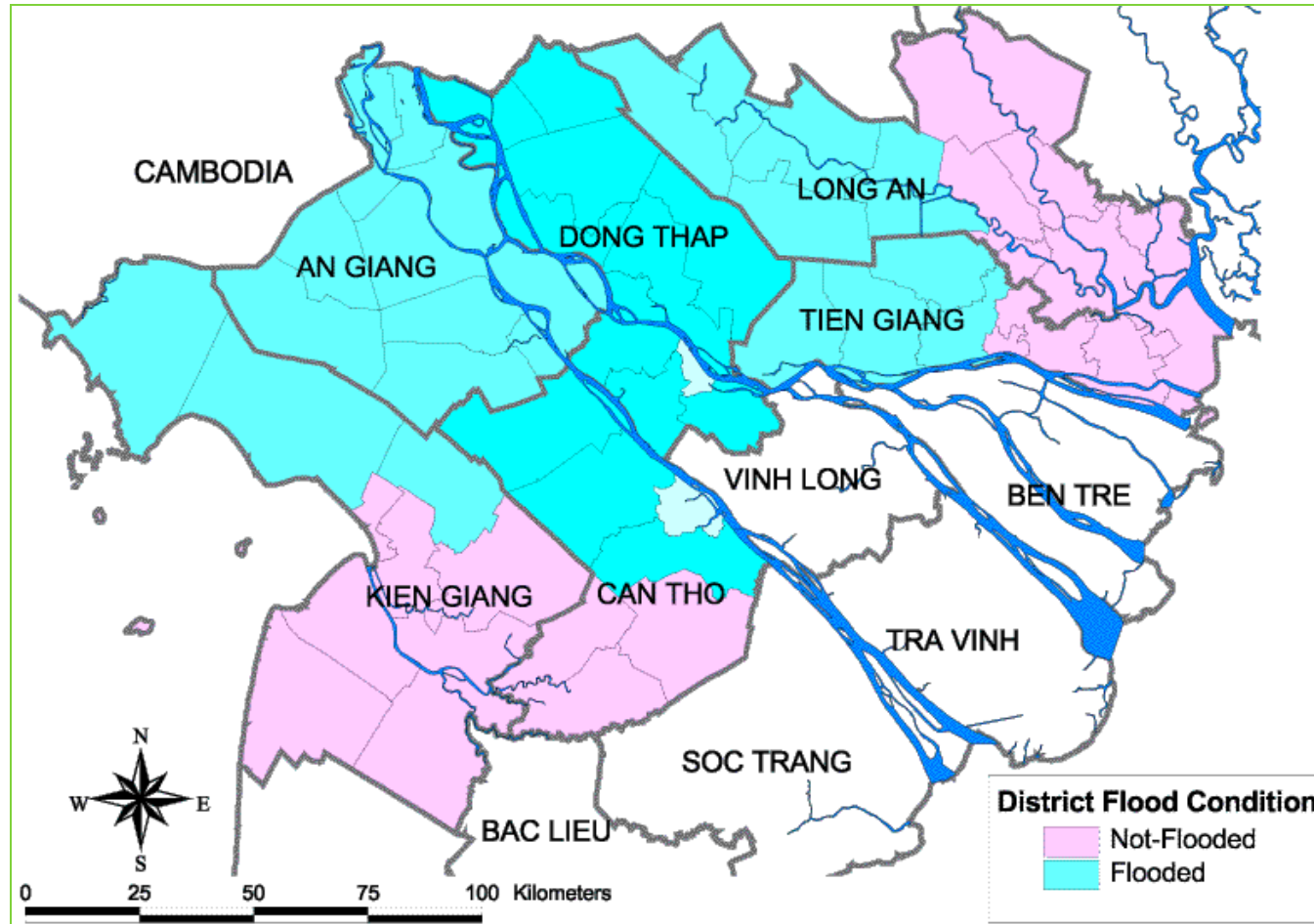
Flood area in Cambodia and Mekong delta

State of the floods



- A vast plain, mainly in the northern parts of the Mekong Delta, is affected by annual flooding by overflows from the river and overland from Cambodia across the Vietnam border
- Long Xuyen Quadrangle (An Giang and Kien Giang provinces) and the Plain of Reeds (Dong Thap and Long An provinces) are damaged by flood from July to November.

State of the floods(1)



MARD-UNDP Disaster Management Unit
September 24, 2001

State of the floods(2)

- The flooded area ranges from 1.2 to 1.4 million ha in years of low and medium flooding; and around 1.9 million ha in years of high flooding (SRV.2005).



- Floods have low discharge capacity. However, they cause prolonged deep inundation, river bank erosion, and transportation difficulties.
- About 50 percent of the Mekong delta experiences flooding and these areas are also susceptible to serious damage by floods about every five years (Sneddon et al. 2001).

Bank erosion

70 sites along the Tien and Hau Rivers face severe bank erosion, especially in Dong Thap and An Giang provinces. Soil erosion in Dong Thap during the 2000 flood season caused 200 ha of severe erosion. An Giang province had nearly 120 ha of land vulnerable to bank erosion.



Navigation hazards

Sedimentation due to floods makes river channel changes which cause hazards and challenges for navigation in the Hau River mouth for ships larger than 3000 Dead Weight Tons (DWT) travelling to Can Tho port.



Pests

Receding flood waters often reveal plagues of Golden Apple Snails (*Panacea canaliculata*) that threaten serious damage to the country's main rice crop. After the 2003 flood, total 31,770 ha of Winter-Spring (Dong Xuan) rice fields were affected by golden apple snails with an associated problem being leaf borers (MARD. 2003)



Invasive exotic plants

Flood flows may disperse invasive exotic plant species such as Giant Mimosa (*Mimosa pigra*) and water hyacinth (*Eichhornia crassipes*). In 2005, the Mimosa infested over 1,600 ha of the Tram Chim National Park - Dong Thap, threatening the grasslands including the feeding habitat of the Eastern Sarus Crane, the *Eleocharis chrostachys* grassland.





Health Risks

Specific health risks related to floods reported by Roger et al (2004) include 3 main categories of disease:

- Water-borne diseases (typhoid, dysentery and cholera)
- Mosquito-borne diseases (dengue fever)
- Skin diseases (fungal skin disease, eye infections and gynaecological infections).



Positive effects or benefits of flood



Fertile sediment

Water quality

Fish spawning

Water provision

Aquatic
products

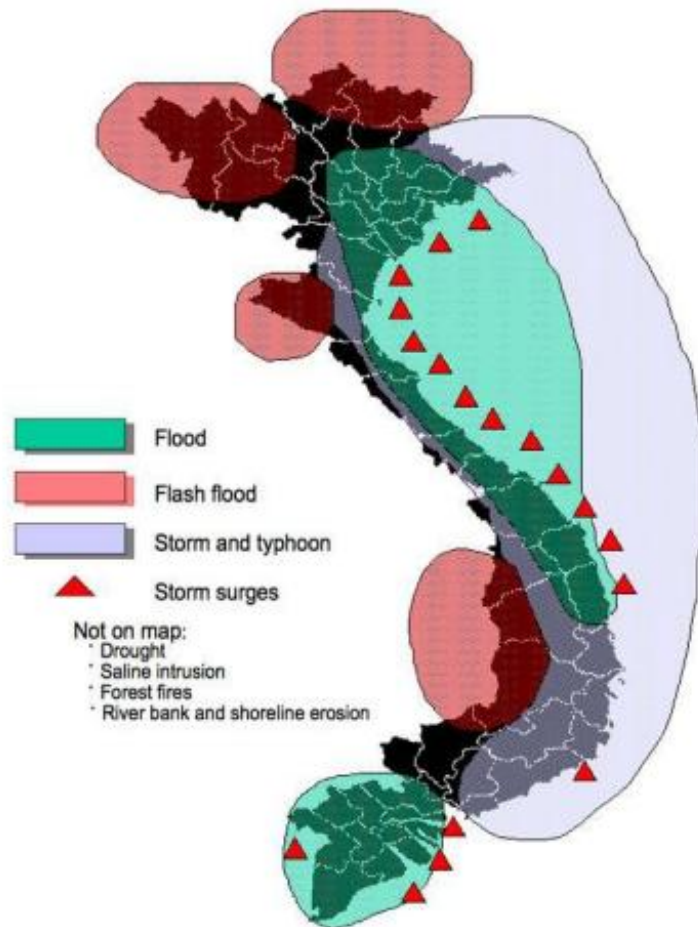
Reduce fire risk

Flushing effect

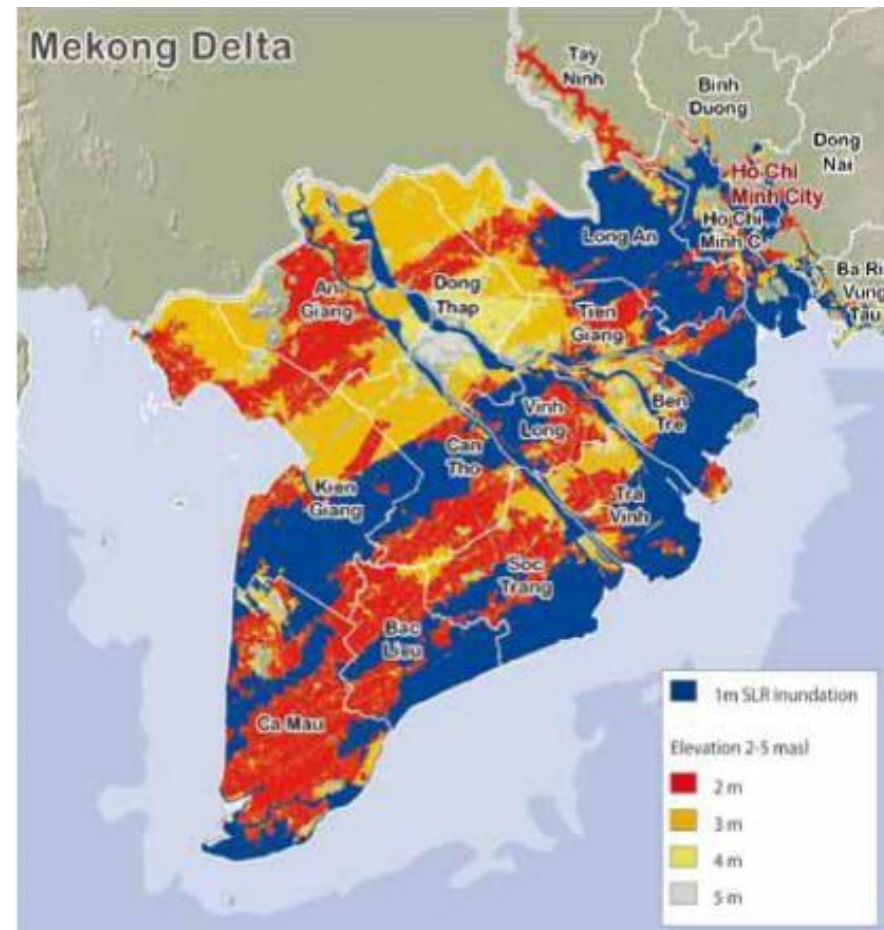
Ecological
drivers

Storm & sea level rise

Storm surge – a WB study, 2009



Inundation areas with 1-5m sea level rise



Expected climate change impacts on the Mekong delta

□ Primary impacts

- Temperature change 1.1° C (2050), 1.5° C (2070)
- Precipitation rainy season: -5 to 5%, dry season -5 to 0%
- Storm surge; sea level rise 12 cm (already), 33 cm (2050), 45 cm (2070)
- Increases frequency and intensity of typhoons

□ Implied impacts

- More flood and droughts (less water in dry season)
- Possible permanent inundation for some areas
- Increases **salinity intrusion** (area and duration)
- Increased risks of infectious diseases

□ Other factors to be considered

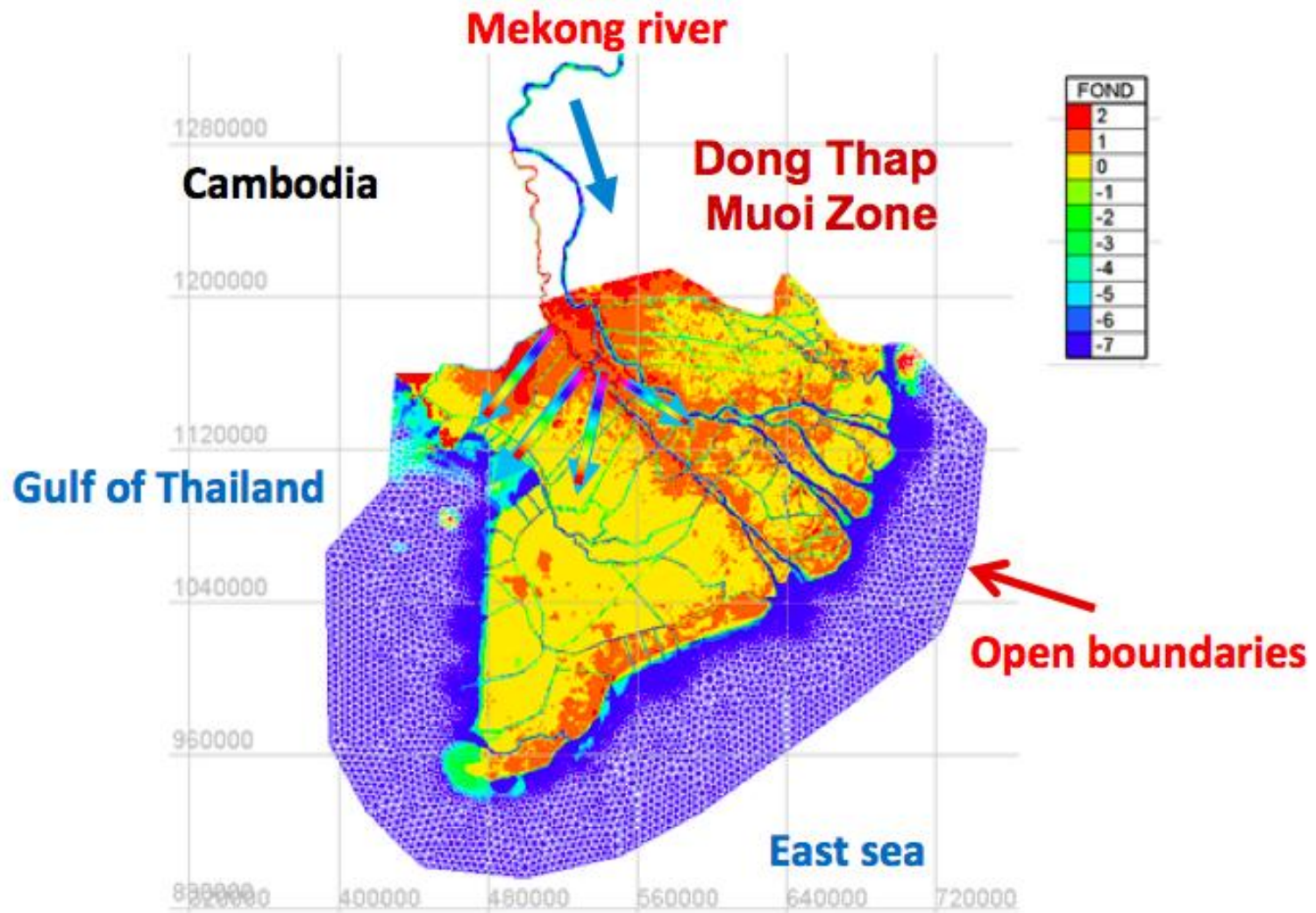
- Upstream development (hydropower station and irrigation)
- Urbanization



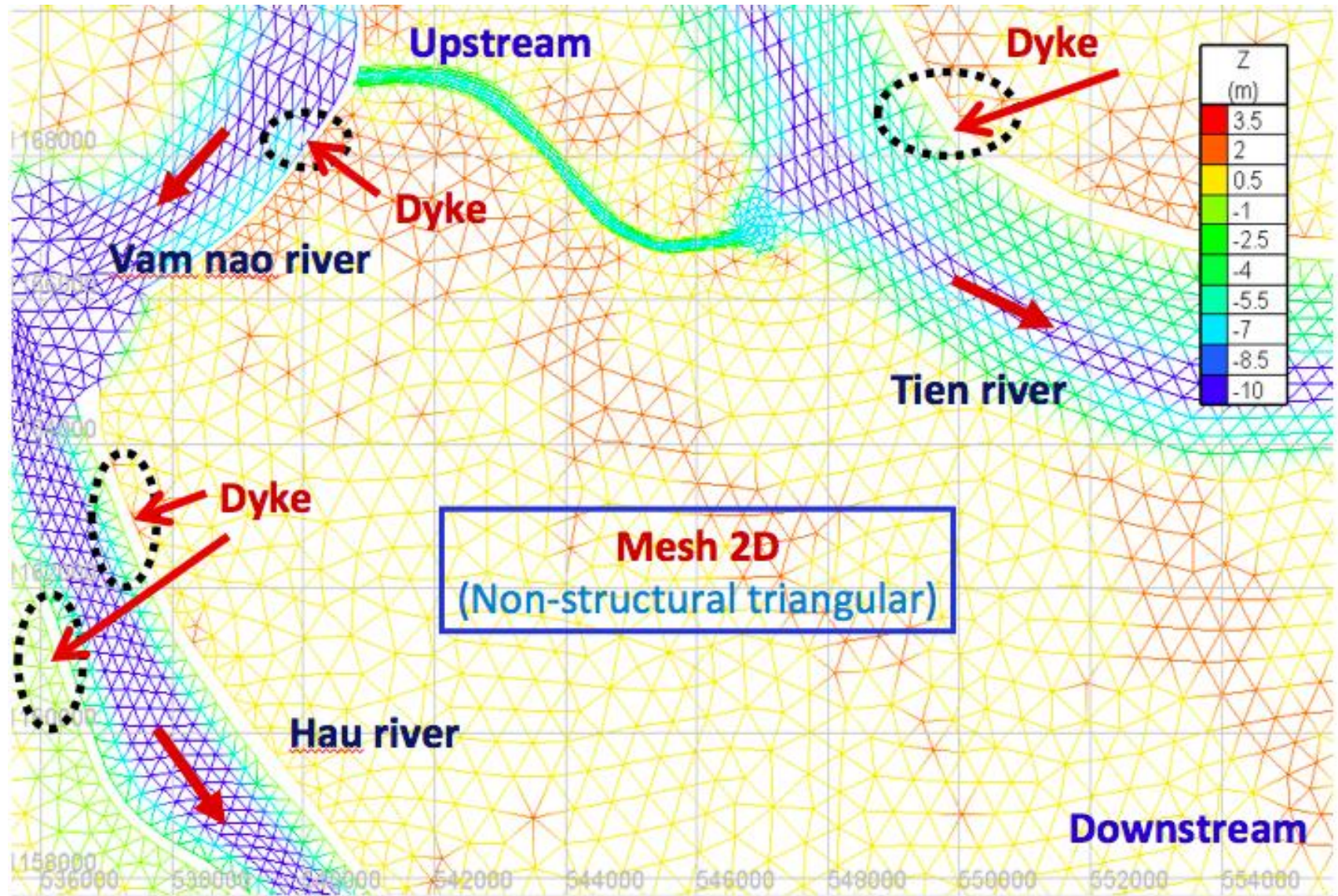
The Mekong delta: historical prospective

- 1975 – 1990: Rice First for Subsistence – investment in the primary and secondary to increase irrigation area;
- 1990 – 2000: Multiple crops–tertiary canals, flood protection dykes and primary sluice gates to control salinity;
- 2000 – 2010: Diversification (mainly aquaculture) – tertiary canals and secondary/tertiary sluice gates

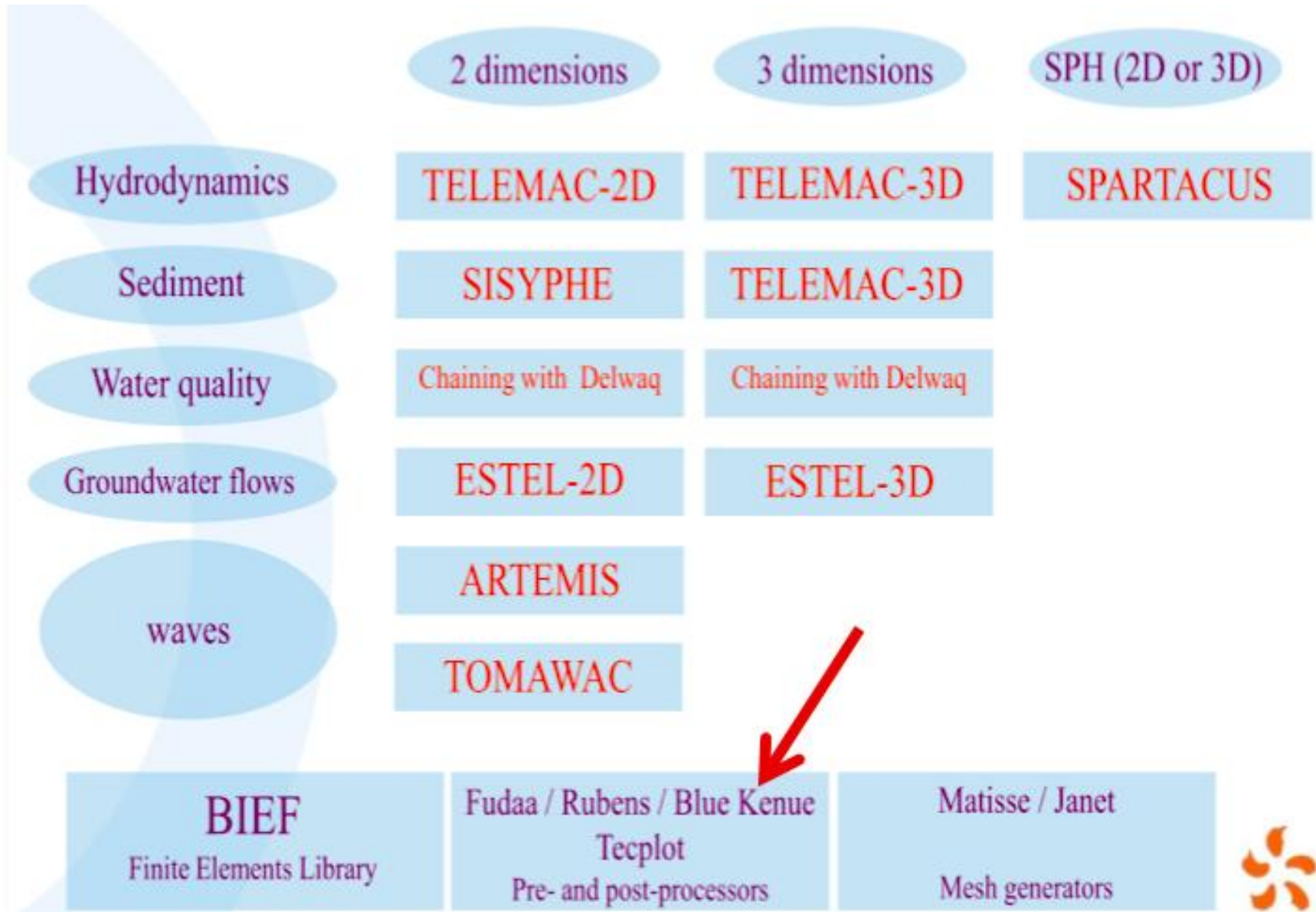
Numerical study (1)



Numerical study (2)



Numerical study (3)



Numerical study (4)

THEORETICAL ASPECTS

TELEMAC-2D simultaneously solves 4 hydrodynamic equations

$$\frac{\partial h}{\partial t} + \vec{u} \cdot \vec{\nabla}(h) + h \operatorname{div}(\vec{u}) = S_h$$

Continuity

$$\frac{\partial u}{\partial t} + \vec{u} \cdot \vec{\nabla}(u) = -g \frac{\partial Z}{\partial x} + S_x + \frac{1}{h} \operatorname{div}(h \nu_t \vec{\nabla} u)$$

Dynamic x

$$\frac{\partial v}{\partial t} + \vec{u} \cdot \vec{\nabla}(v) = -g \frac{\partial Z}{\partial y} + S_y + \frac{1}{h} \operatorname{div}(h \nu_t \vec{\nabla} v)$$

Dynamic y

$$\frac{\partial T}{\partial t} + \vec{u} \cdot \vec{\nabla}(T) = S_T + \frac{1}{h} \operatorname{div}(h \nu_T \vec{\nabla} T)$$

Convection
tracer

- **Telemac2D** → SAINT VENANT
- **Telelmac3D** → NAVIER-STOKES
- **Method:** Finite element or finite volume
- Parallelism

Numerical study (5)

Area: 81.10^3 km^2

→ 716.000 triangular elements :

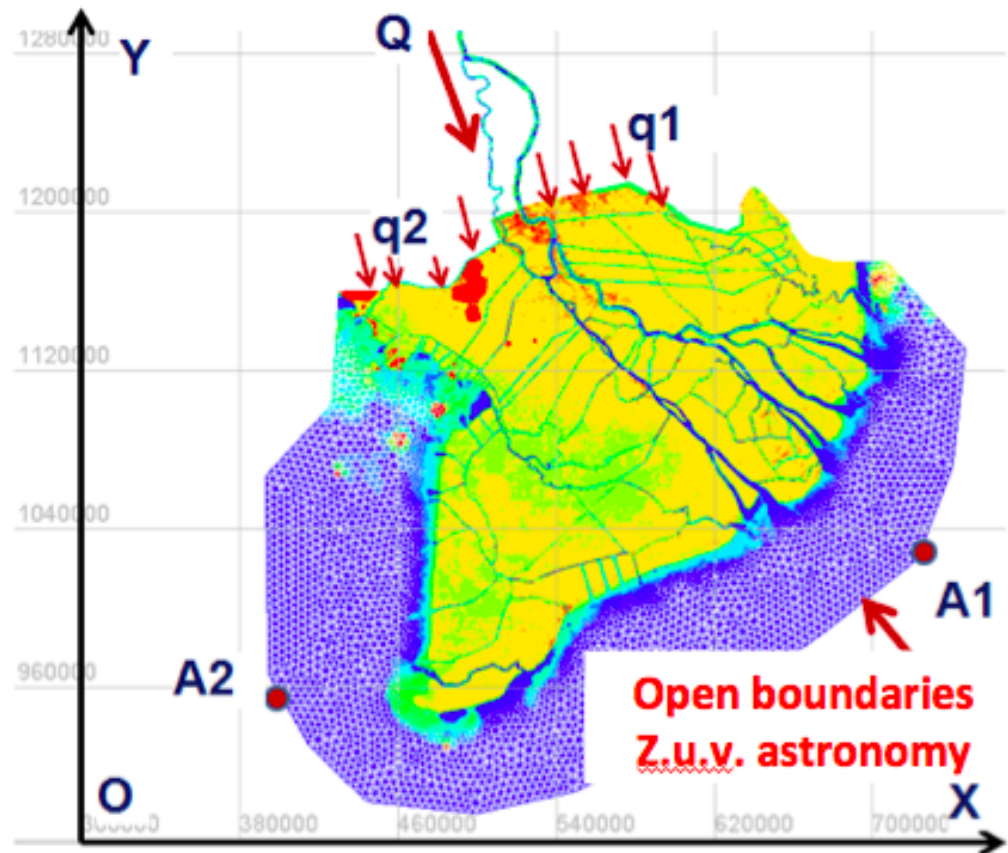
+ 20m (in rivers. canals)

+ 6000 m (in the sea).

Boundary conditions:

$Q(t)$. $q(t)$: upstream

$Z(t)$: Astronomical tide data





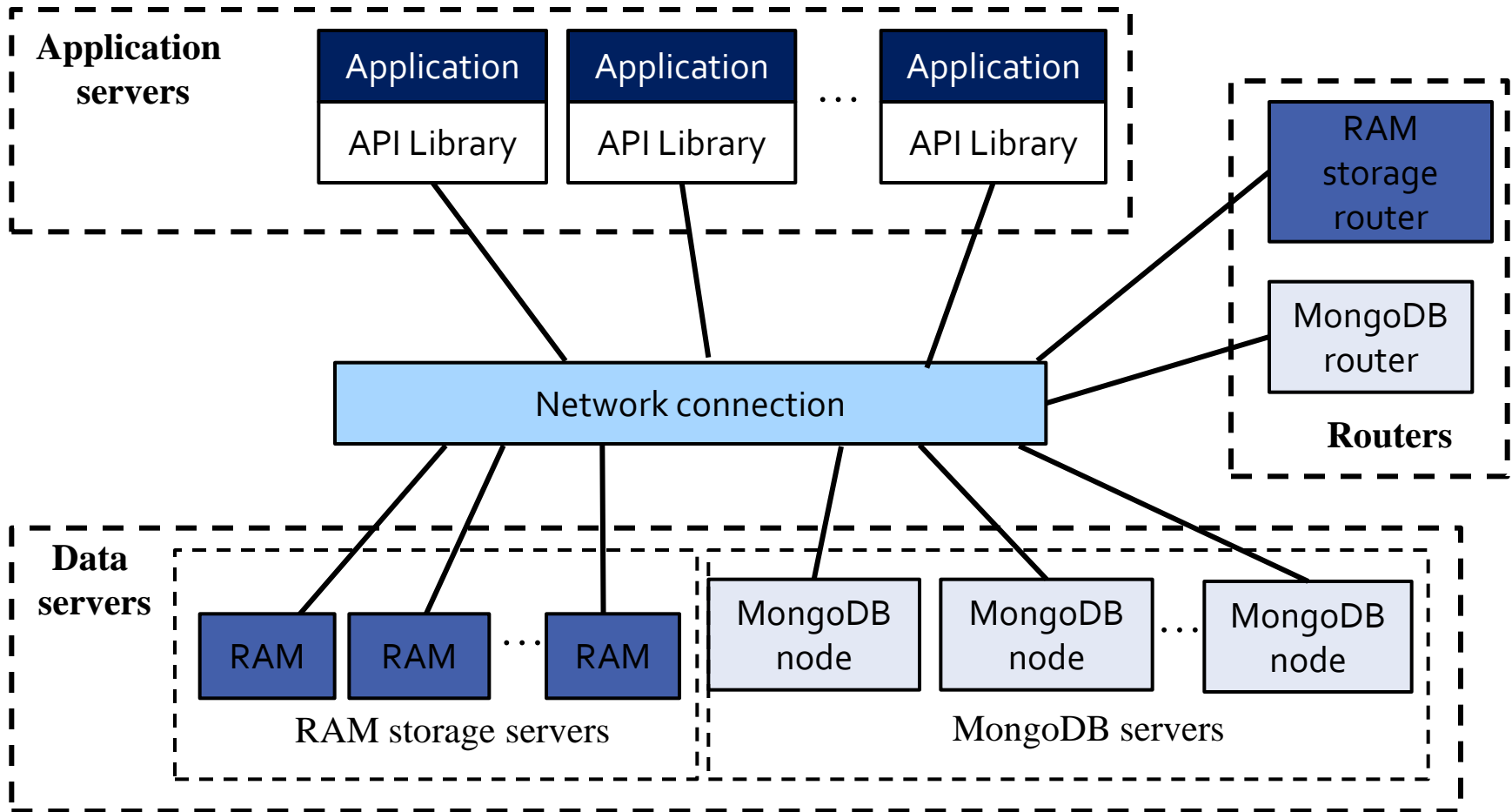
Thank you!

More information:

`namthoai@hcmut.edu.vn`

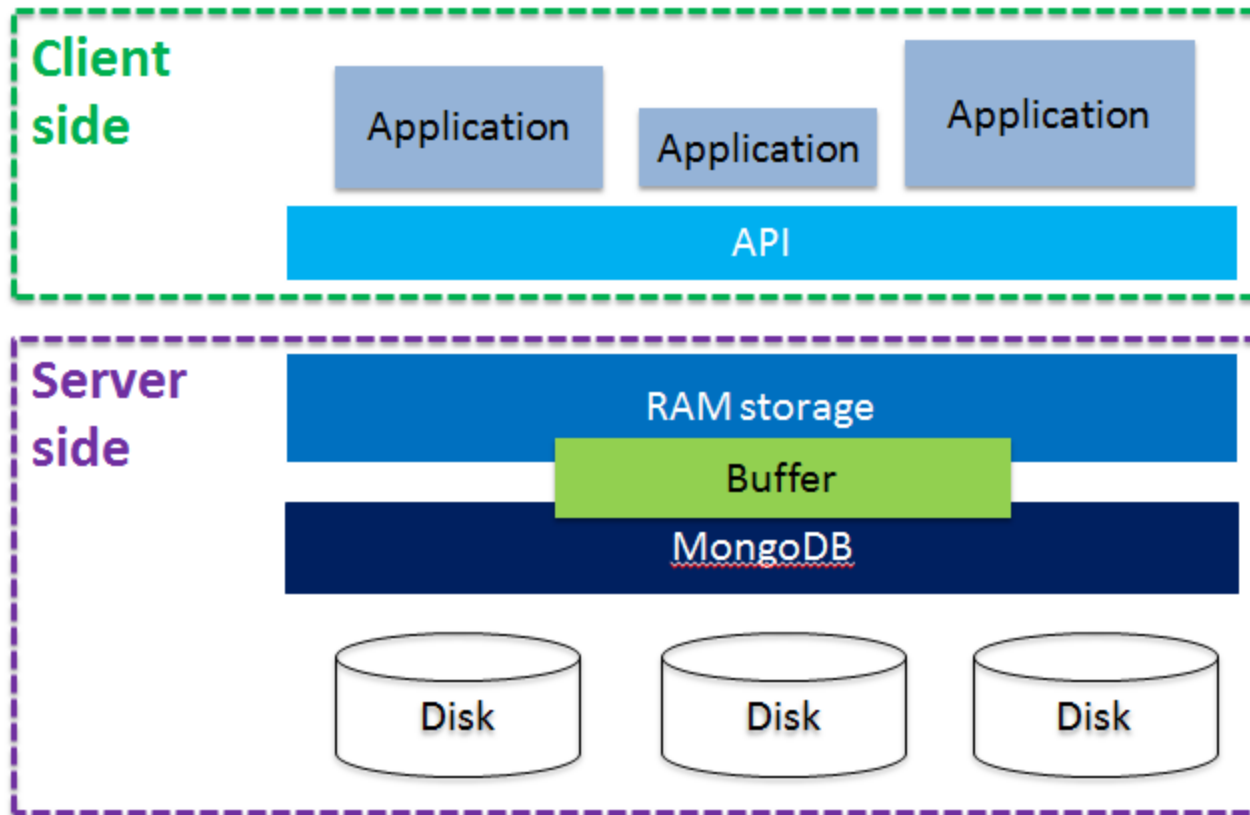
`http://www.cse.hcmut.edu.vn/`

Architecture of storage system for real-time traffic data (physical view)

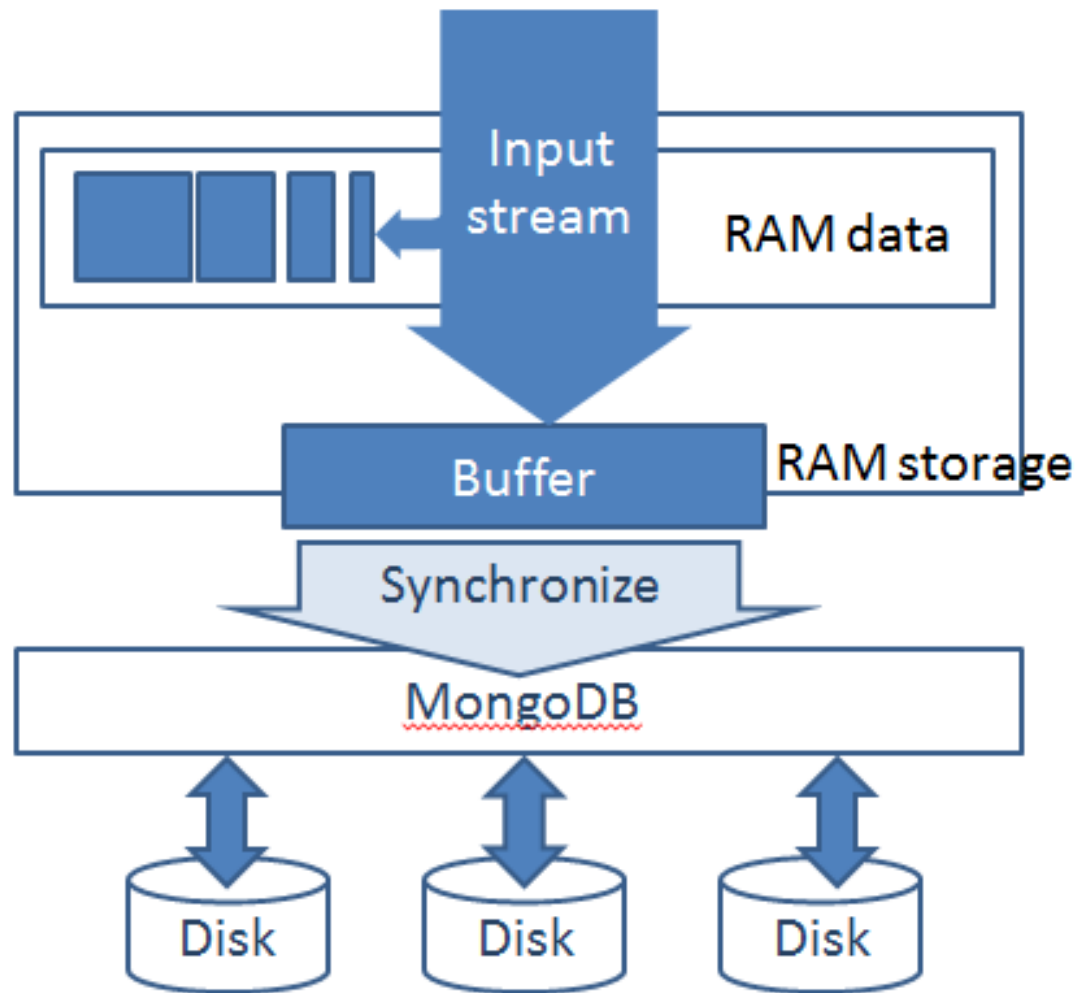


Solution

- Collecting data per cell
- Multi-server
- Data on RAM

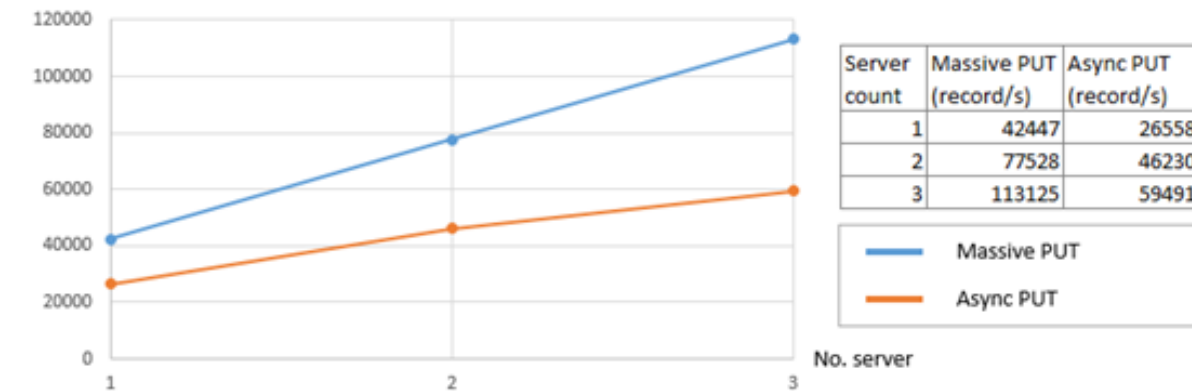


Storing data in real time (1)

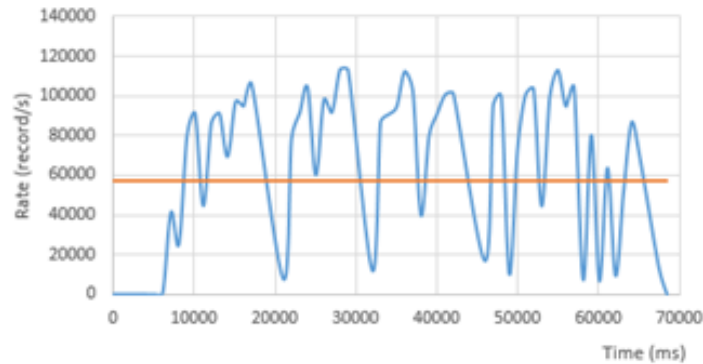


Storing data in real time (2)

PUT rate and server count relation



PUT rate (without synchronization)



PUT rate (with synchronization)

