

# Real-Time Traffic Monitoring & Information System for a Smart City

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Education Workshop

“The Role of Information Technology in the Development of Smart City”

8 March 2018 @ Ho Chi Minh City

# CONTENTS

- **URBAN TRANSPORT PROBLEMS**
- **SMART URBAN MOBILITY FRAMEWORK**
- **REAL-TIME TRAFFIC INFORMATION SYSTEM**
- **LANDUSE MONITORING SYSTEM**
- **CONCLUSIONS**

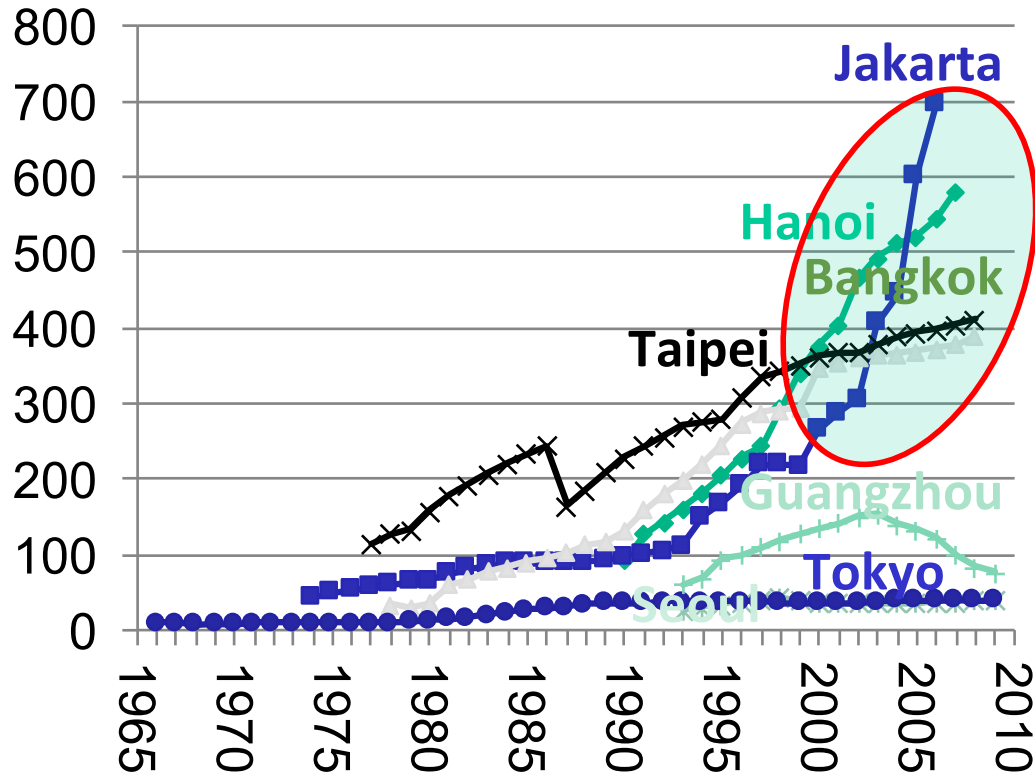






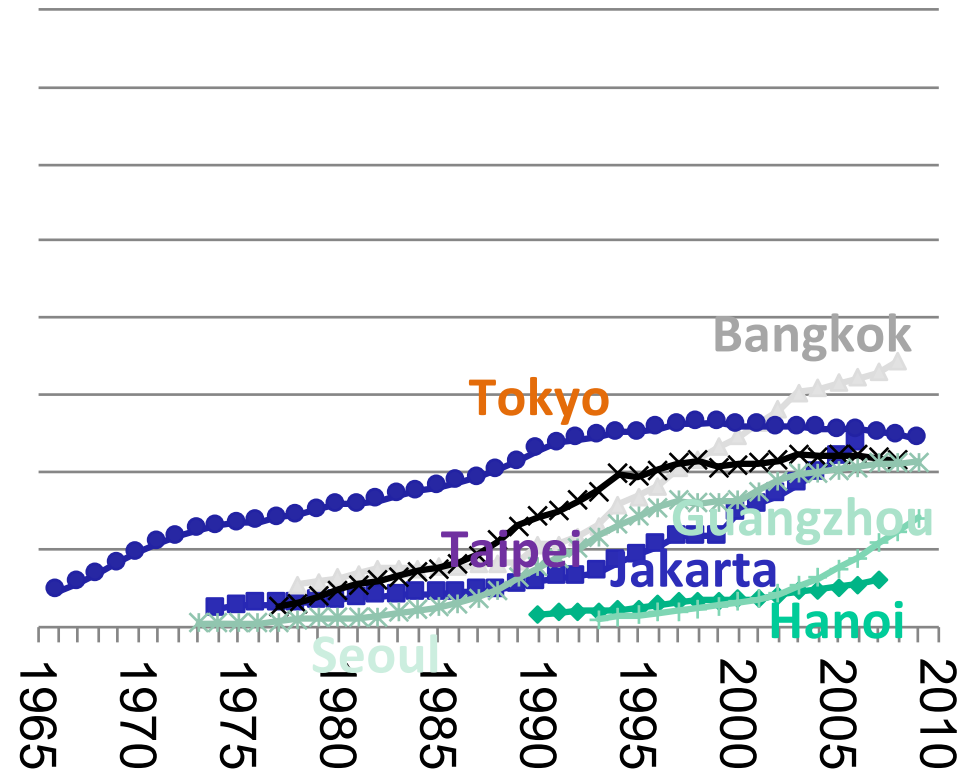
# Motorization in selected Asian cities

Motorcycle / 1000 person



- MC rapidly increased in Hanoi, Jakarta despite of lower incomes
- Continued increasing in Taipei at high incomes

Prv't passenger car / 1000 person



- Cars increasing rapidly in Bangkok, Jakarta
- Hanoi may do so in the future

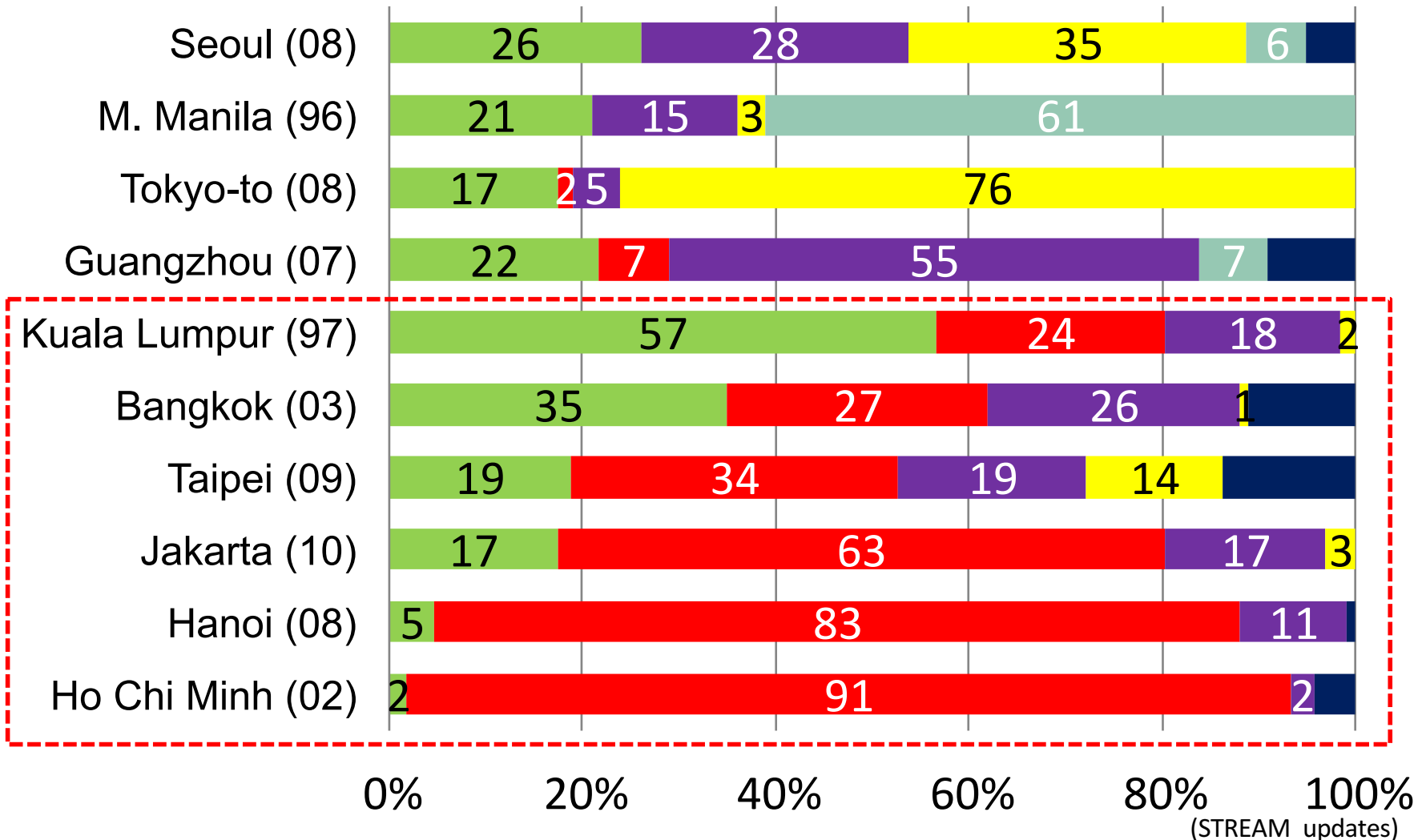
(V.A. Tuan,, 2014)



# Modal splits in major Asian cities

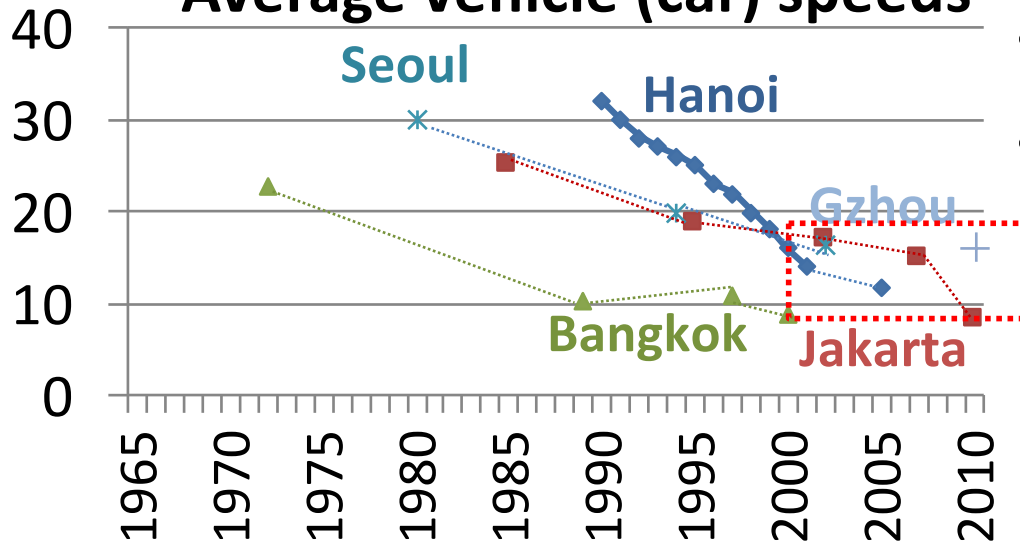
(% motorized trips)

■ Car ■ M-cycle ■ Bus ■ Train ■ Paratransit ■ Others



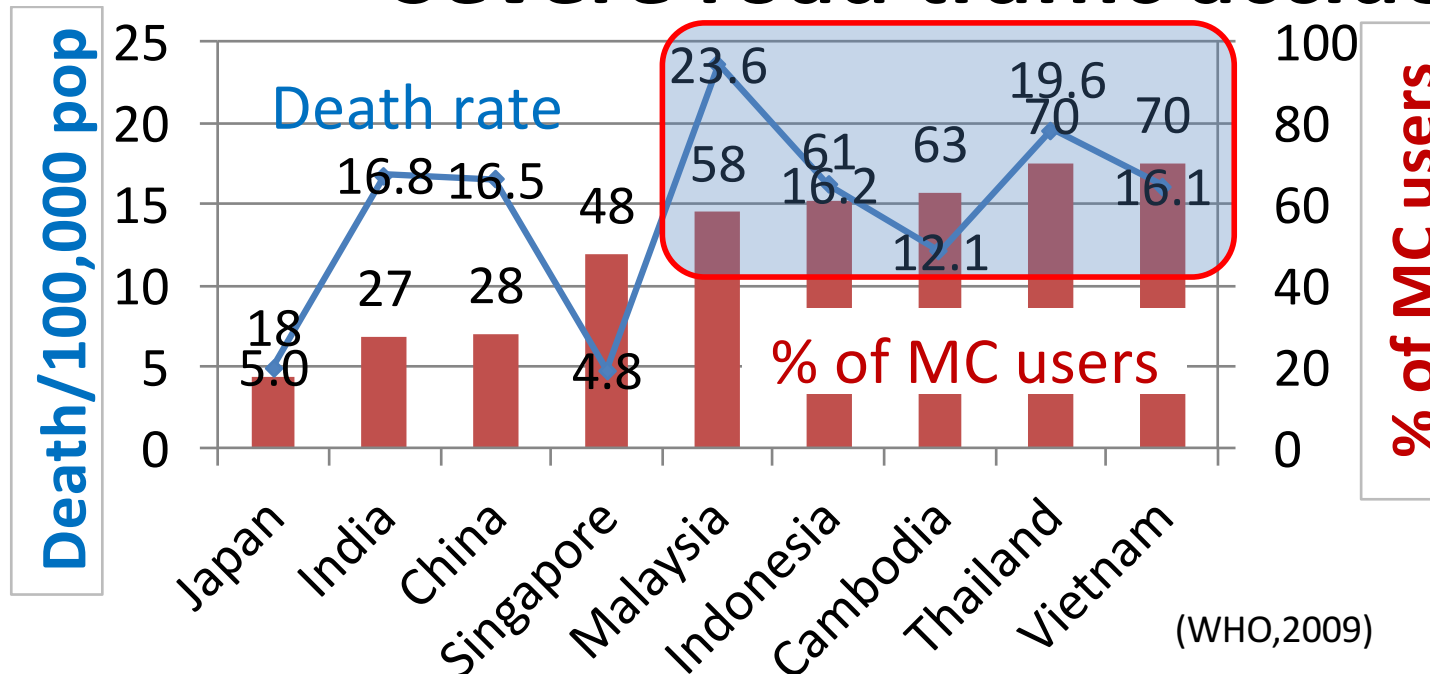
# Increased road congestion

Average vehicle (car) speeds



- Sharp decline of road speeds
- Enormous economic loss (Jakarta 600 mil. US\$ / year)
- High death rates in DACs
- 60-70% deaths are MC users

## Severe road traffic accidents



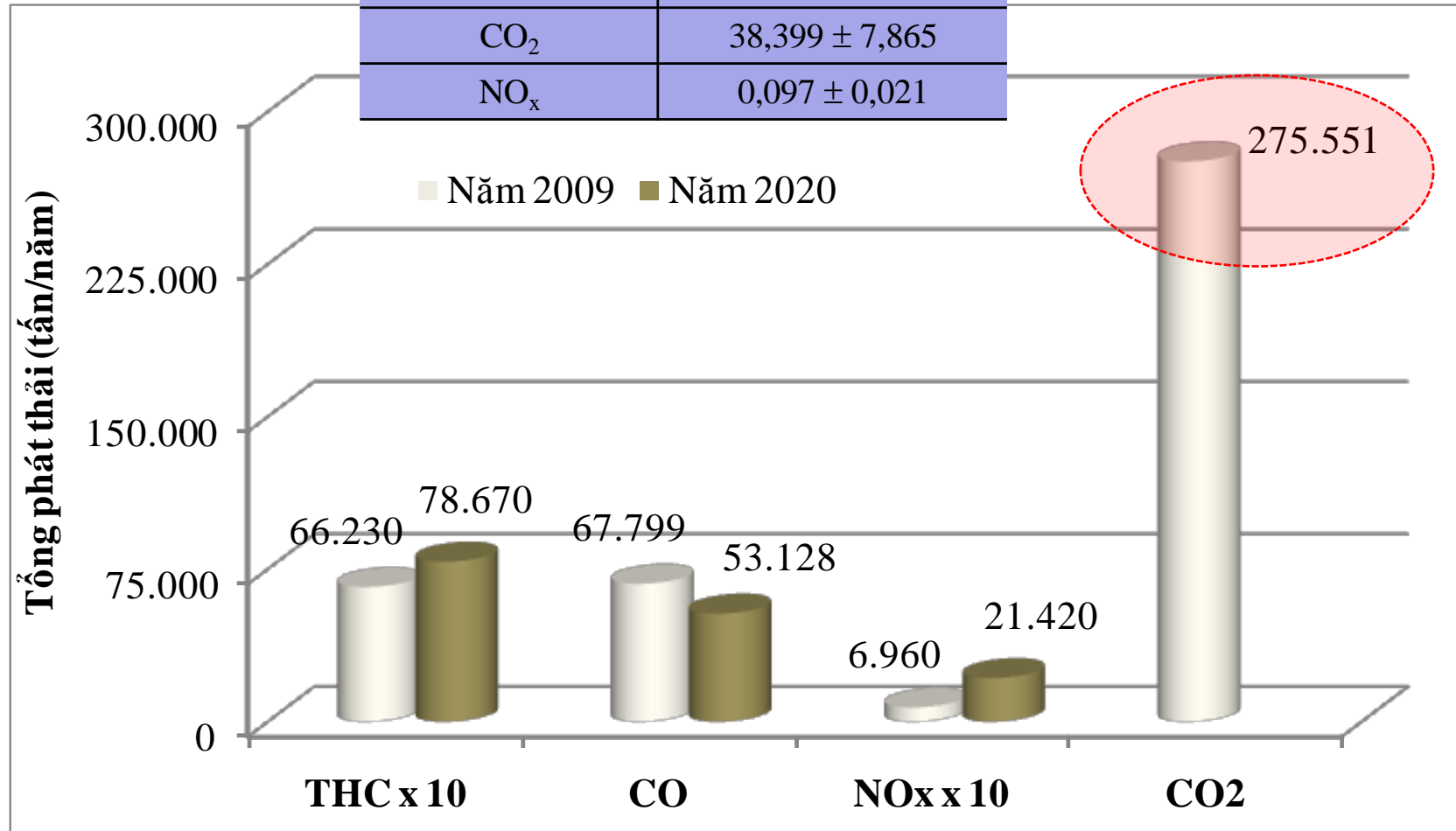
(WHO, 2009)





# Motorcycle Pollutions in Hanoi

Pollutants	Value (g/km)
THC	$0,923 \pm 0,178$
CO	$9,448 \pm 1,864$
CO <sub>2</sub>	$38,399 \pm 7,865$
NO <sub>x</sub>	$0,097 \pm 0,021$

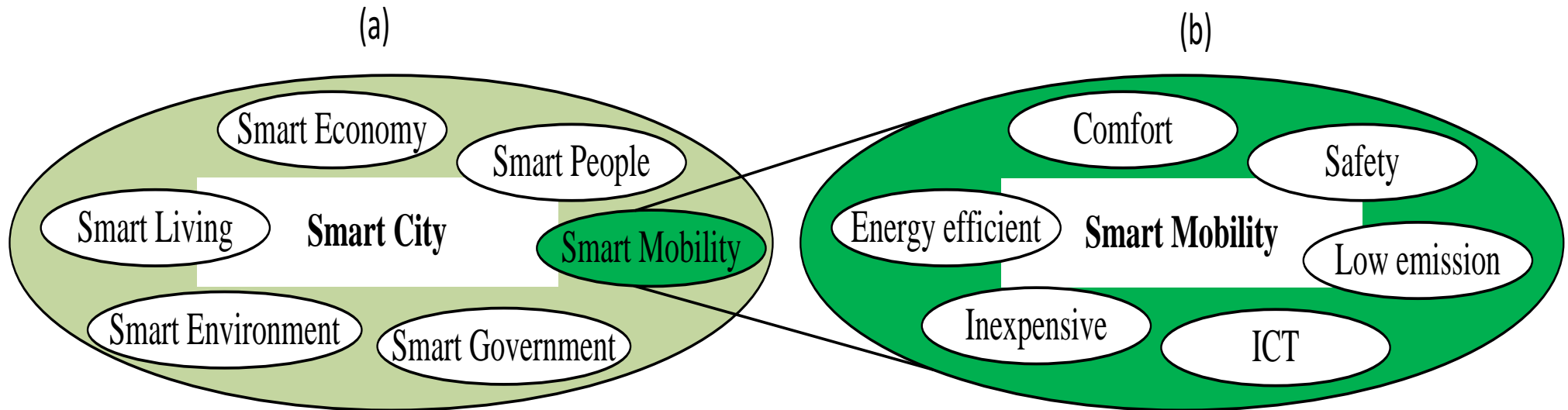


Source: Lê Anh Tuấn et al. (2011)

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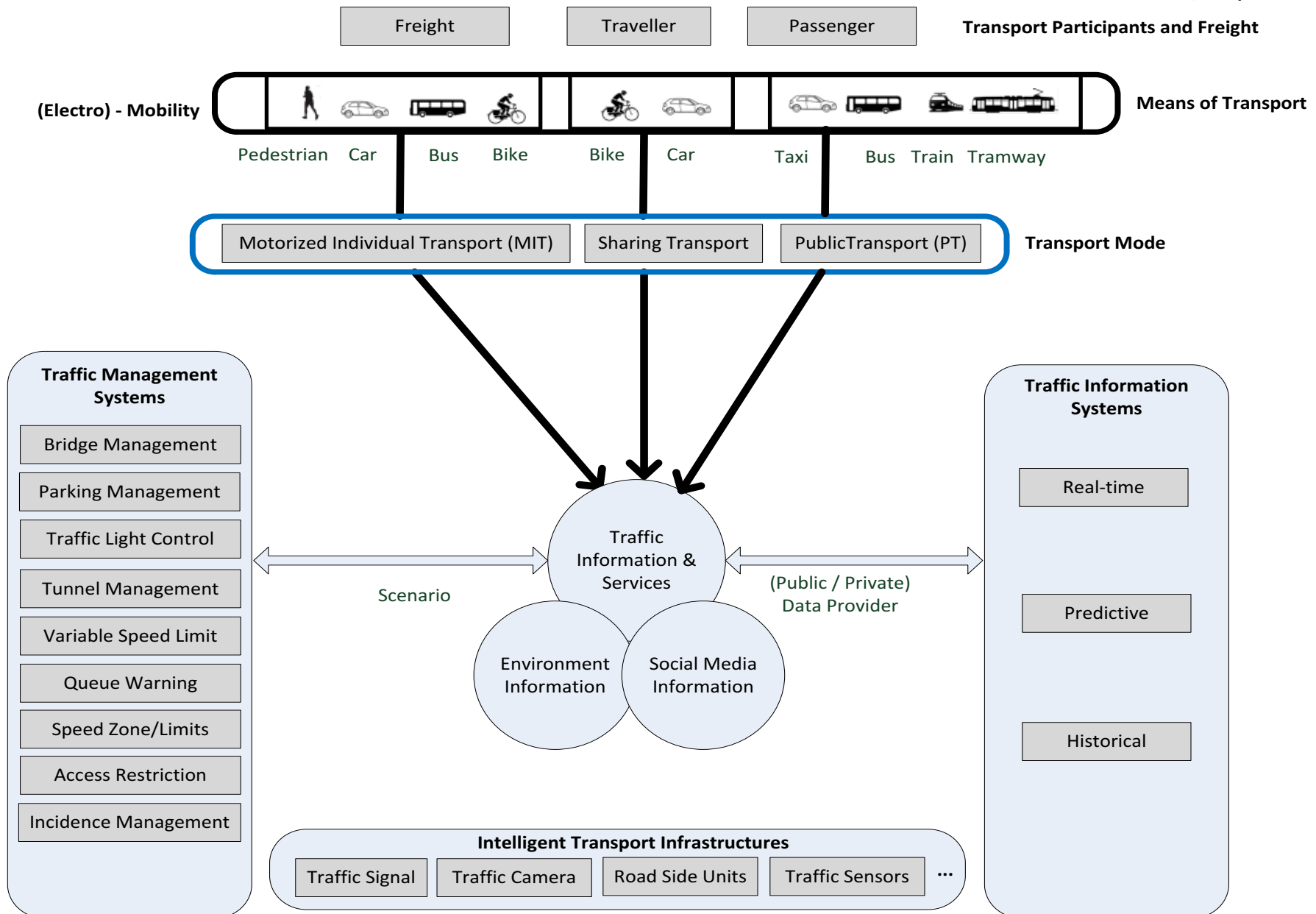


## ➤ Definition

- Smart mobility as part of a Smart City that offers an “energy efficient”, “low emission”, “safe”, “comfortable” and “inexpensive” mobility system,
- which is smartly used by traveling people

## ➤ Focus

- Establishing new efficient infrastructures/services
  - Optimizing existing ones through the use of ICT
-



## Smart Mobility System for Smart City



# Real Time Monitoring of Urban Transport - Solutions for Sustainable Transport Management and Urban Development in Hanoi

AS&P



INTERNATIONALE AKADEMIE BERLIN  
für innovative Pädagogik, Psychologie und Ökonomie gGmbH (IAA)



VGU  
Vietnamese-German University

WWL Umweltplanung  
und Geoinformatik GbR

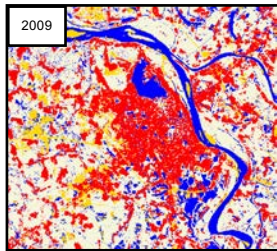
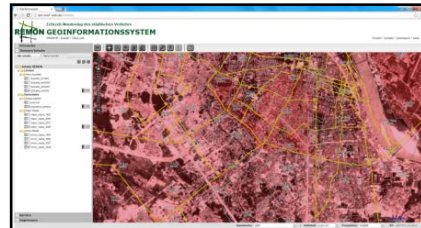
## Key objectives

- Reduction of traffic induced air pollutants
- Reduction of energy consumption in urban transport

## Project duration

- 3 years (Jan 2013 to Dec 2015)

## Project Components

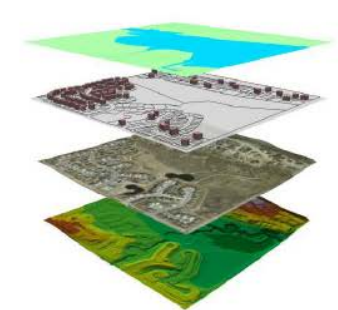
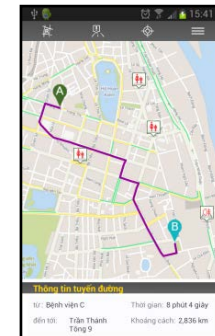


Landuse  
Change & Urban  
Growth Model  
(GIS, Digital  
Street Map)

Traffic  
Information  
System  
(FCD, FPD)

Traffic  
Management  
(Strategies &  
Modelling)

Policy Analysis  
for Energy-  
efficient Urban  
Planning

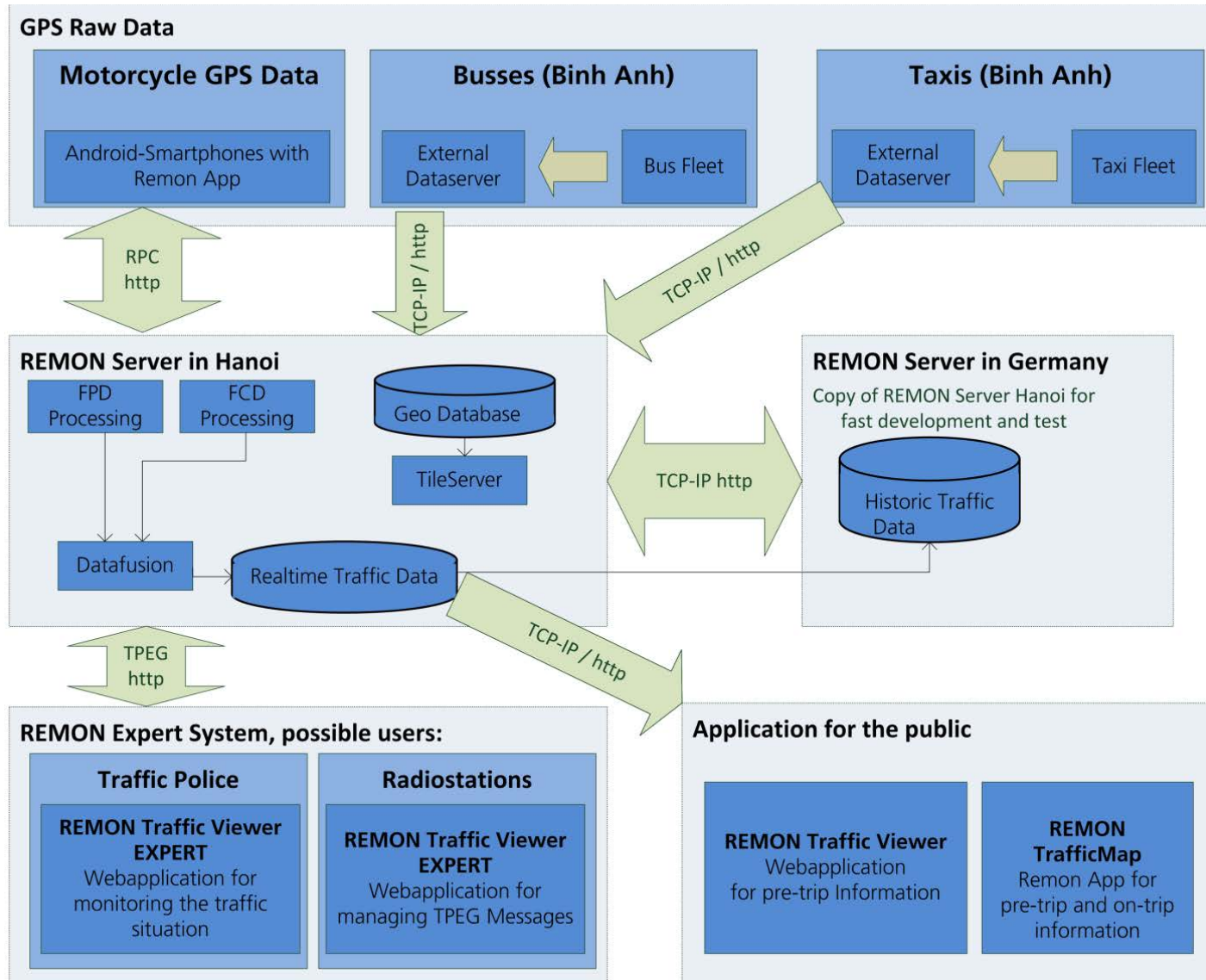




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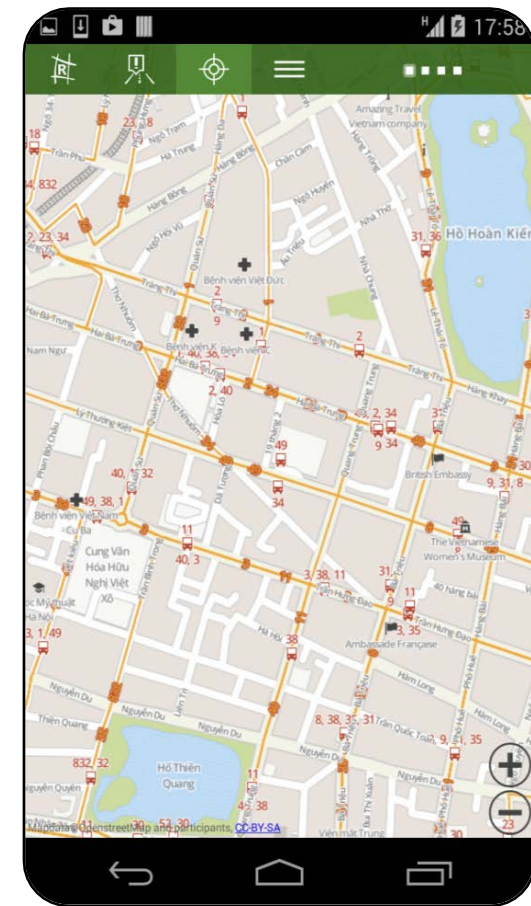
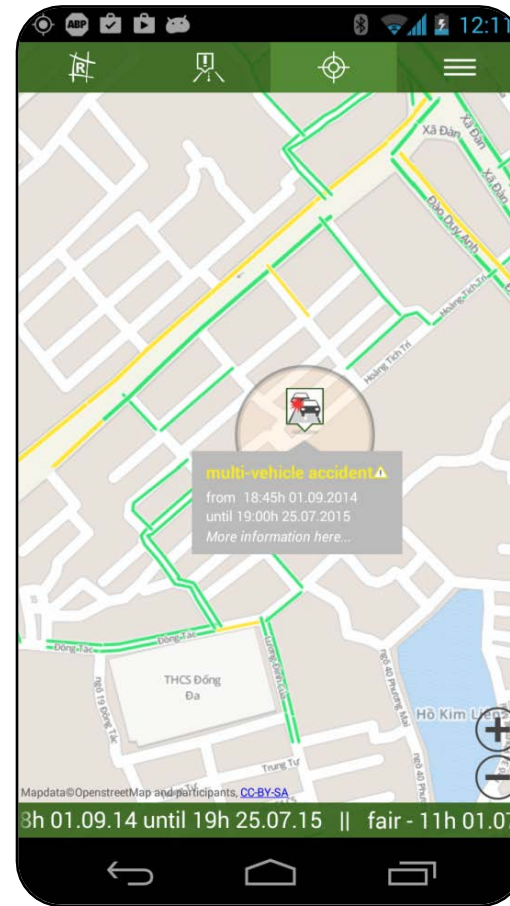
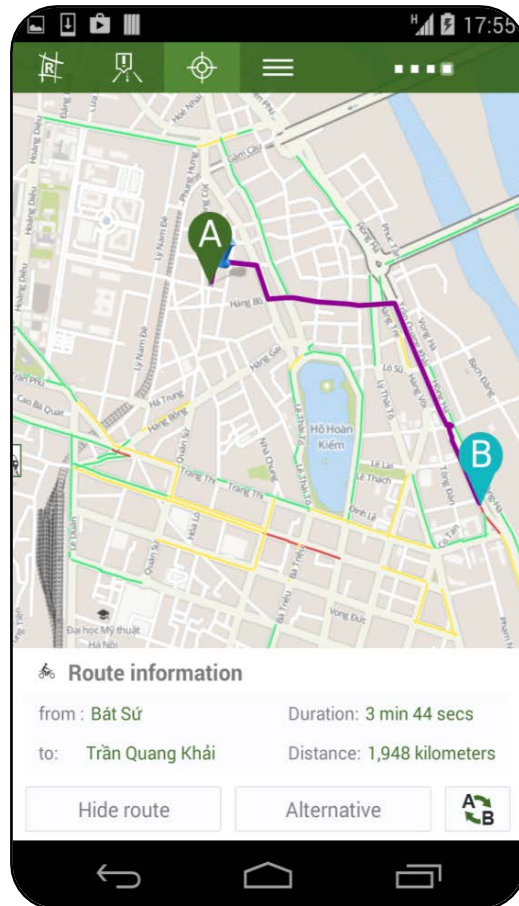
# System Architecture



- FCD, FPD, FMD
- Mapping traffic LOS
- Analysis of hot spots

(Alexander Sohr, 2015)

# REMON Traffic Map App - Screenshots

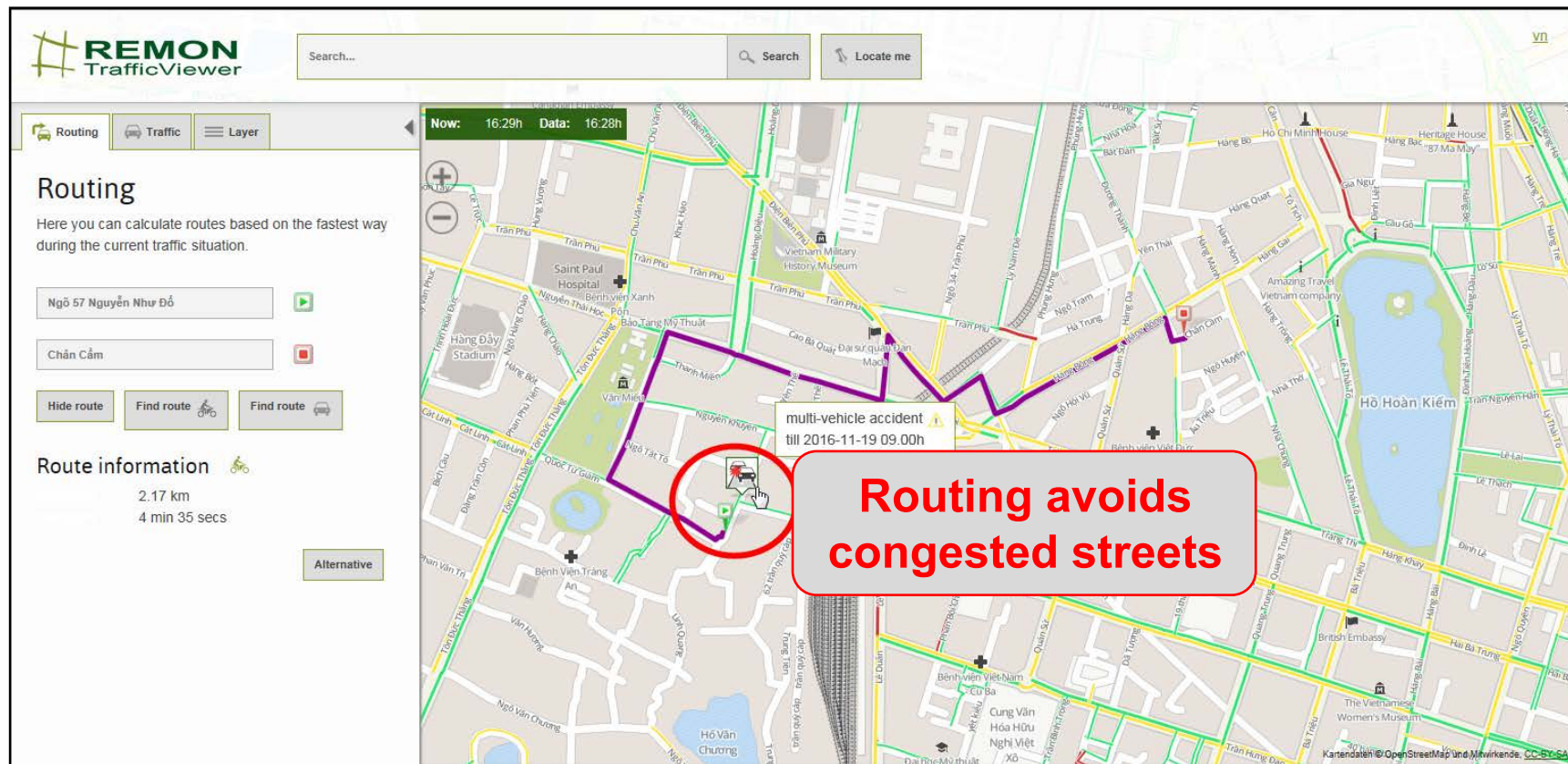


(Alexander Sohr, 2015)



# Traffic Viewer

- Traffic information (LOS)
- TPEG messages
- Dynamic routing
- POI (Points Of Interest)



(Alexander Sohr, 2015)



# Traffic Viewer **Expert**

The screenshot displays the REMON TrafficViewer Expert web application. The interface includes a search bar at the top, a map of Hanoi, Vietnam, and a sidebar with various controls. A red box highlights the 'Routing' section, which contains input fields for 'Quốc Tử Giám' and 'Hai Bà Trưng', and buttons for 'Hide route', 'Find route' (with a bicycle icon), and 'Find route' (with a car icon). Below this, the 'Route information' section shows 'Priority: best (with traffic prediction)', 'Distance: 2.26 km', and 'Duration: 5 min 56 secs'. A red arrow points from the 'Routing functions' label to the 'Find route' buttons. Another red box highlights the 'Layer' section, which includes checkboxes for 'public transport', 'Banks and ATM', and 'Gas stations'. A red arrow points from the 'TPEG messages' label to a red circle on the map containing a truck icon. At the bottom, a 'Traffic Ticker' displays three messages: 'hicle accident - from 09:00 03.12.2012 till 09:00 19.11.2016', 'major roadworks - from 13:45 01.09.2014 till 11:00 30.04.2015', and 'multi-vehicle accident - from 13:45 01.09.2014 till 14:00 25.07.201'.

**Routing functions**

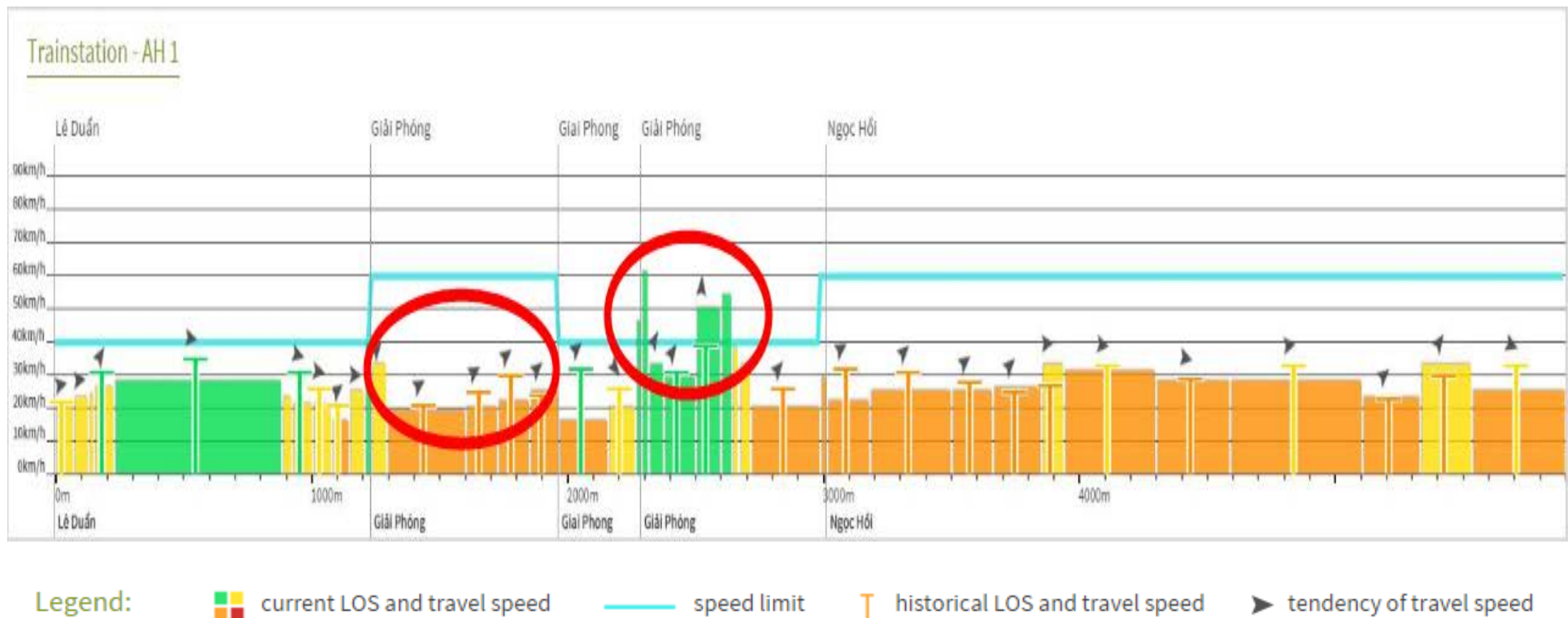
**TPEG messages**

Traffic Ticker: hicle accident - from 09:00 03.12.2012 till 09:00 19.11.2016 || major roadworks - from 13:45 01.09.2014 till 11:00 30.04.2015 || multi-vehicle accident - from 13:45 01.09.2014 till 14:00 25.07.201

(Alexander Sohr, 2015)

## Traffic Viewer **Expert** - Route Monitoring

- Traffic visualisation of defined routes (including trends)

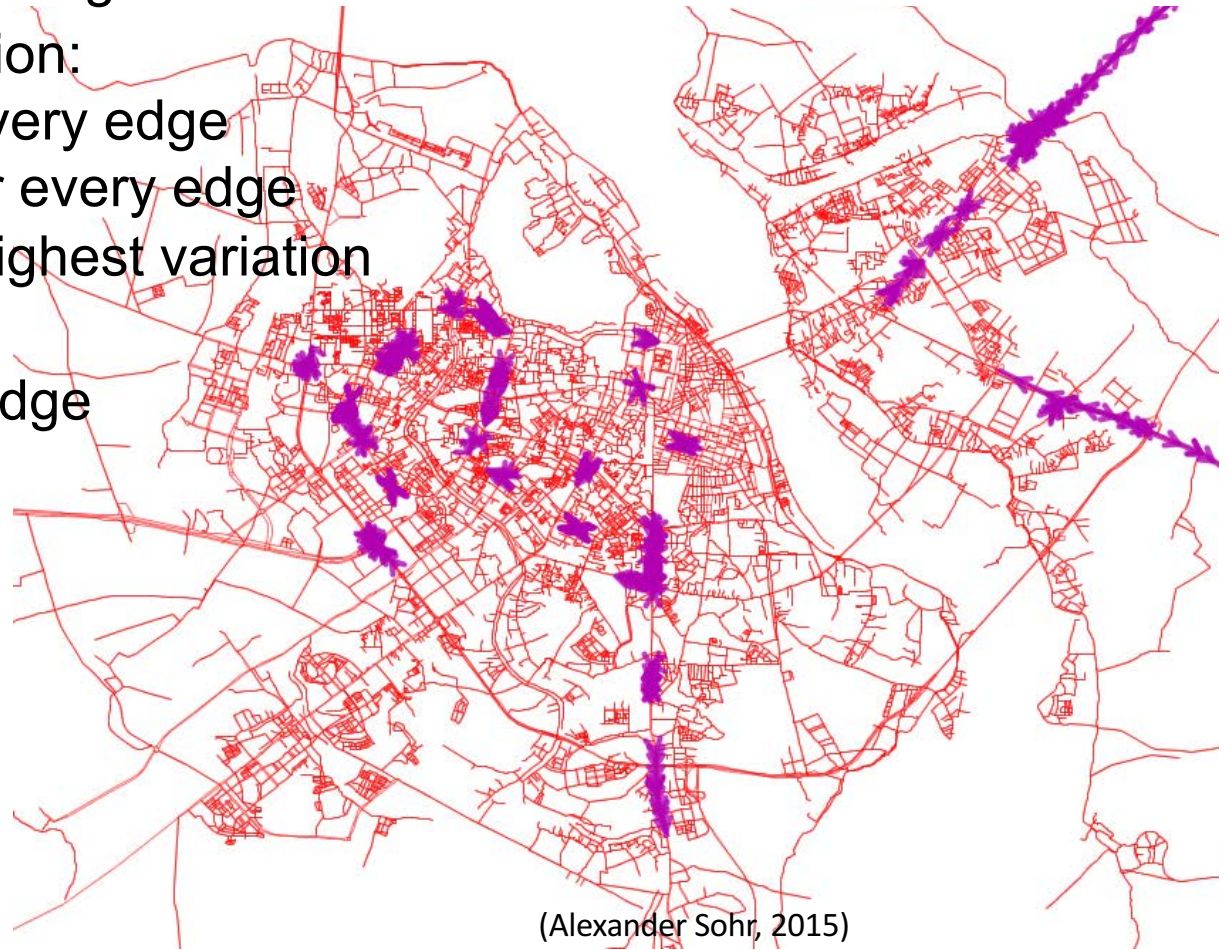


(Alexander Sohr, 2015)



# Hotspot Analysis

- Data source:
  - historical taxi data of four months (no weekends)
  - daily courses for every edge in the road network
- Automatic **Hotspot** detection:
  - ,FreeFlowSpeed for every edge
  - Standard Deviation for every edge
  - Filter the edges with highest variation
- Defining **Hotspots**
  - based on local knowledge



(Alexander Sohr, 2015)

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  - Monitoring landuse changes over the past 20 years
  - Analyzing urban expansion by zone, corridor
  - Modeling urban dynamics

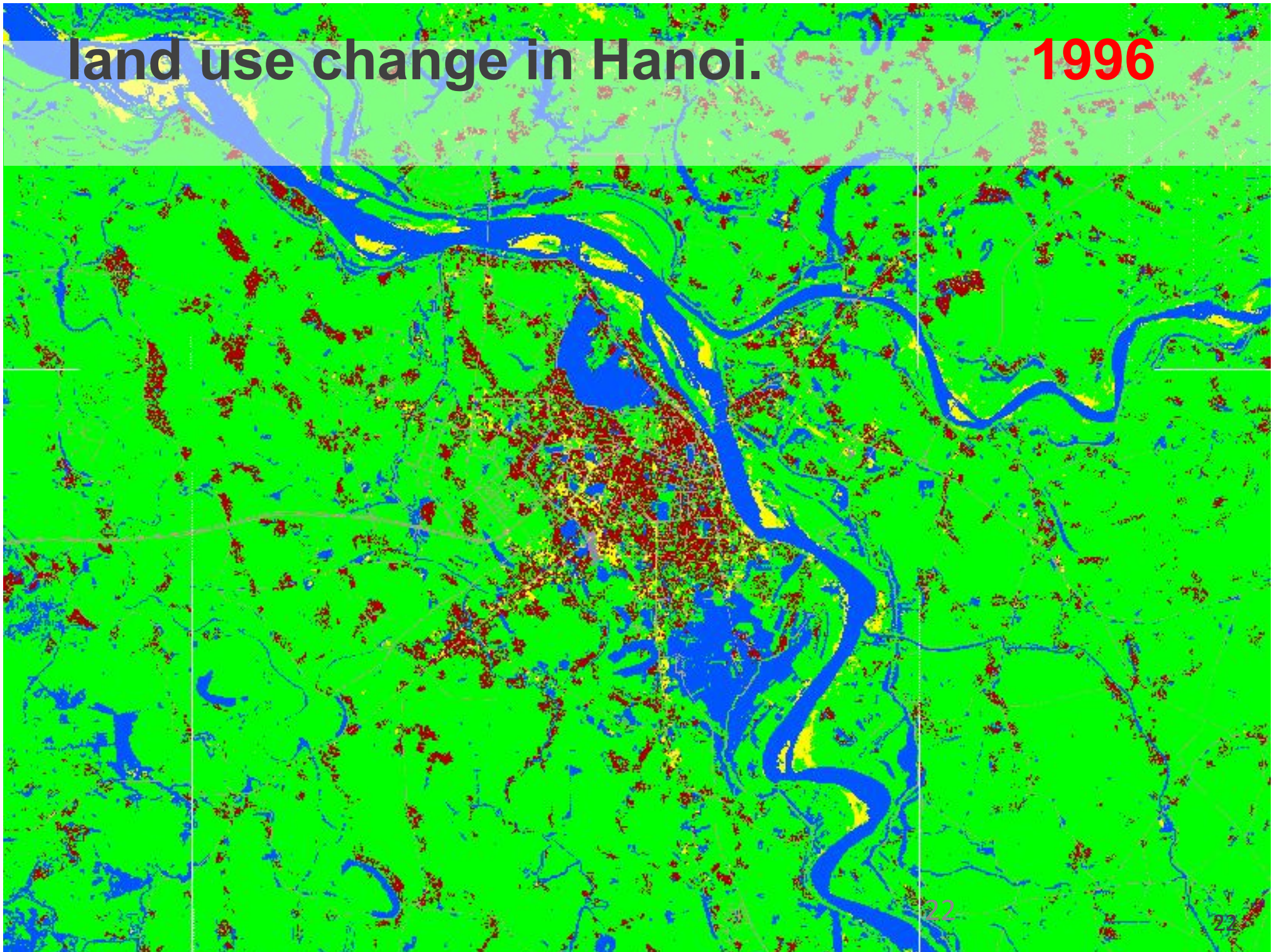


date	Satellite Sensor	Spectral resolution	Geometric resolution	Radiometr. resolution
29.12.1975	Landsat MSS	4 (blau, rot, NIR1, NIR2)	57 x 57m <sup>2</sup> (79 x 79m <sup>2</sup> )	8 Bit (256)
27.12.1993	Landsat TM5	7 (blau, grün, rot, NIR1, MIR1, PAN, MIR2)	30 x 30m <sup>2</sup>	8 Bit (256)
30.09.1996	Landsat TM5	7 (blau, grün, rot, NIR, MIR1, PAN, MIR2)	30 x 30m <sup>2</sup>	8 Bit (256)
20.12.1999	Landsat ETM7	9 (blau, grün, rot, NIR, MIR1, TR1, TR2, MIR2, PAN)	30 x 30m <sup>2</sup>	8 Bit (256)
11.04.2000	Landsat ETM7	9 (blau, grün, rot, NIR, MIR1, TR1, TR2, MIR2, PAN)	30 x 30m <sup>2</sup>	8 Bit (256)
23.11.2001	Landsat ETM7	9 (blau, grün, rot, NIR, MIR1, TR1, TR2, MIR2, PAN)	30 x 30m <sup>2</sup>	8 Bit (256)
08.11.2007	Landsat ETM7	9 (blau, grün, rot, NIR, MIR1, TR1, TR2, MIR2, PAN)	30 x 30m <sup>2</sup>	8 Bit (256)
10.12.2010	WorldView II	5 (blau, grün, rot, NIR, PAN)	2 x 2m <sup>2</sup>	11 Bit (2.048)
18.11.2012	RapidEye	5 (blau, grün, rot, Red Edge, NIR)	5 x 5m <sup>2</sup>	16 Bit (65.536)
20.05.2013	RapidEye	5 (blau, grün, rot, Red Edge, NIR)	5 x 5m <sup>2</sup>	16 Bit (65.536)
03.11.2013	RapidEye	5 (blau, grün, rot, Red Edge, NIR)	5 x 5m <sup>2</sup>	16 Bit (65.536)
14.05.2014	RapidEye	5 (blau, grün, rot, Red Edge, NIR)	5 x 5m <sup>2</sup>	16 Bit (65.536)



land use change in Hanoi.

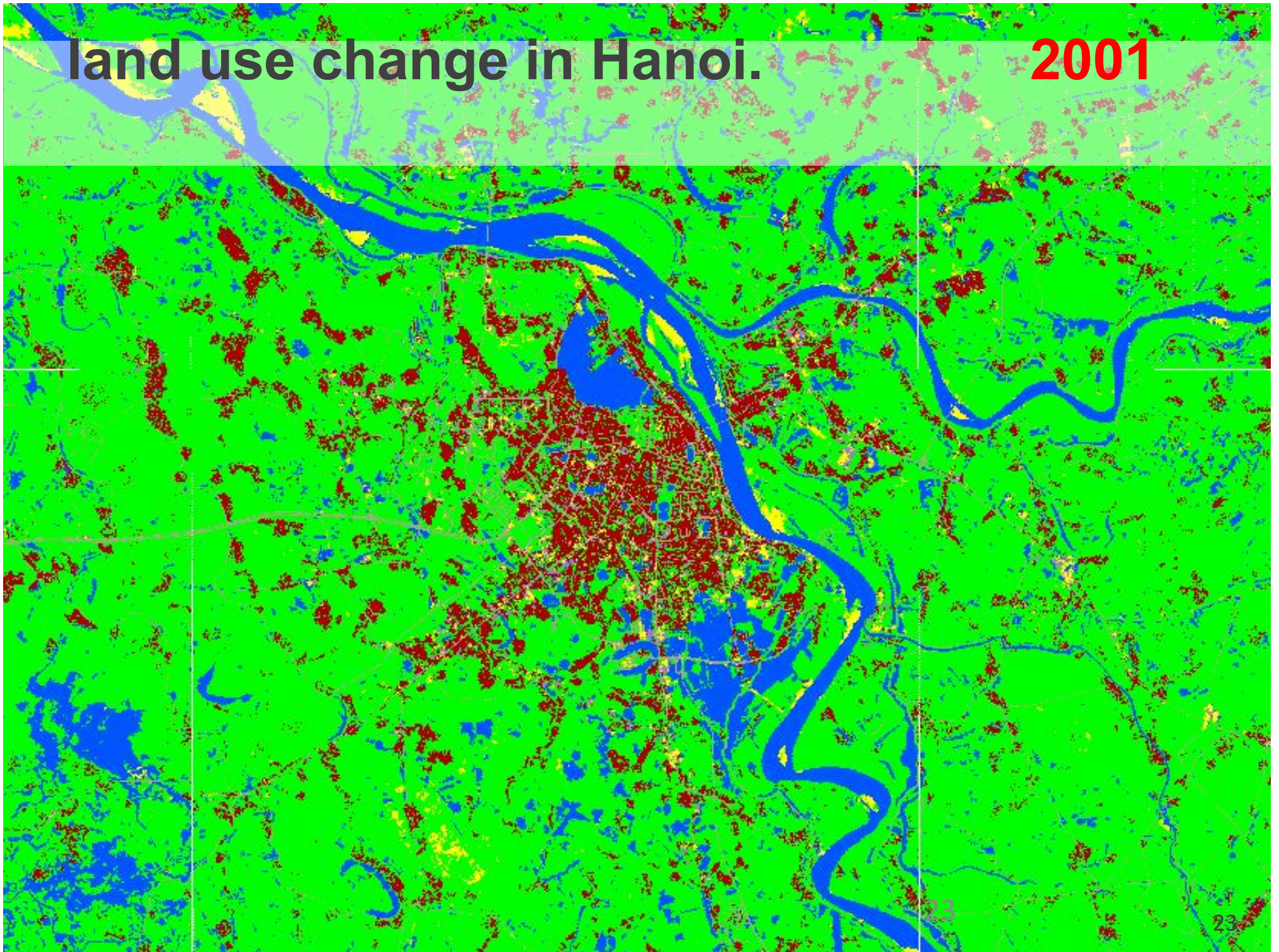
1996





land use change in Hanoi.

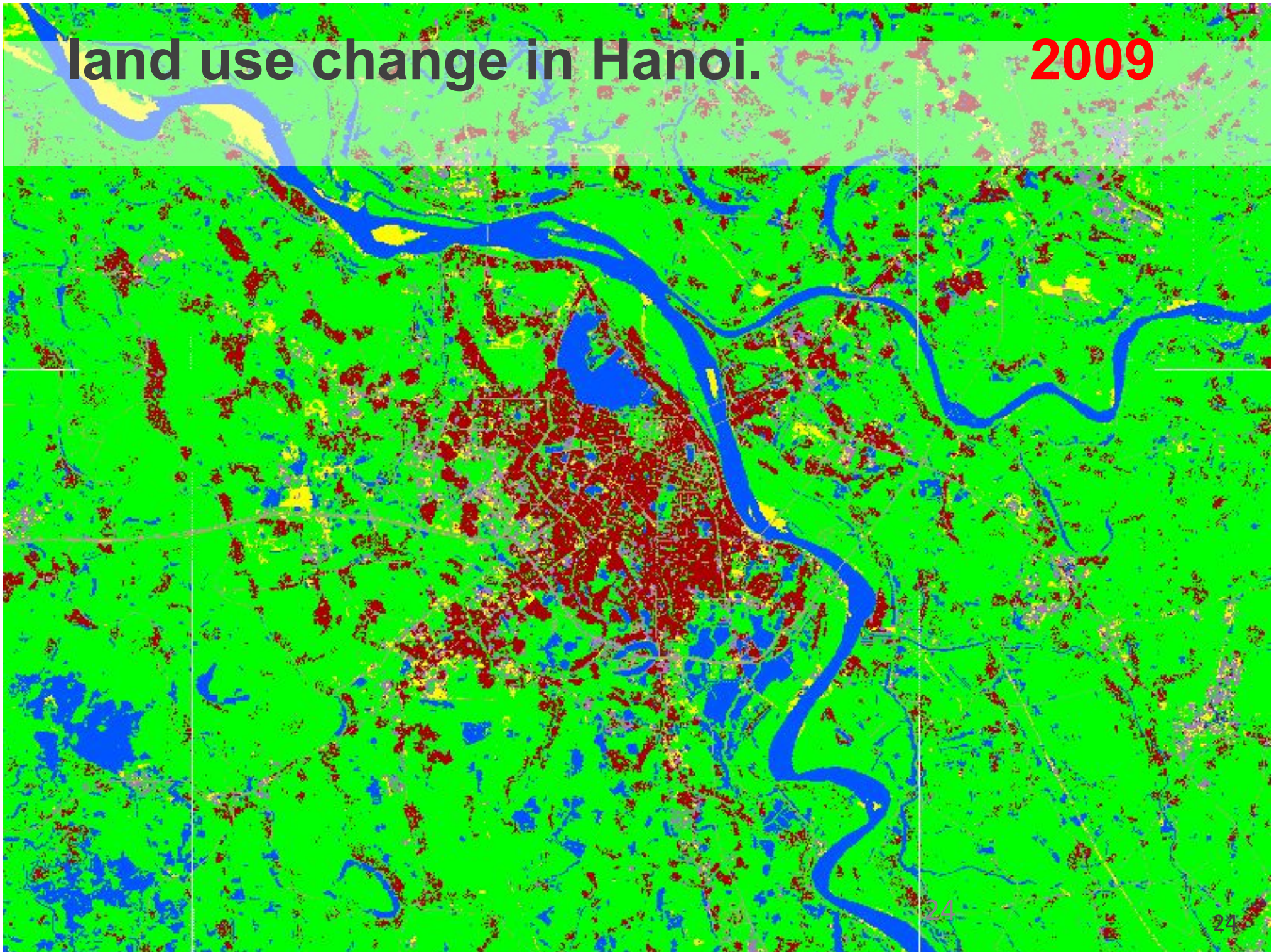
2001





land use change in Hanoi.

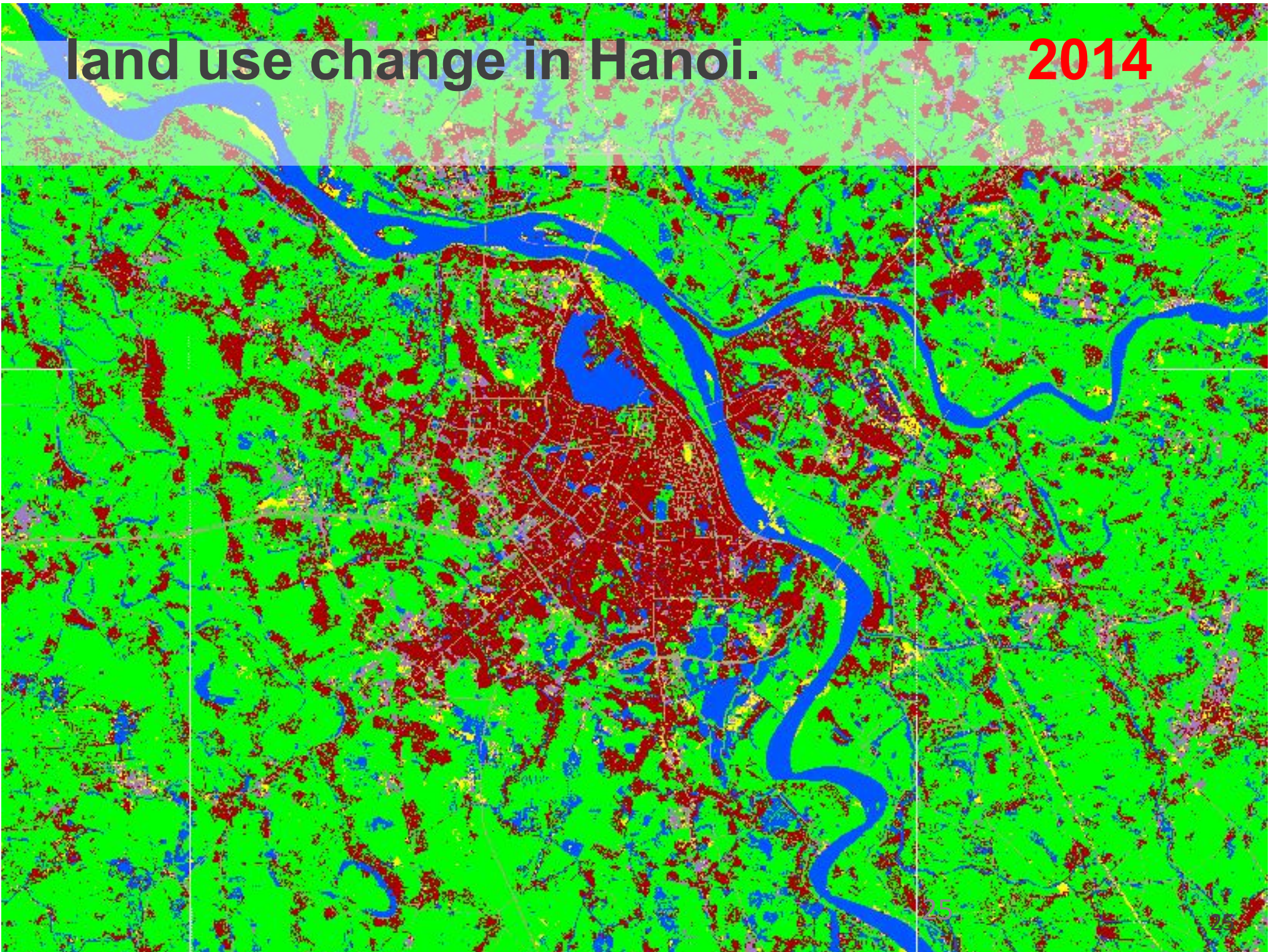
2009





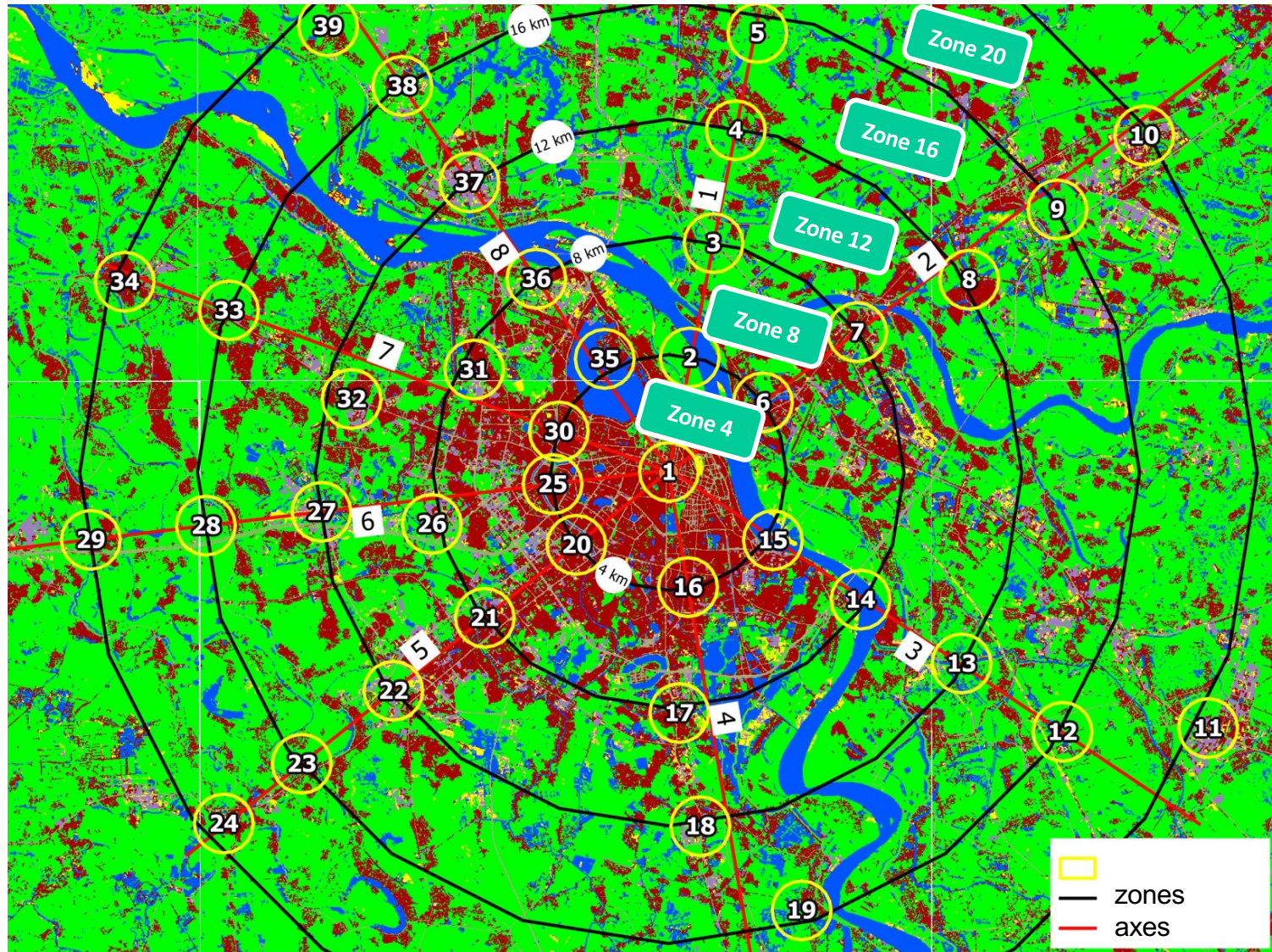
land use change in Hanoi.

2014



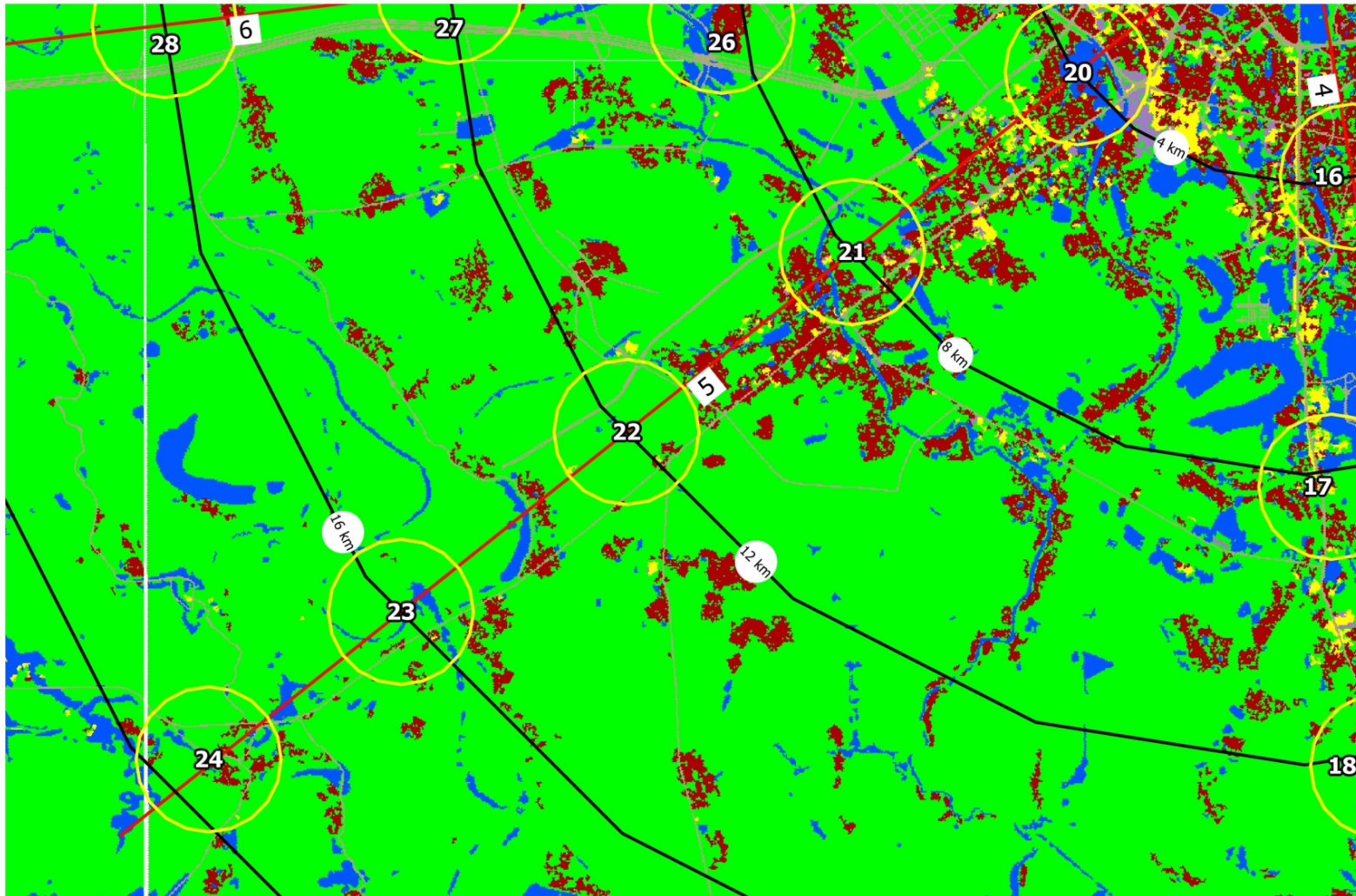


# Analysis of urban development



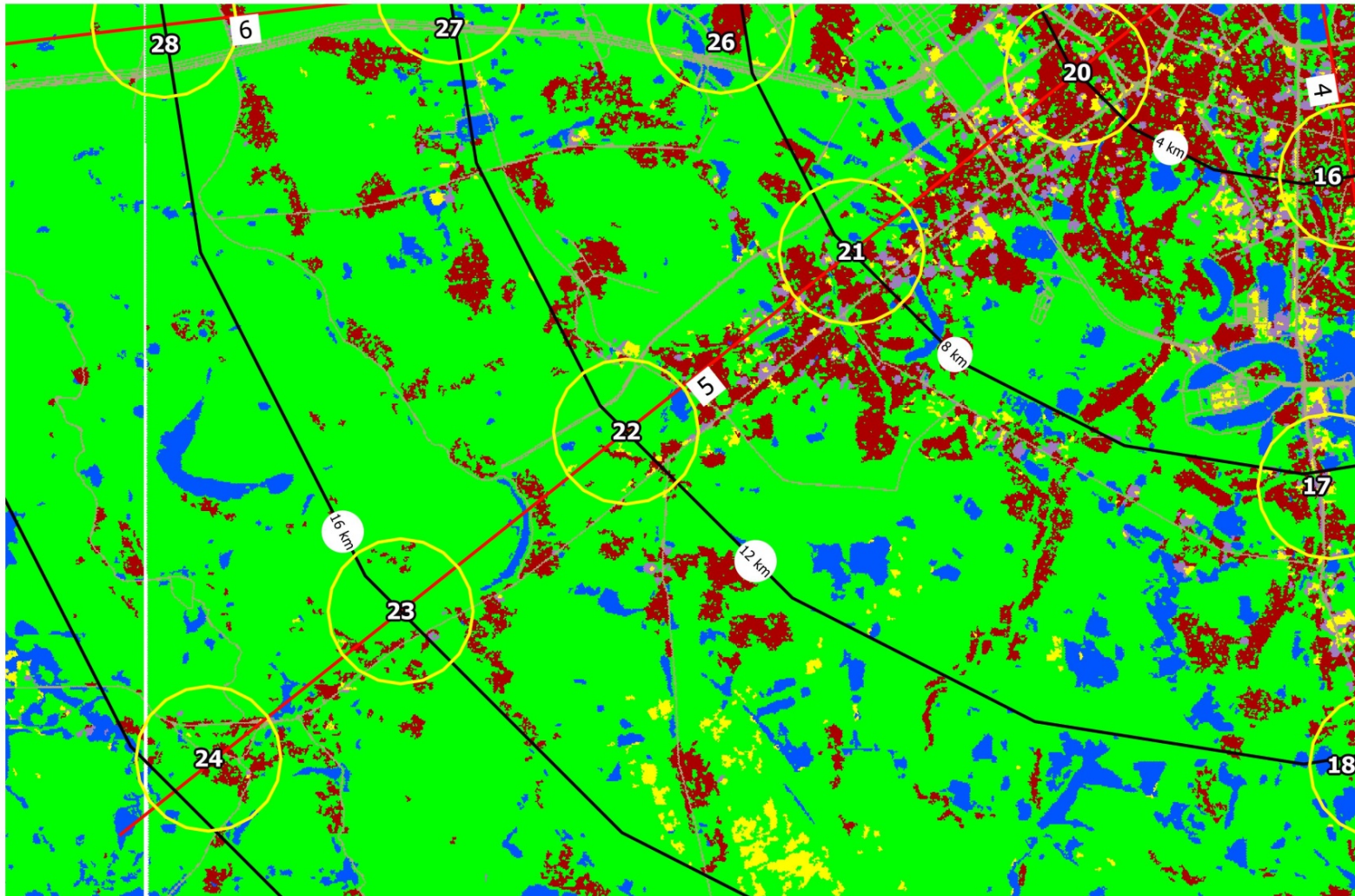


## comparison of different axes. 1993



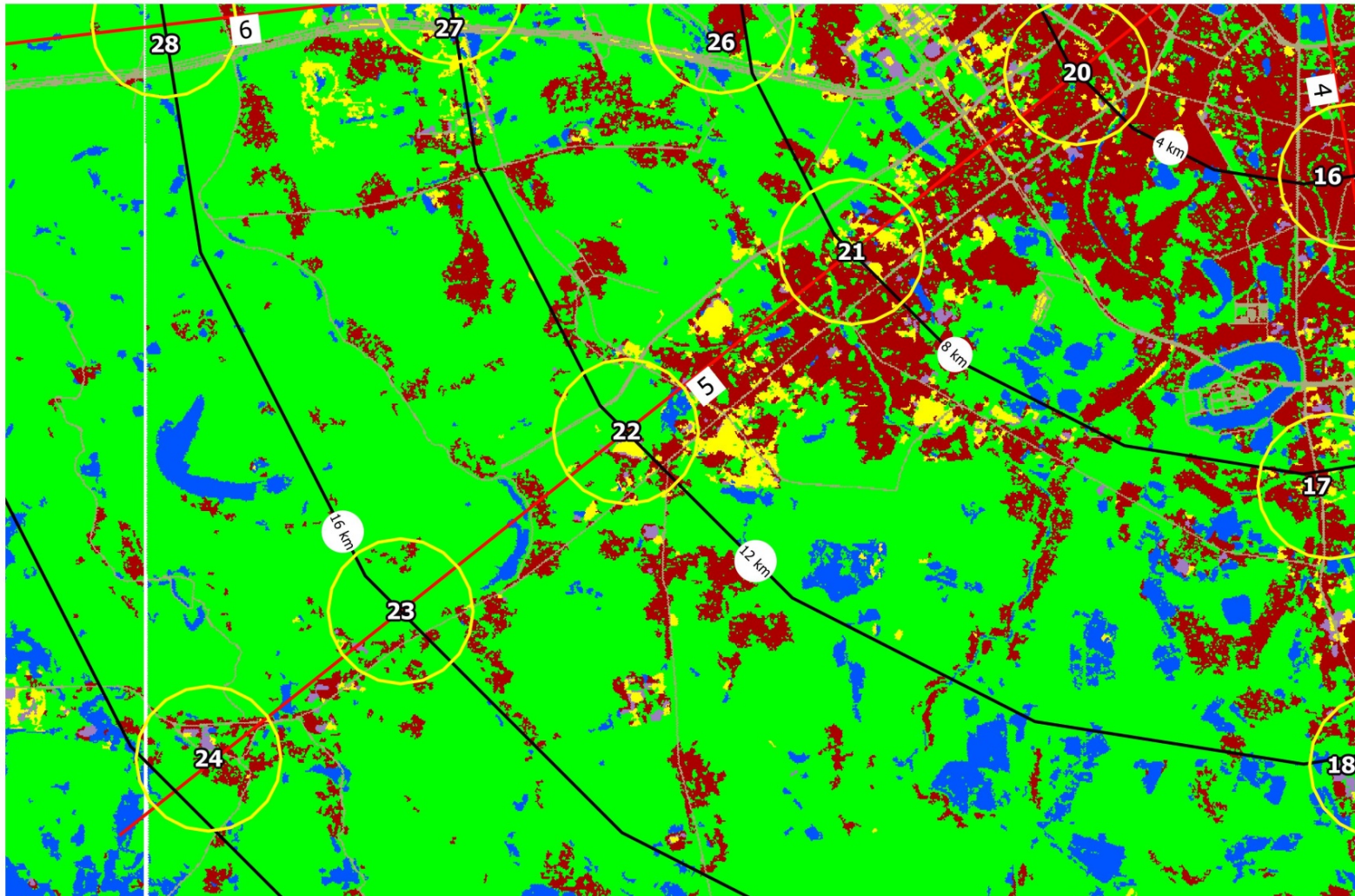


## comparison of different axes. 2001



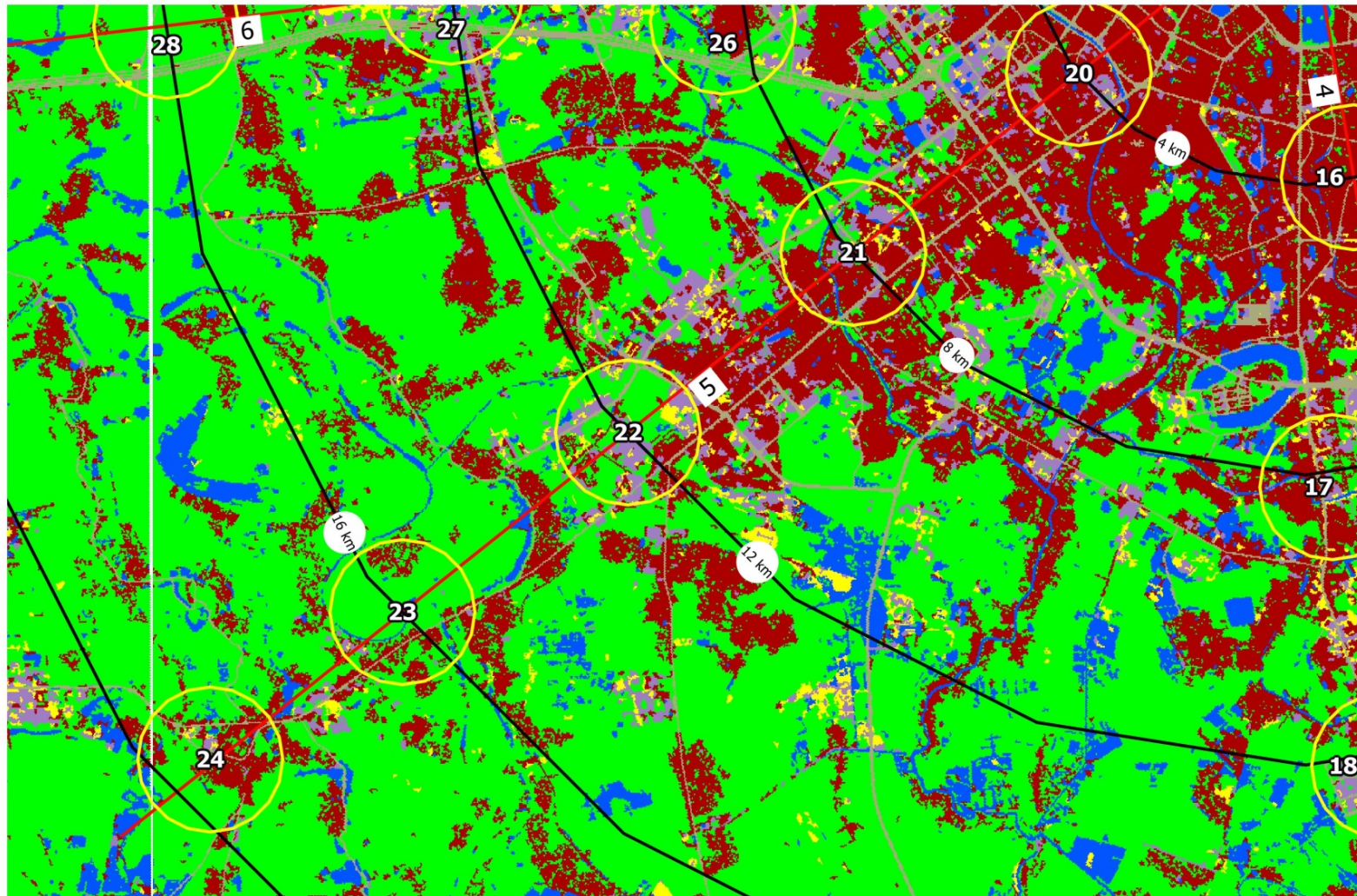


## comparison of different axes. 2007





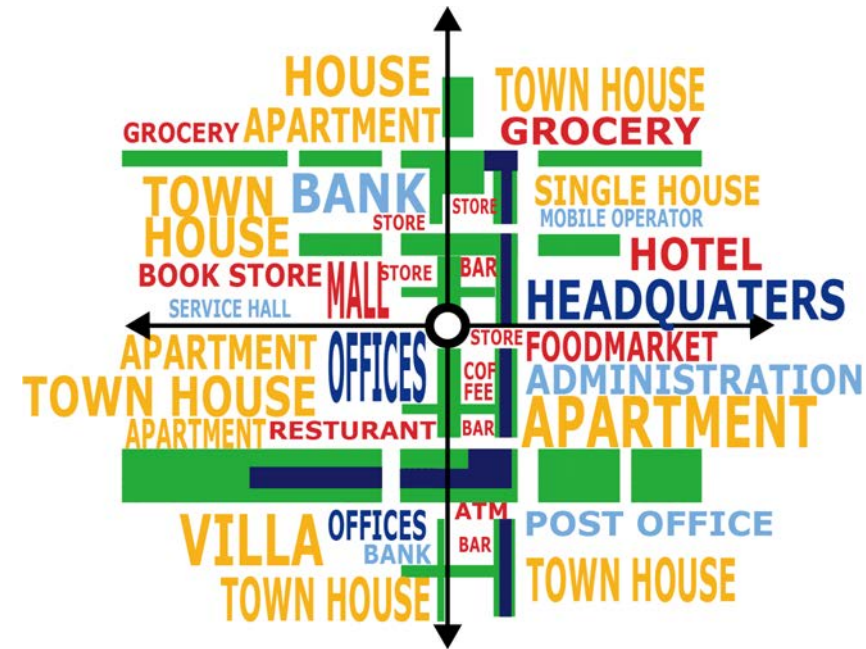
## comparison of different axes. 2014



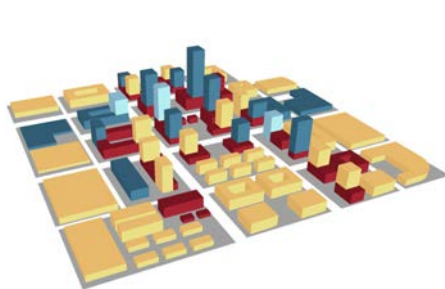
## Transit Oriented Development (TOD)

5D criteria:

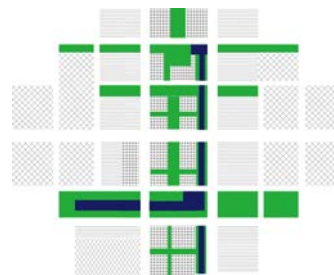
- Increased **Density** around stations
- **Diversity** of functions and services
- Quality of Urban **Design**
- Minimize **Distance** to transit
- **Destination** accessibility



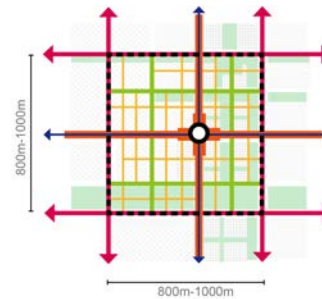
*Density*



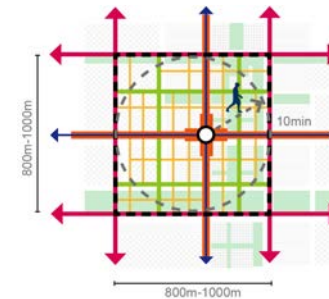
*Diversity*



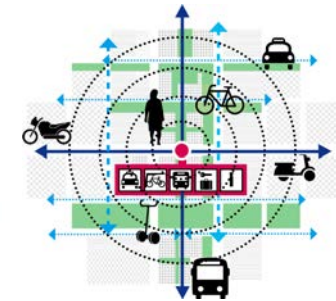
*Design*



*Distance*



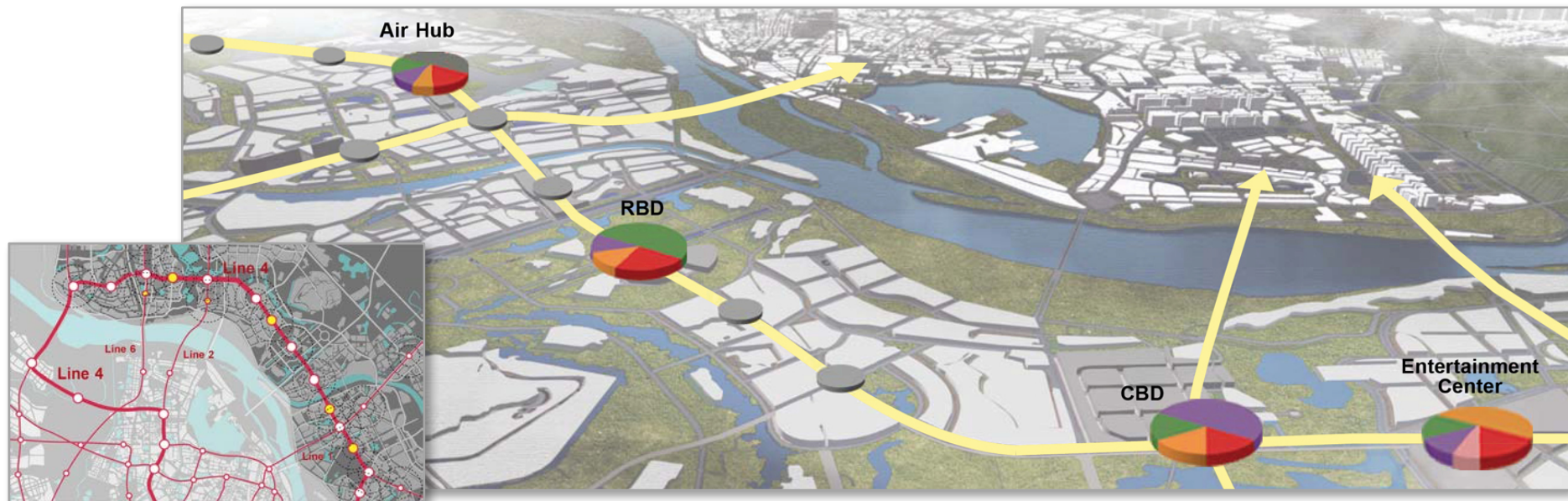
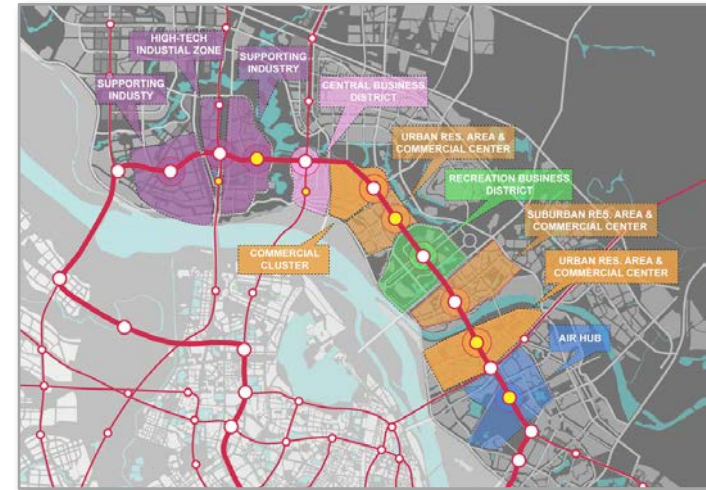
*Destination*





## Adjustments to the approved Metro Network Plan

- Add more metro stations
- Move stations to the existing settlement centers
- Create links between sub-centers
- Define core areas based on the mix of land functions with varying proportions
- Introduce green transport network (bicycle and pedestrian)





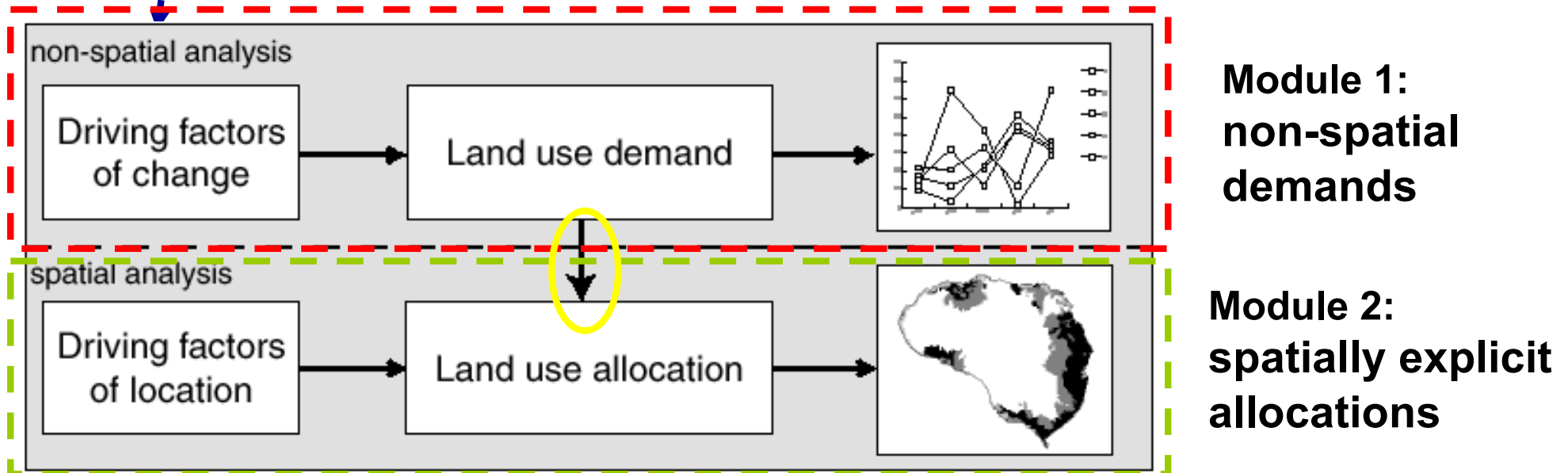
## Adjustments to the approved Metro Network Plan for Selected Core Area

- Public transport joint to serve National Stadium & Touristic link to connect Relic Town
- Integrating the existing villages into a new settlement pattern



## Structure CLUE-Model

- Demand for housing, mobility,...



- Distance to roads, distance to centers, land cover, prices, development area, original land cover / land use

(Verburg et al. 2002)



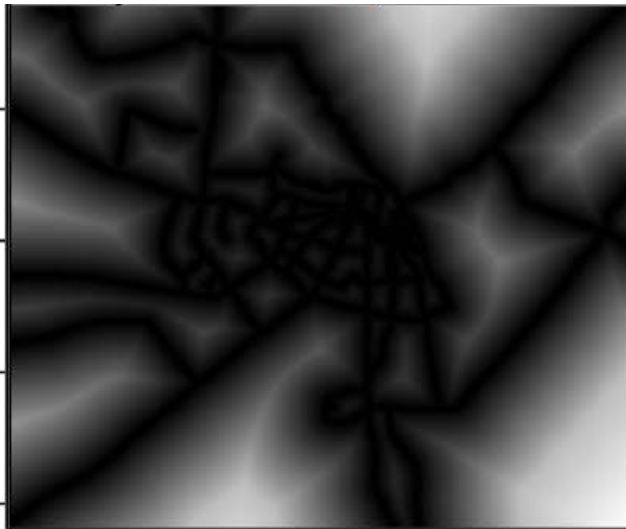
# Approach for modelling urban dynamics

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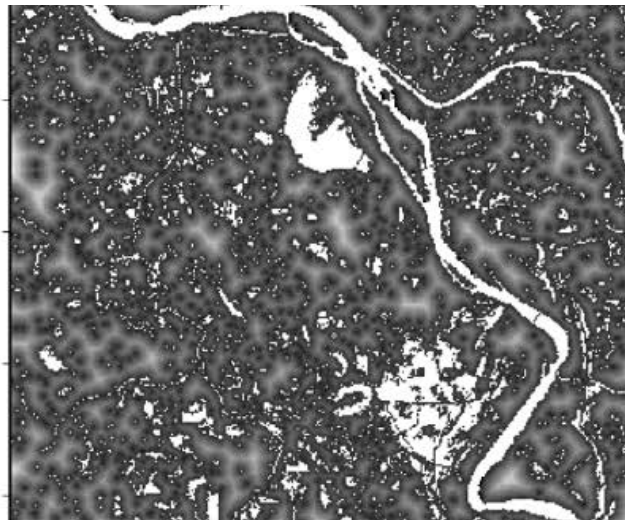
Parameters influencing urban dynamics Hanoi



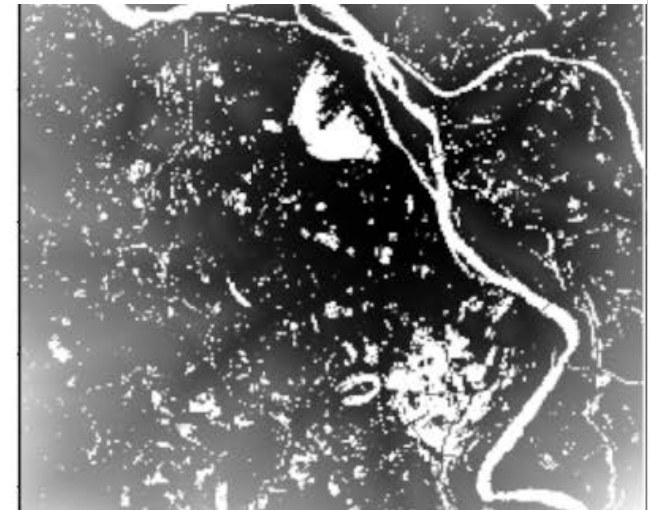
Distance to roads



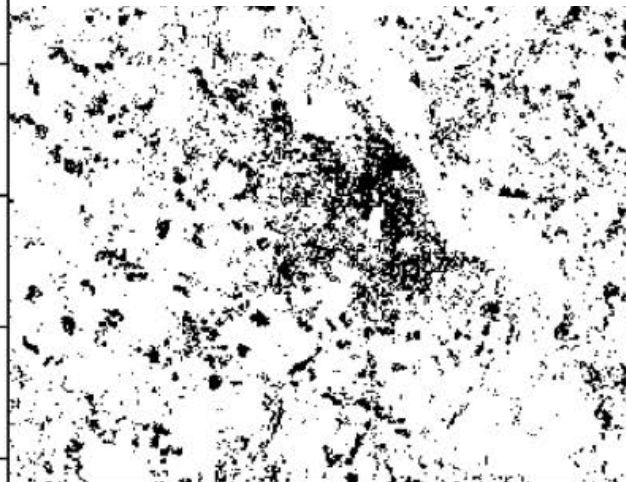
Distance to water



Distance to centres



urban areas



vegetation

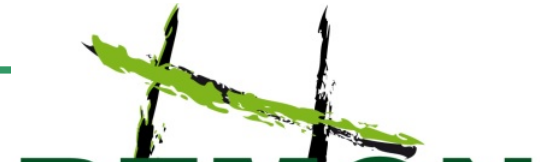


sand / barren land



# Approach for modelling urban dynamics

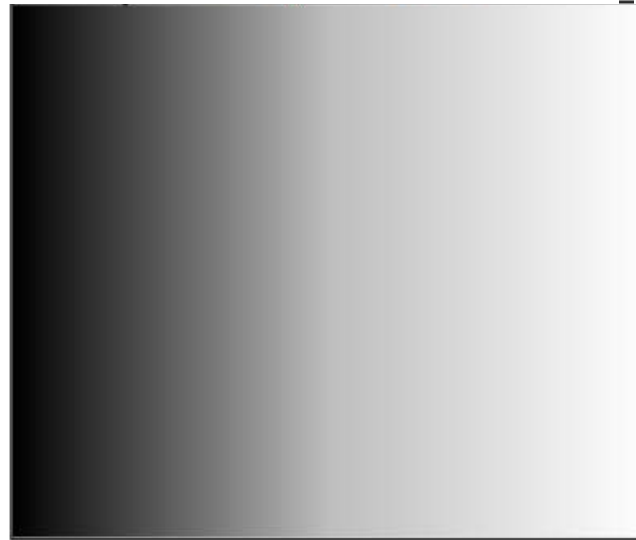
## Parameters of urban dynamics



water



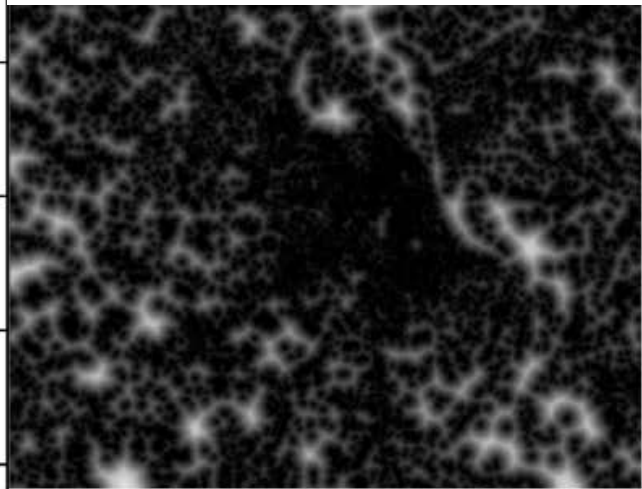
easting coordinates



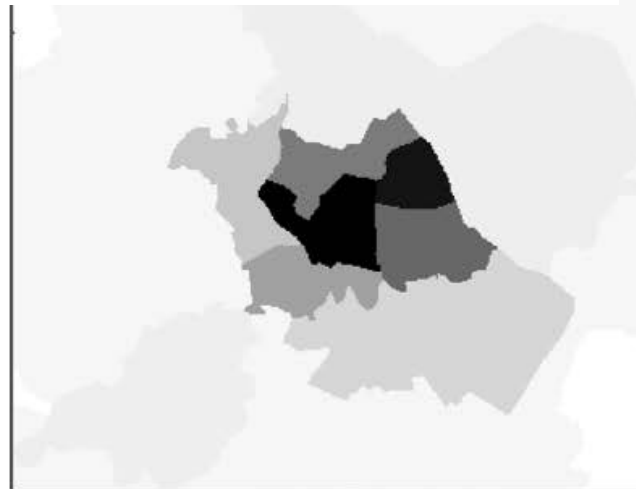
northing coordinates



distance to urban

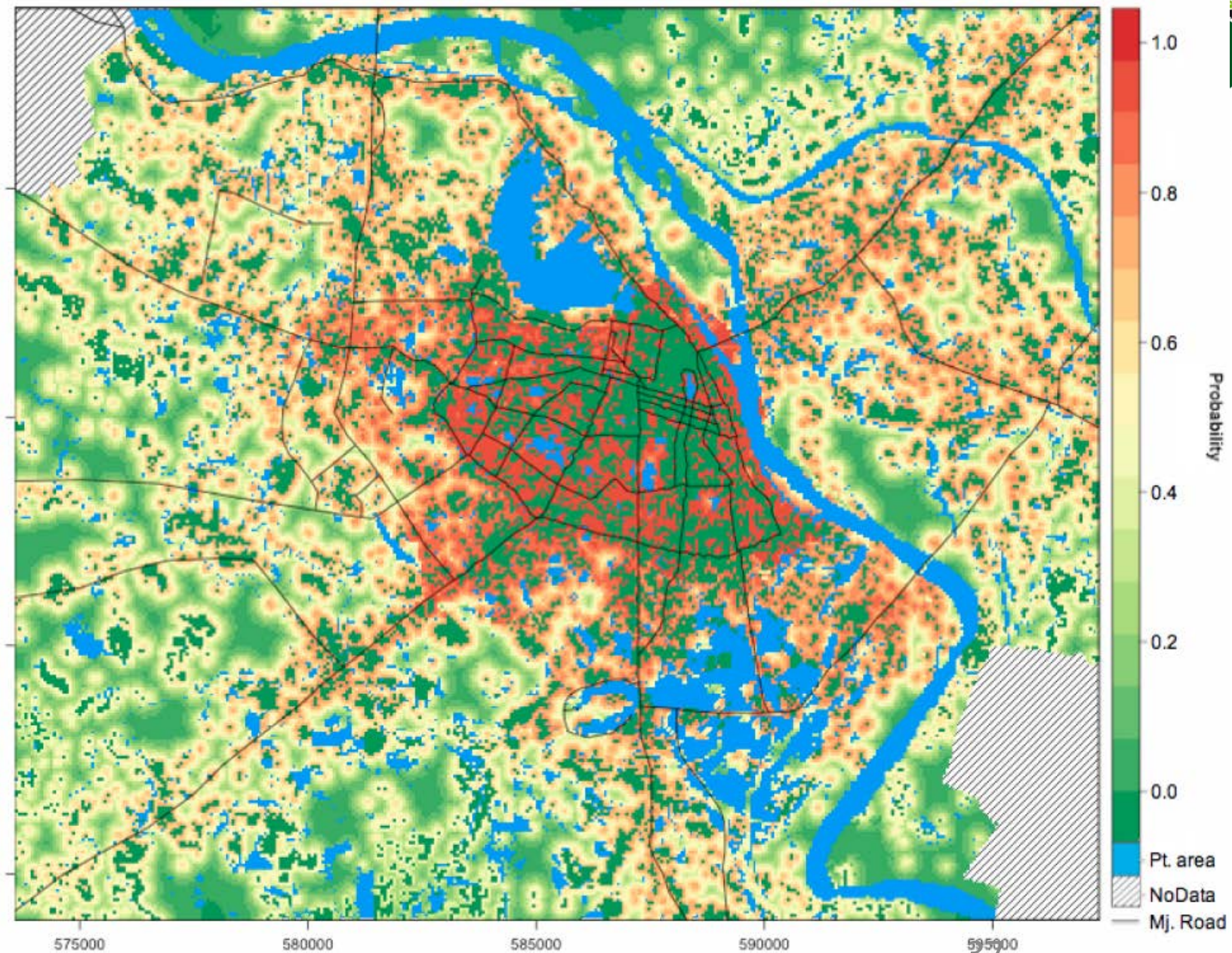


population density





# Mapping Probability of conversing land to Urban



## Conclusions

- Developed a real-time traffic information system
  - Tailored traffic management strategies
  - Sound policy recommendations on urban development
  - Showcases of energy-efficient urban and transport planning
- 
- Local government and authorities will be able ...
    - to monitor and predict traffic conditions
    - to test GHG reduction impacts of proposed policy measures
    - to monitor the performance of transport infrastructure/services
- 
- Next Phase will be focused on...
    - Severe weather conditions (flooding) → Climate Services
    - Measures for emissions reduction (E-mobility)
    - Exposure to local pollutants (PM, NOx, Sox,..) & measures
    - Road accidents & safety measures



Thank you for your attention

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