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# REMON

## ATRANS Conference – 21 August 2015, Bangkok



**Tuning for Sustainable Urban Transport Development by Real-Time Traffic Monitoring and Information System – A Case Study in Hanoi**

**Dr. Vu Anh Tuan, Vietnamese-German University, HCMC, Vietnam**

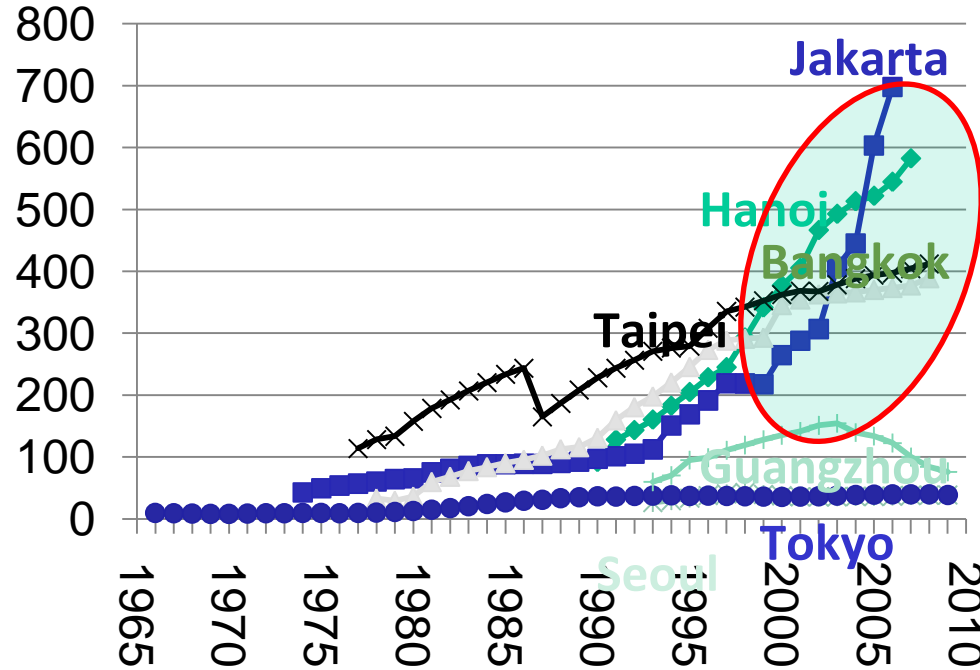
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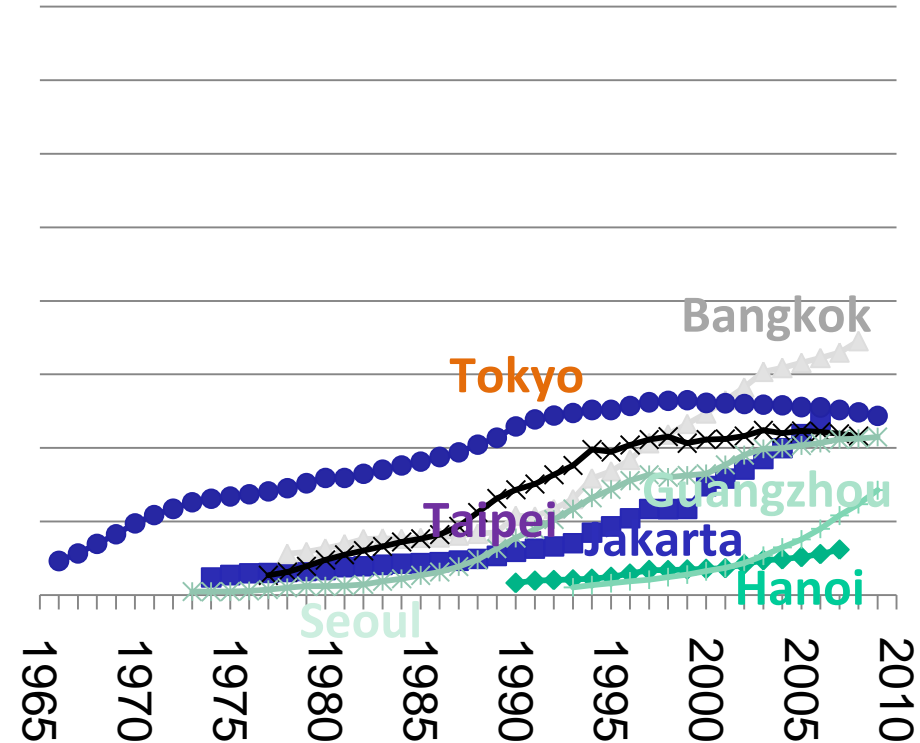
# Introduction

- Urban Transport Issues and Challenges in Asia
- Specific Issues of Hanoi City

## Motorcycle / 1000 person



## Prv't passenger car / 1000 person



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

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

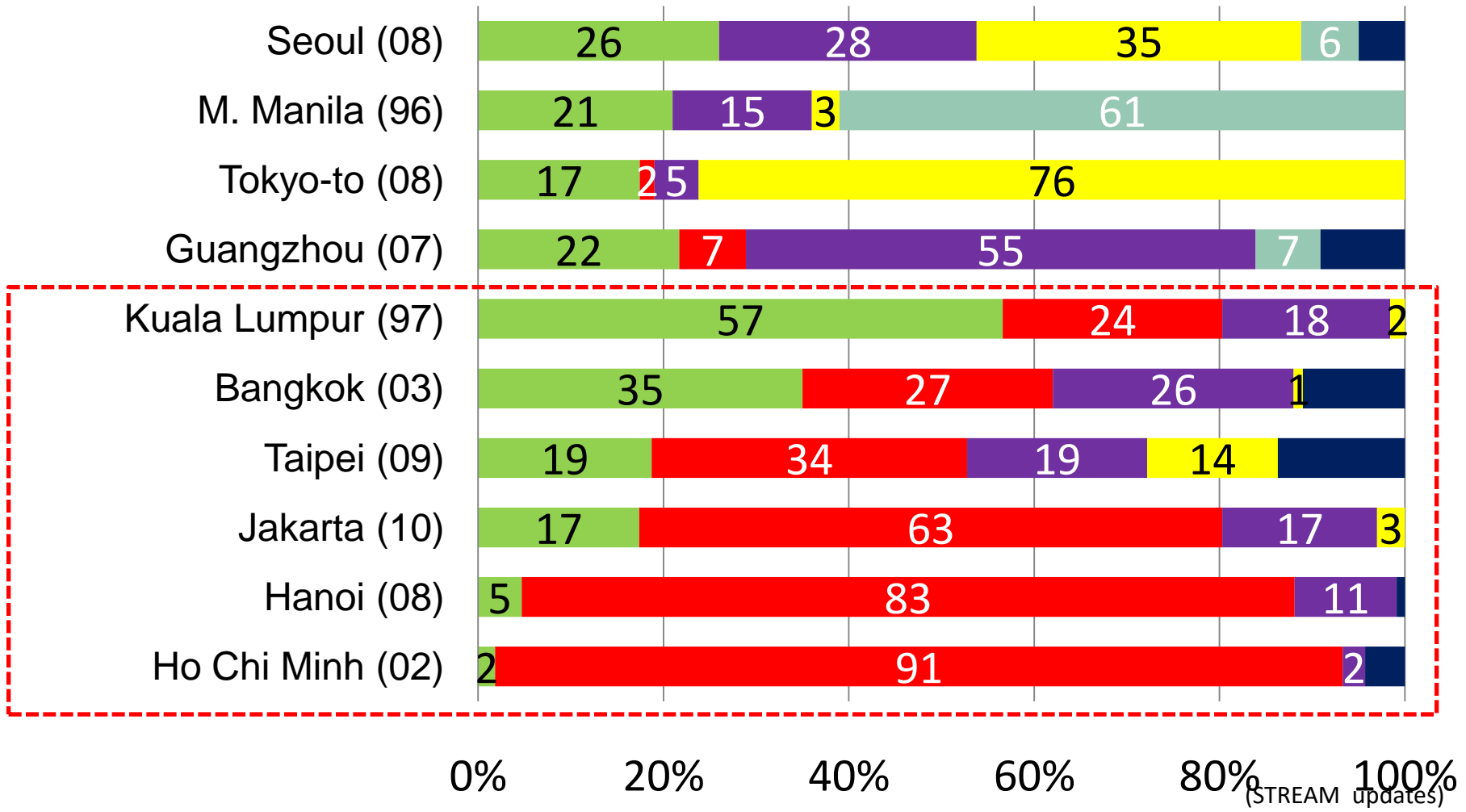
(V.A. Tuan,, 2014)



# Modal splits in major Asian cities



(% motorized trips)





# Hanoi's Transport: 1990s vs 2000s

1990s



SEEN ON  
REDS.VN

2000s



SEEN ON  
REDS.VN



Nguồn: <http://reds.vn/index.php/khoanh-khac-lich-su/402-ha-noi-1990/>

(Huyen, 2015)

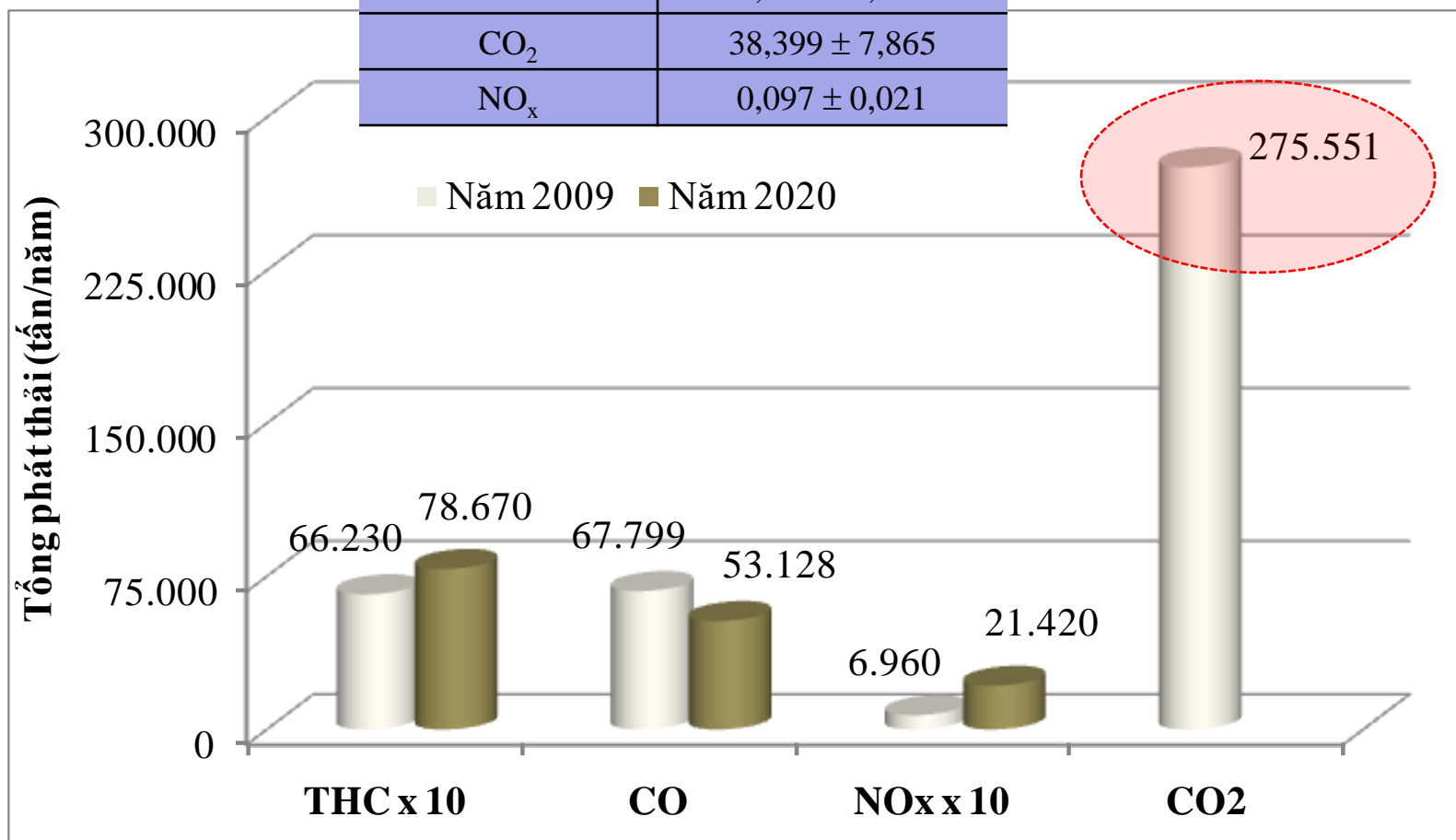
# Traffic Situation in Hanoi City

- Motorcycle dependent city
- High utilisation of existing infrastructure
- Many trips per person and day
- Short distances (inner city)
- Low speeds
- Many starts and stops



# Pollutions by motorcycles in Hanoi

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



Source: Lê Anh Tuấn et al. (2011)

# Agenda Setting and Policy Making in Vietnam

- Political institutions are centrally organised
- High awareness in central institutions

## E.g., Vietnam Green Growth Strategy

- National action plan to respond to climate change
- Key strategies:
  - Development of public transport
  - Introduction of low carbon fuels
  - Control of the number of motorized vehicles in urban areas

But on local level:

- Low awareness
- Political institution for climate change is missing
- Strongly limited financial and personnel resources

→ **Weak and vulnerable implementation**

# Overview of REMON Project

- Objectives
- Project duration
- Project partners
- Components

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

## Key objectives

- Reduction of traffic induced air pollutants
- Reduction of energy consumption within Hanoi's urban transport sector

## Project duration: 3 years

- Jan 2013 to Dec 2015

## Project Partners



AS&P - Albert Speer & Partner GmbH



Delphi IMM GmbH



German Aerospace Center (DLR), Optical Information Systems at the Institute of Robotics and Mechatronics



Freie Universität Berlin, Remote Sensing and Geoinformatics



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

International Academy Berlin for Innovative Pedagogy, Psychology and Economics gGmbH (INA), Institute for International Urban Research



TECHNISCHE  
UNIVERSITÄT  
DARMSTADT

Technische Universität Darmstadt, Transport Planning and Traffic Engineering (FGVV)



Transport Development and Strategy Institute (TDSI), Ministry of a of Vietnam



University of Transport and Communications, Institute of Transport Planning and Management



Vietnamese-German University

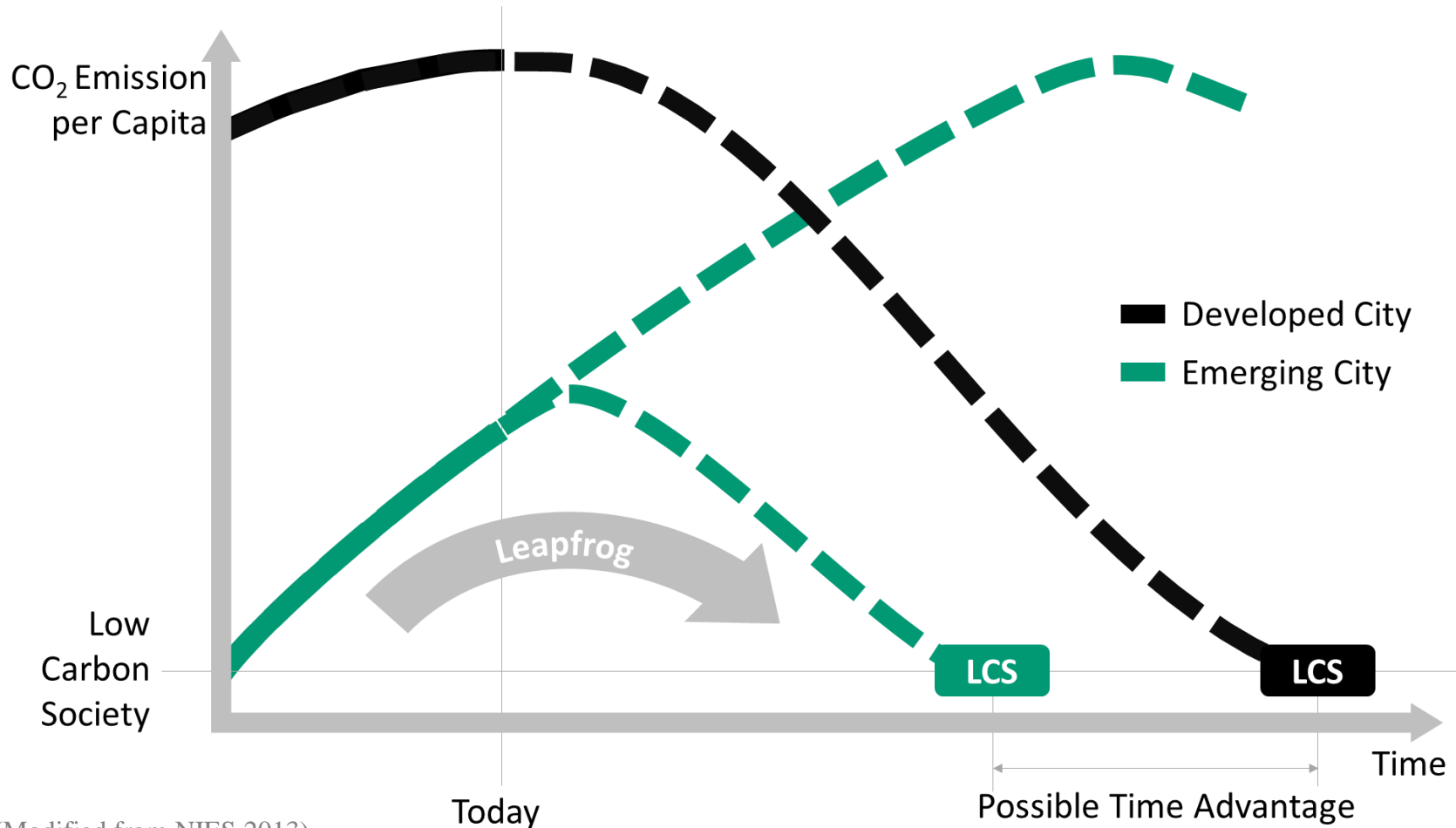
Vietnamese-German University, Vietnamese-German Transport Research Centre (VGTRC)



Umweltplanung  
und Geoinformatik GbR

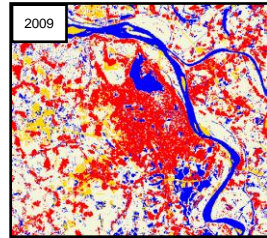
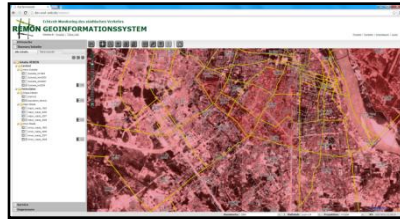
WWL Umweltplanung und Geoinformatik GbR

# Possible development paths for developing cities



(Modified from NIES 2013)

# Components of REMON Project

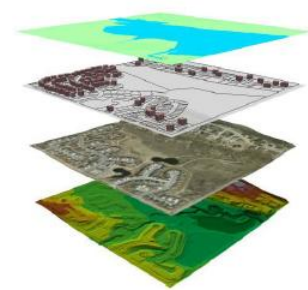
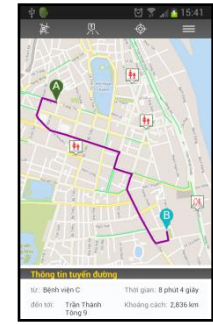


GIS, Digital Street Map, Land Use Change, Urban Growth Model

Traffic Information System: FCD and FPD

Traffic Management: Strategies and Transport Modelling

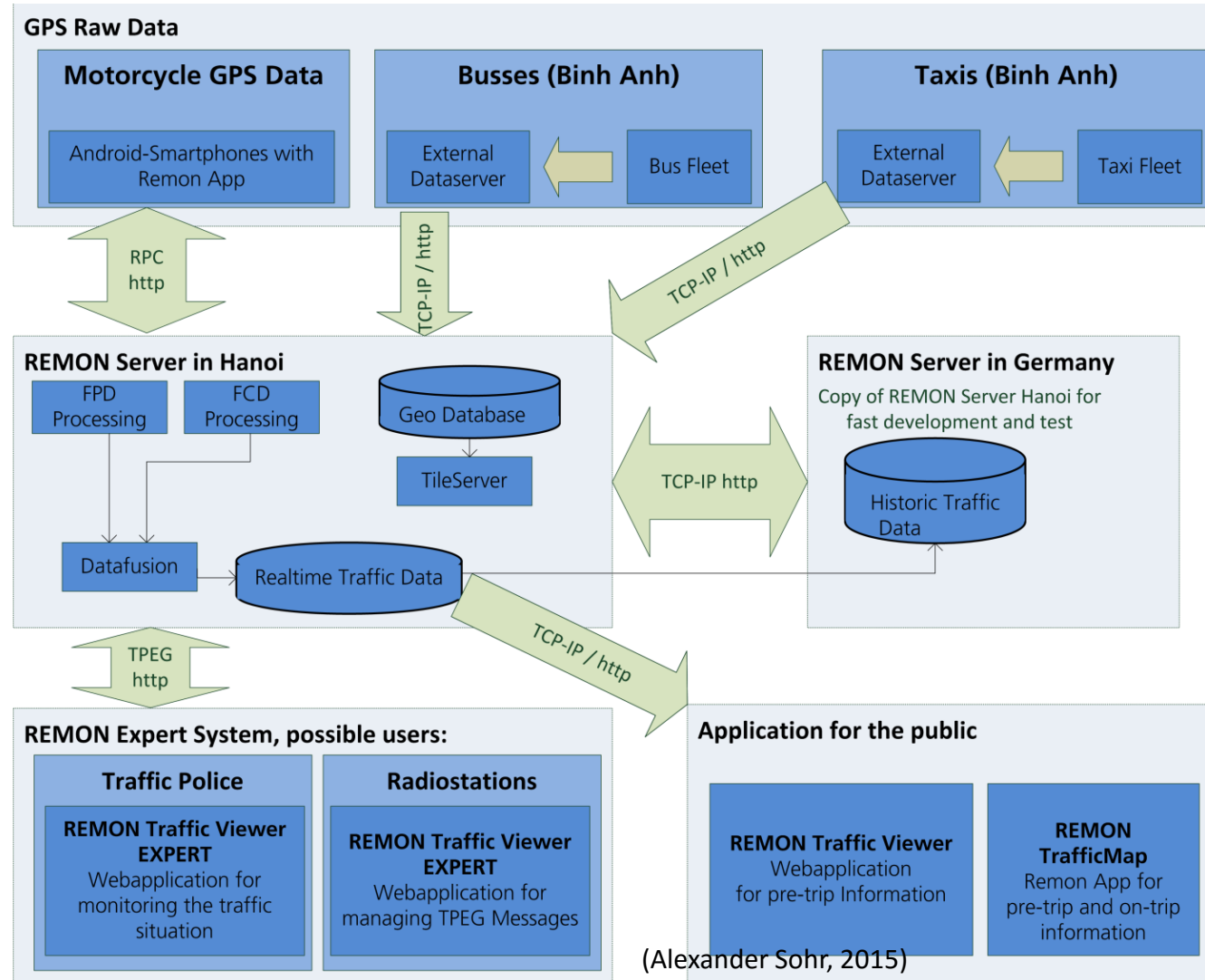
Policy Analysis, Scenarios and Energy-efficient Urban Planning



# Real-time Traffic Information System

- FCD, FPD & FMD
- Mapping traffic LOS
- Analysis of hot spot

# System Architecture



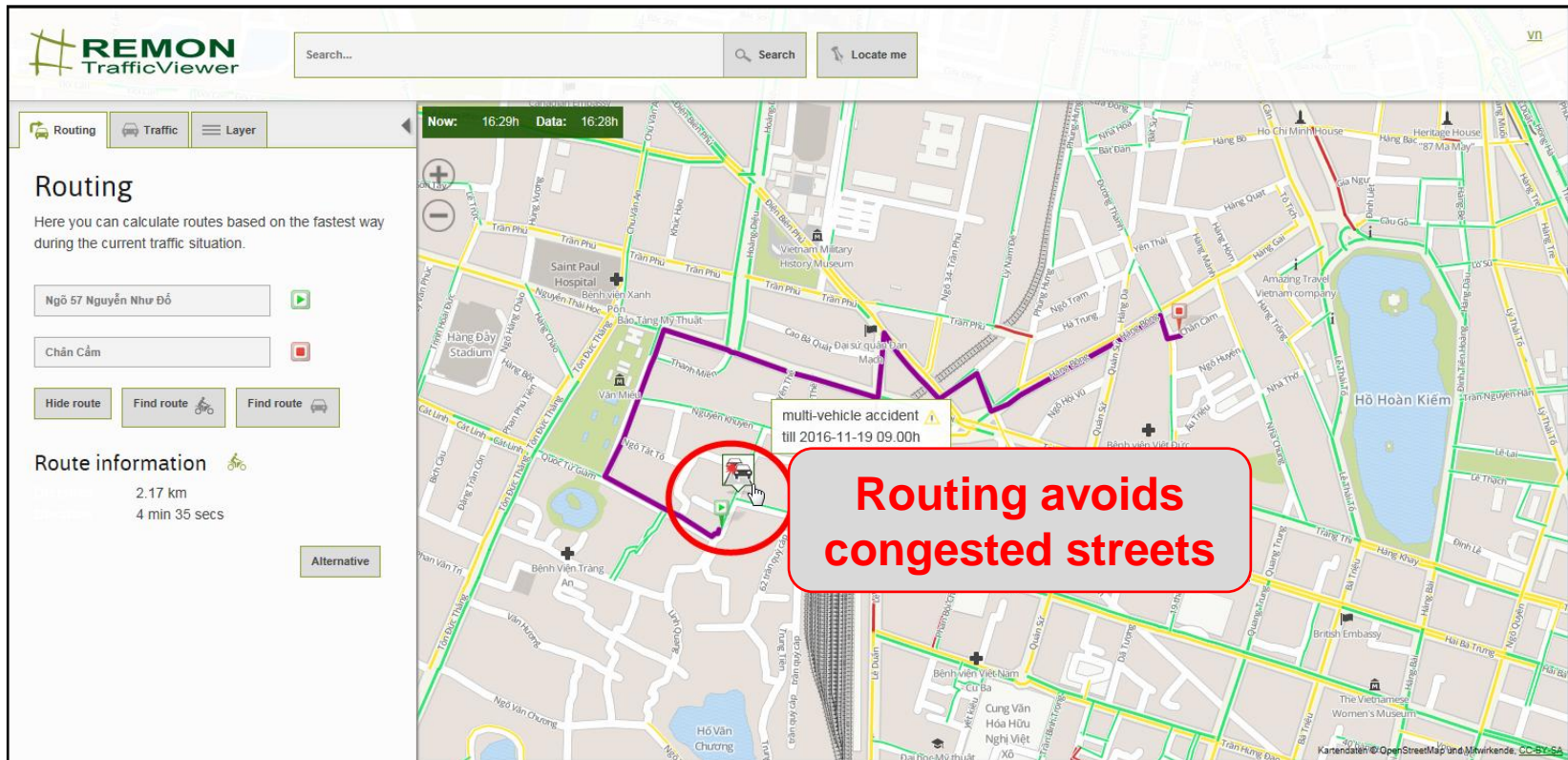
## Data Processing:

- Mapping current positions on street map and deriving trajectories
- Calculating travel times for affected streets for each vehicle type (cars, busses and motorbikes)
- Data Fusion: Combining all current information for each street and determining its current

(Alexander Sohr, 2015)

# Traffic Viewer

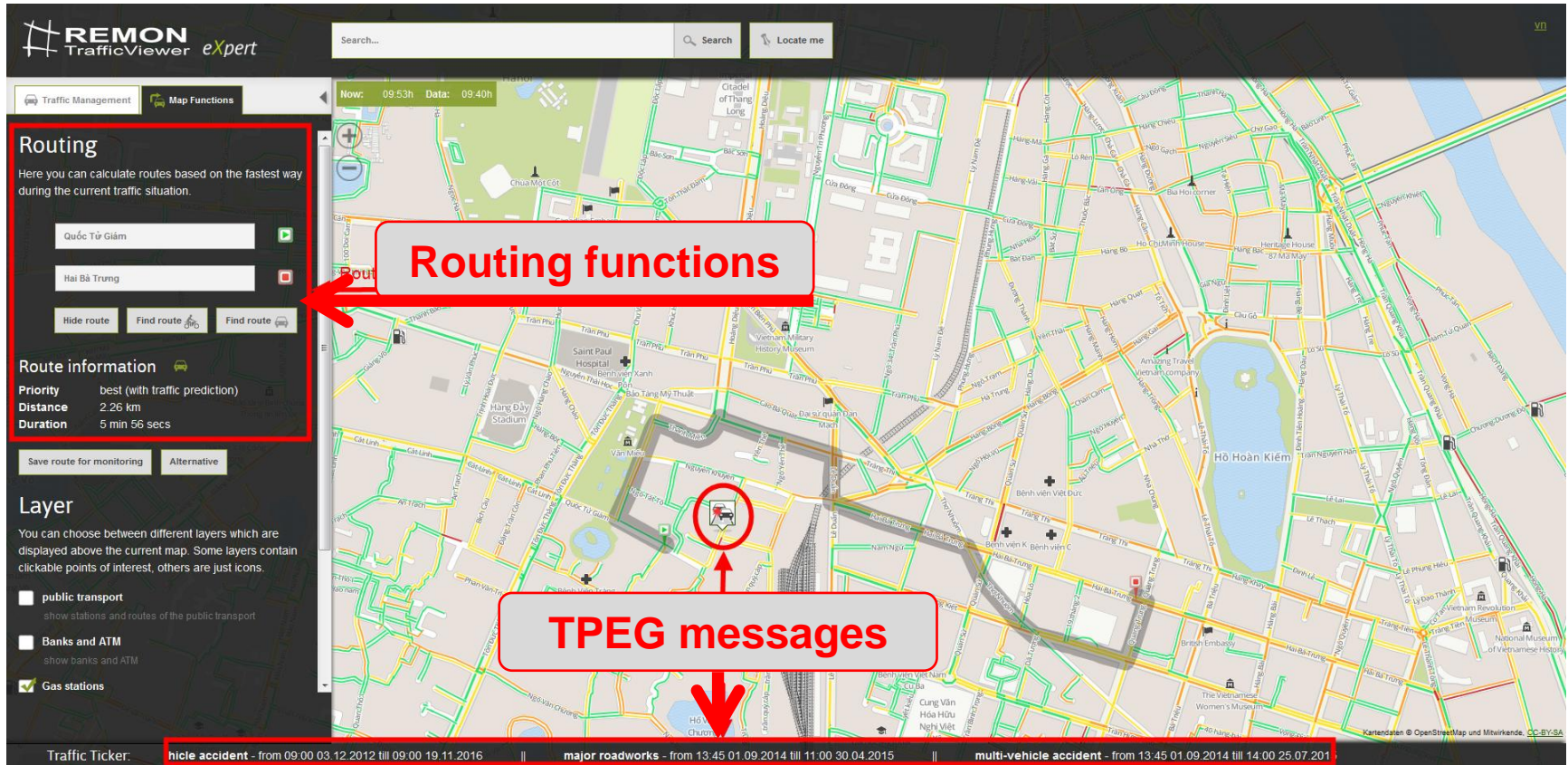
- Traffic information (LOS)
- TPEG messages
- Dynamic routing
- POI (Points Of Interest)



The screenshot shows the REMON TrafficViewer interface. On the left, there is a 'Routing' panel with a search bar containing 'Ngõ 57 Nguyễn Như Đỗ' and 'Chân Cầm'. Below the search bar are buttons for 'Hide route', 'Find route' (with a bicycle icon), and 'Find route' (with a car icon). The 'Route information' section shows a distance of 2.17 km and a time of 4 min 35 secs. The main map area displays a purple routing path through Hanoi, Vietnam, starting from the search location and ending at the destination. A red circle highlights a specific point on the map where a 'multi-vehicle accident' occurred on 2016-11-19 09:00h. A red box with white text overlaid on the map states 'Routing avoids congested streets', indicating that the purple path successfully bypasses the accident location. The map also shows various landmarks like Saint Paul Hospital, the Vietnam Military History Museum, and Hồ Hoàn Kiếm.

(Alexander Sohr, 2015)

# Traffic Viewer **Expert**



The screenshot displays the REMON Traffic Viewer Expert interface. On the left, there is a sidebar with several sections:

- Routing:** A section for calculating routes. It includes input fields for start and end points (currently '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). A red box highlights this section, with a red arrow pointing to it from a red callout box labeled 'Routing functions'.
- Route information:** Displays details for the selected route: 'Priority: best (with traffic prediction)', 'Distance: 2.26 km', and 'Duration: 5 min 56 secs'. It also has buttons for 'Save route for monitoring' and 'Alternative'.
- Layer:** A section for selecting map layers. It includes checkboxes for 'public transport', 'Banks and ATM', and 'Gas stations'. The 'Gas stations' checkbox is checked. A red box highlights this section, with a red arrow pointing to it from a red callout box labeled 'TPEG messages'.

The main area is a map of Hanoi, Vietnam, showing traffic conditions with color-coded roads (green for free flow, yellow for slow, red for congested). A red circle on the map highlights a specific location, with a red arrow pointing to it from the 'TPEG messages' callout box. At the bottom, a 'Traffic Ticker' displays real-time traffic events:

- 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)

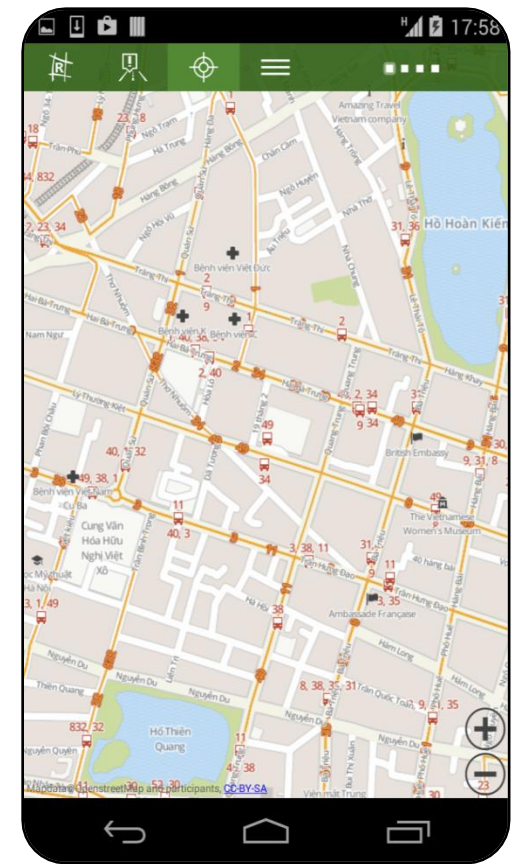
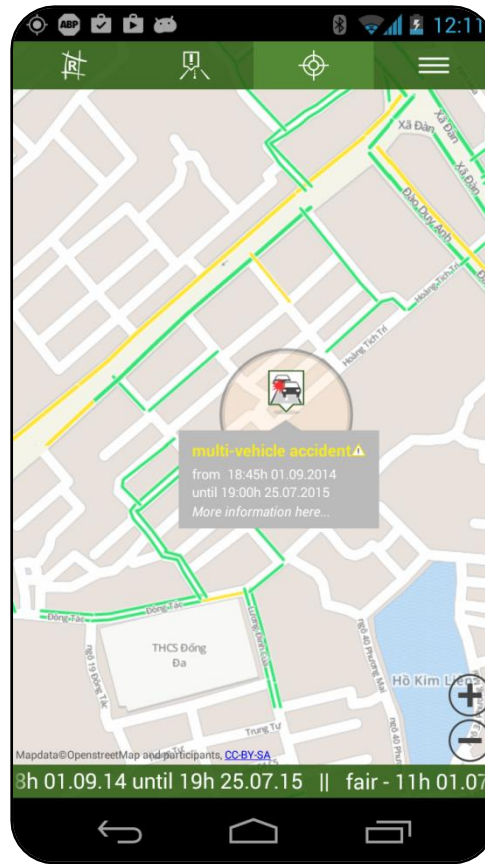
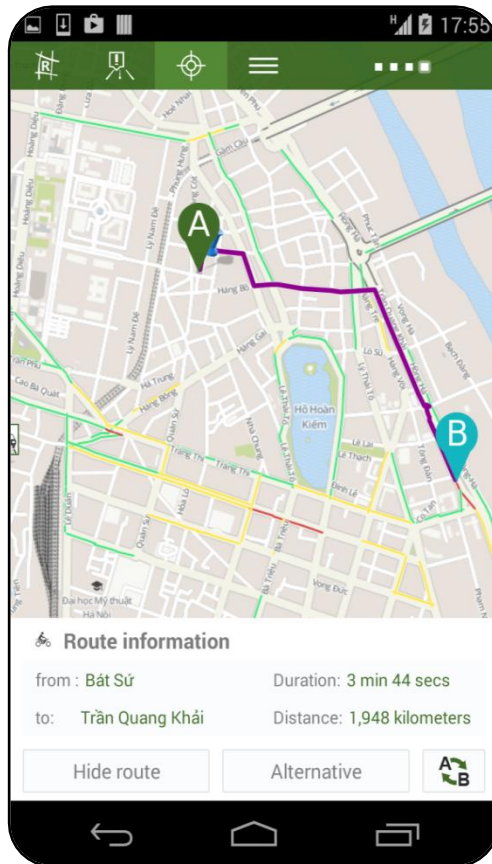


Legend:

- current LOS and travel speed
- speed limit
- historical LOS and travel speed
- tendency of travel speed

(Alexander Sohr, 2015)

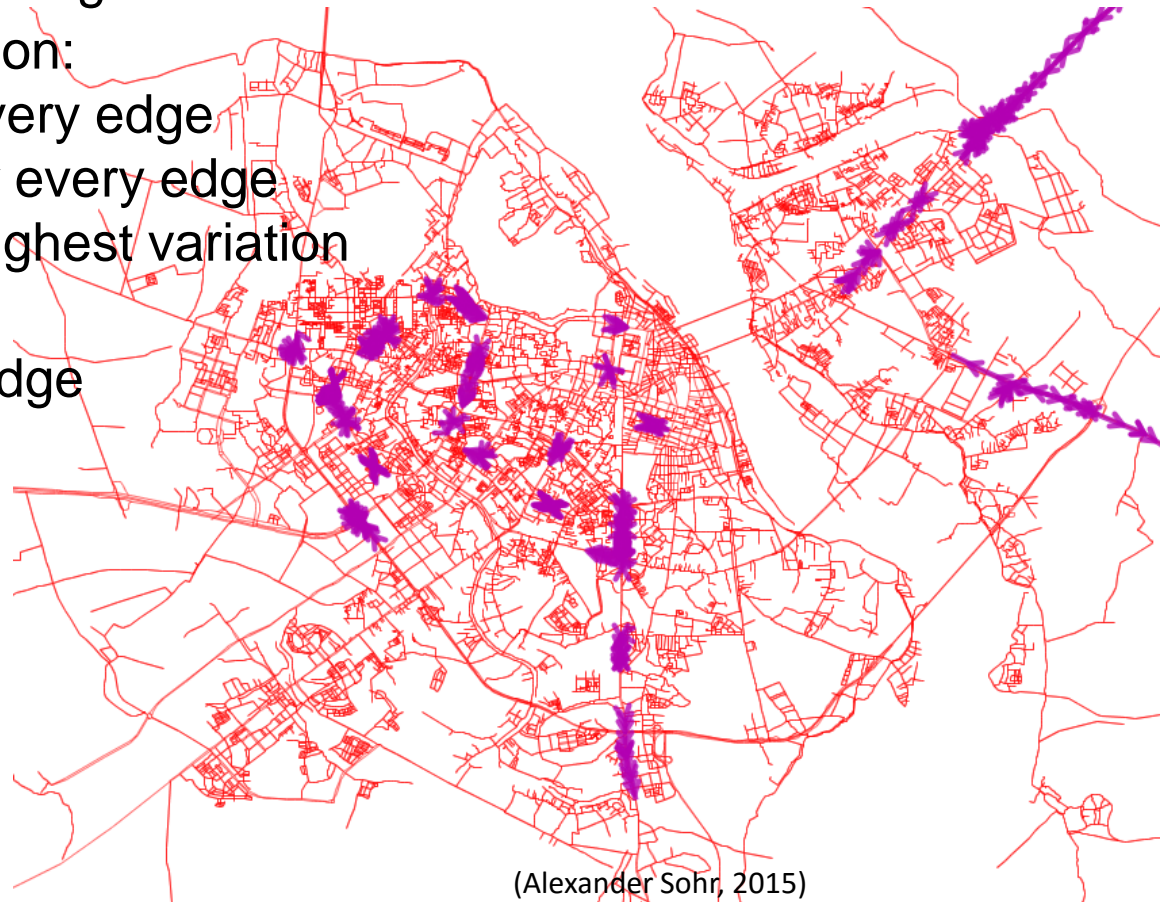
# REMON Traffic Map App - Screenshots



(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)

# Traffic Management Strategy & Transport Modelling

- Traffic management strategy tailored made for Hanoi City
- Transport model
- Initial results of policy impact testing

## Measures tailor-made for Hanoi's Requirements

General requirements of the measures:

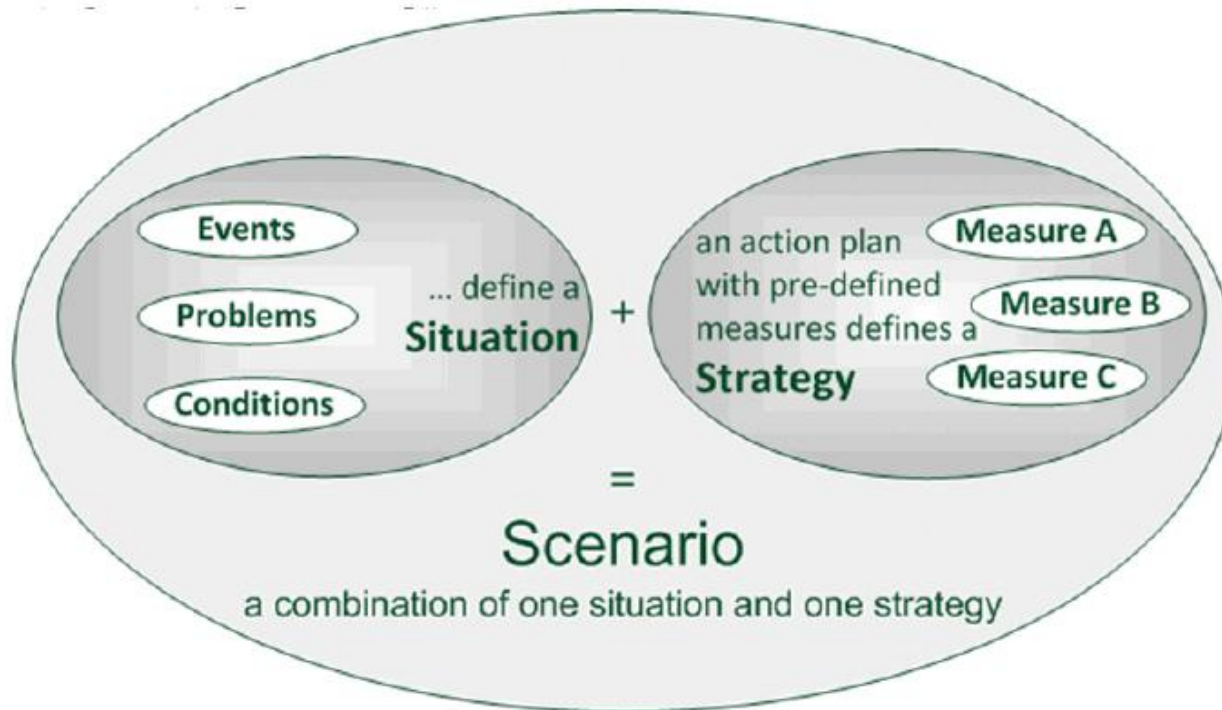
- Applicable in the short term
- Considering political, economic conditions, and current traffic situation, e.g.:
  - Willingness to introduce regulatory (and economic) measures
  - Ability to utilise existing informational channels

Approaches	AVOID	SHIFT	IMPROVE
<b>Instruments</b>			
<b>Technological</b>	E-Commerce	Development of Infrastructure for Multimodal Use	Development of Signal Coordination
<b>Regulatory</b>	Transit Oriented Development (TOD)	Parking Restrictions / Metering	Restrictions on Registration
<b>Informational</b>	Influencing Lifestyle	Dynamic Guidance and Routing	Dynamic Guidance and Routing
<b>Economic</b>	Spatial differentiated Subsidies	Tolling / Taxing	Reduced Parking Fees for Low Emission Vehicles

Source: WCTRS et al. 2004, slightly modified

# The most favorable traffic management measures (evaluated by Vietnamese experts)

Position in overall ranking	Traffic Management Measure	Position in applicability ranking	Position in effectiveness ranking
1	Flexible cycle time and traffic signal control	1	2
2	Static parking restrictions in congested areas for all vehicles	2	5
3	Static parking restrictions in congested areas for specific vehicles	3	11
4	Dynamic parking restrictions in congested areas for specific vehicles	7	3
5	Integrated traffic control center	8	4
6	Dynamic alternative routing	11	6
7	Traffic signal coordination	4	16
8	Improved scheduling (buses)	9	12
9	Bus feeder system	12	7
10	Temporal access restrictions for specific vehicles	5	19



- Project's targets
  - Traffic jam reduction: 5-10%
  - Emissions reduction: 10-15%

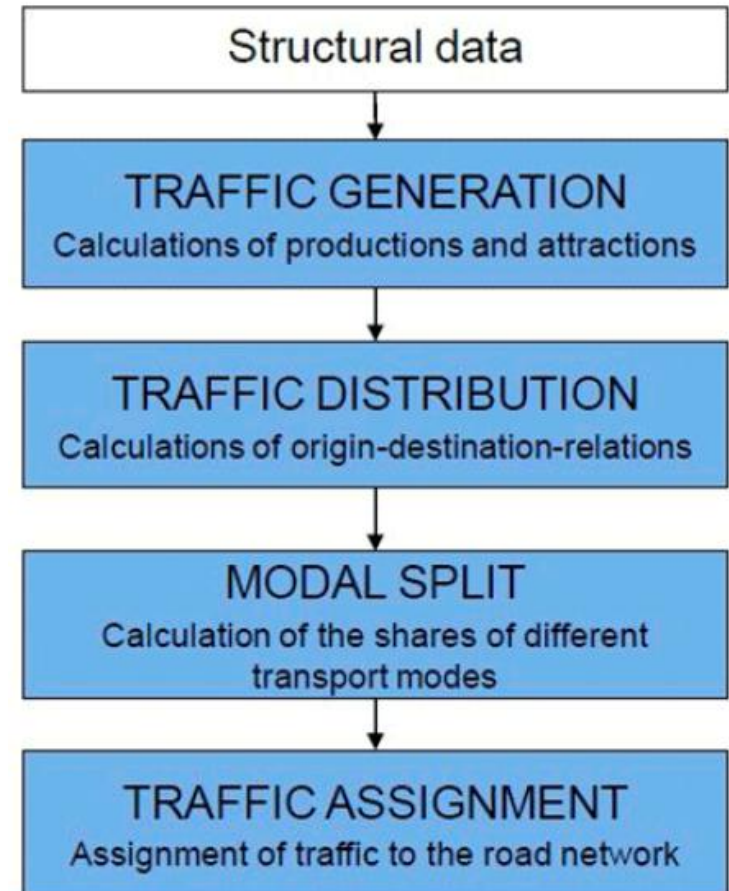
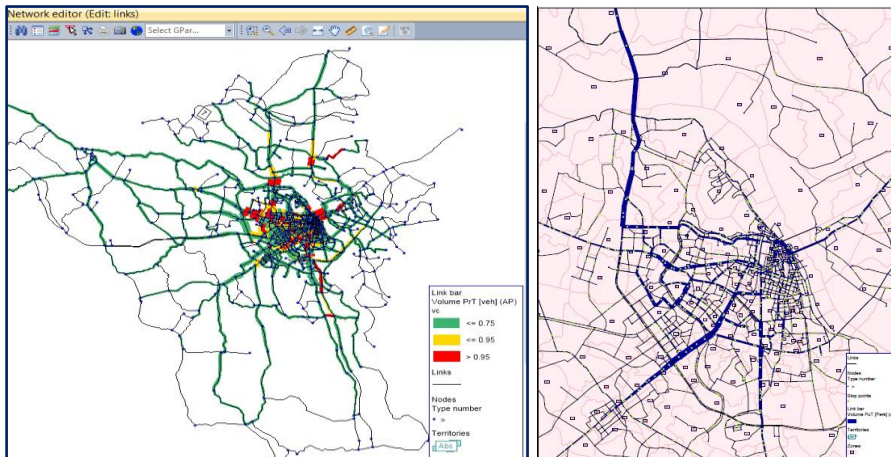
# The 4-Step Model (VISUM)

## Available data

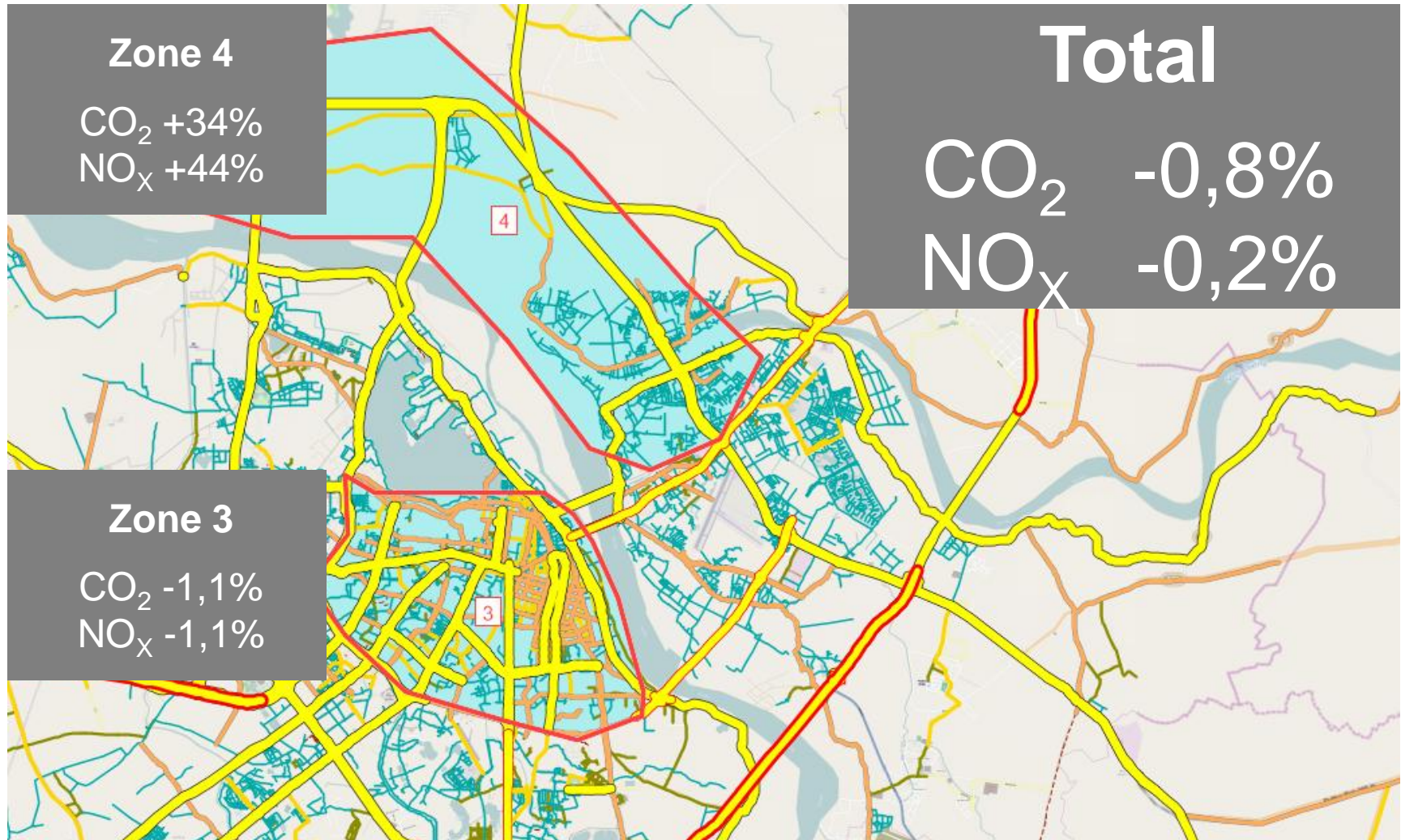
- HAIDEP (2006)
- Census
- Road inventory (2012)
- Public transport network (2013)
- TEDI HIS, Traffic Counts,... (2011)

## Additional data

- Conducted under REMON (traffic counts, speed survey, etc)

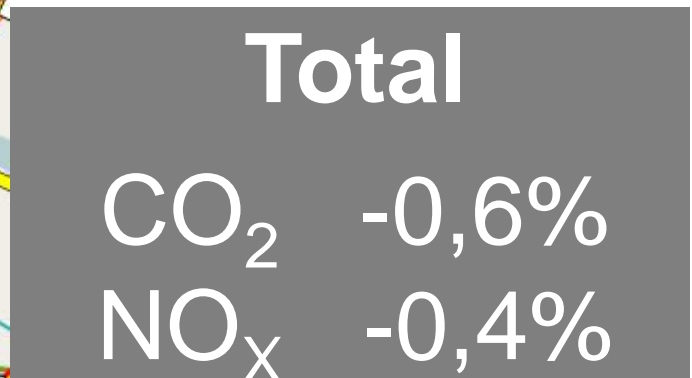


# Preliminary Results – New Bridge across Red River

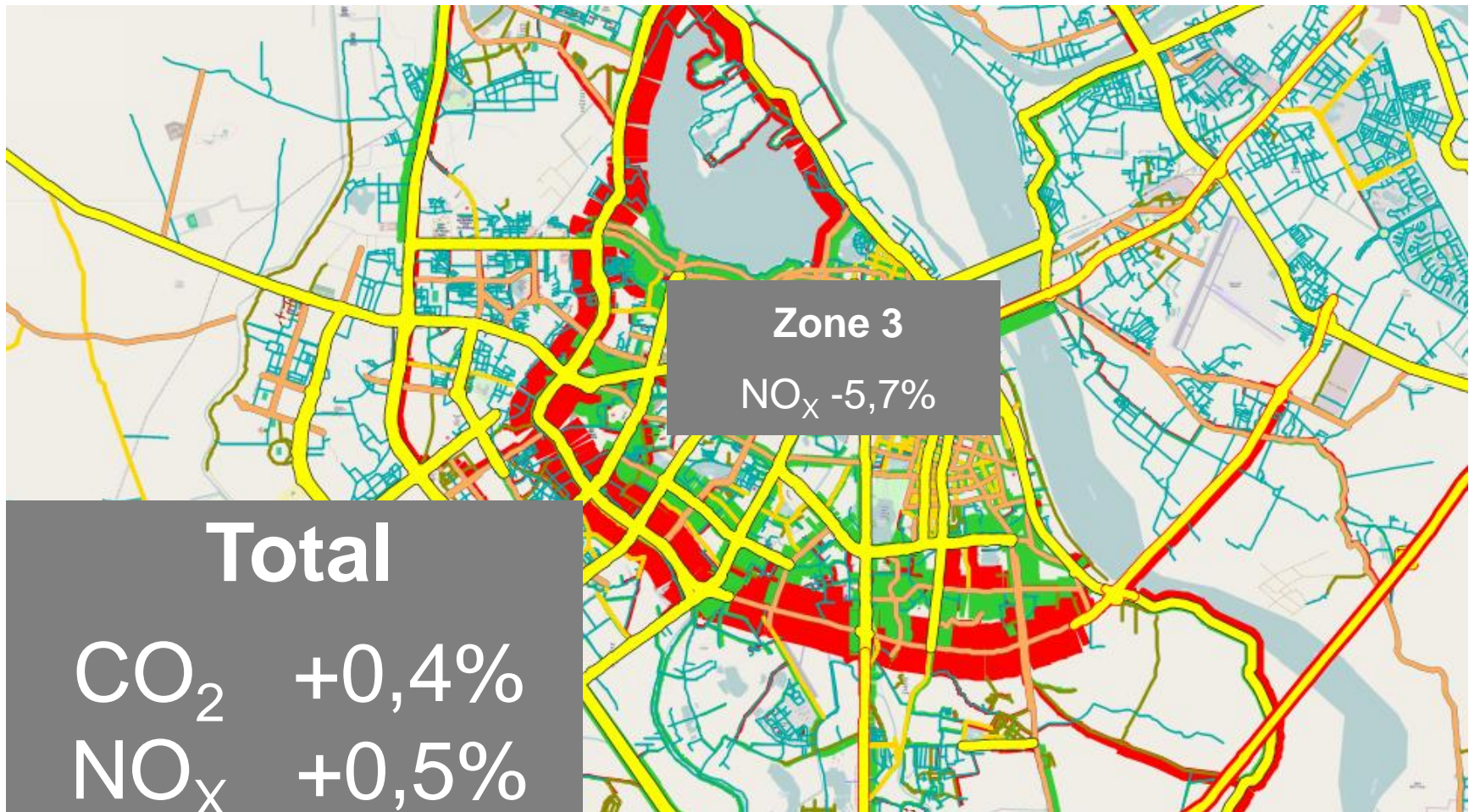




## Preliminary Results – Extended Ring Road



## Preliminary Results – Extended Ring Road + Metering

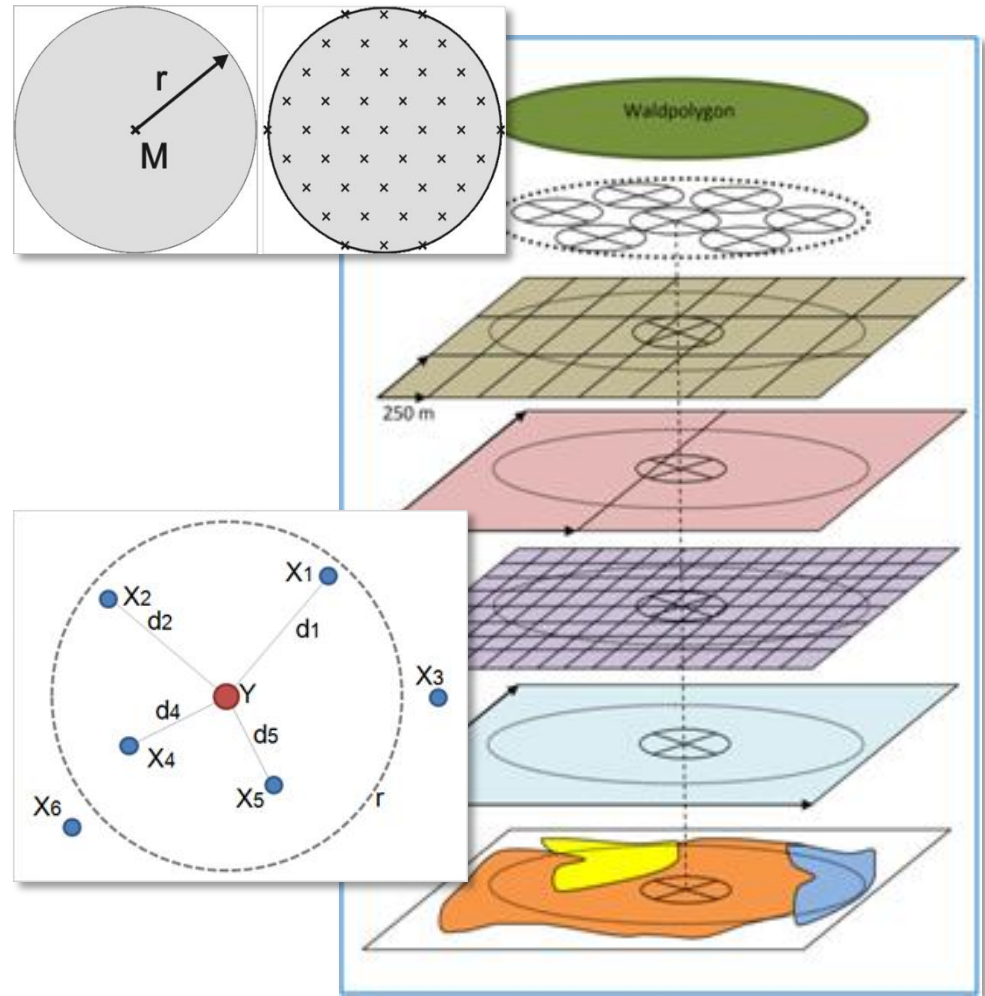


# Land-use Change Monitoring & Urban Growth Modelling

- Monitoring of landuse changes over the past 20 years
- Urban expansion analysis by zone and corridor
- Modeling urban dynamics and initial results

# eConstruction Method

- A point is defined a **representative** of the image
- Data from different sources can be analysed by adequate rules (e.g. radius, method)
- The features can be analysed by new technologies, depending on the question

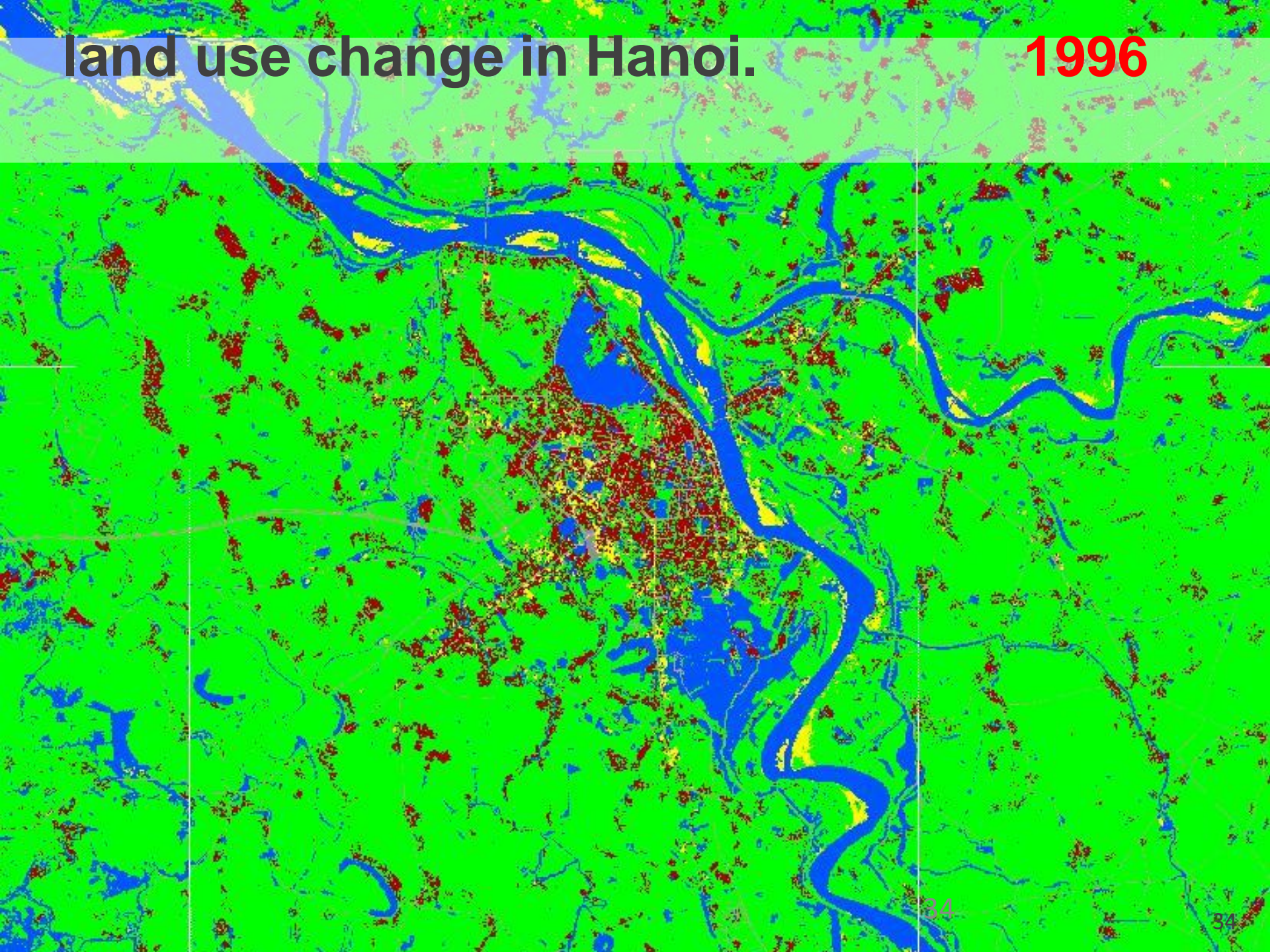




<b>date</b>	<b>Satellite Sensor</b>	<b>Spectral resolution</b>	<b>Geometric resolution</b>	<b>Radiometr. resolution</b>
29.12.1975	Landsat MSS	4 (blau, rot, NIR1, NIR2)	57 x 57m <sup>2</sup> (79 x 79m <sup>2</sup> )	8 Bit (256)
27.12.1993	Landsat TM5	7 (blau, grün, rot, NIR1, MIR1, PAN, MIR2)	30 x 30m <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)

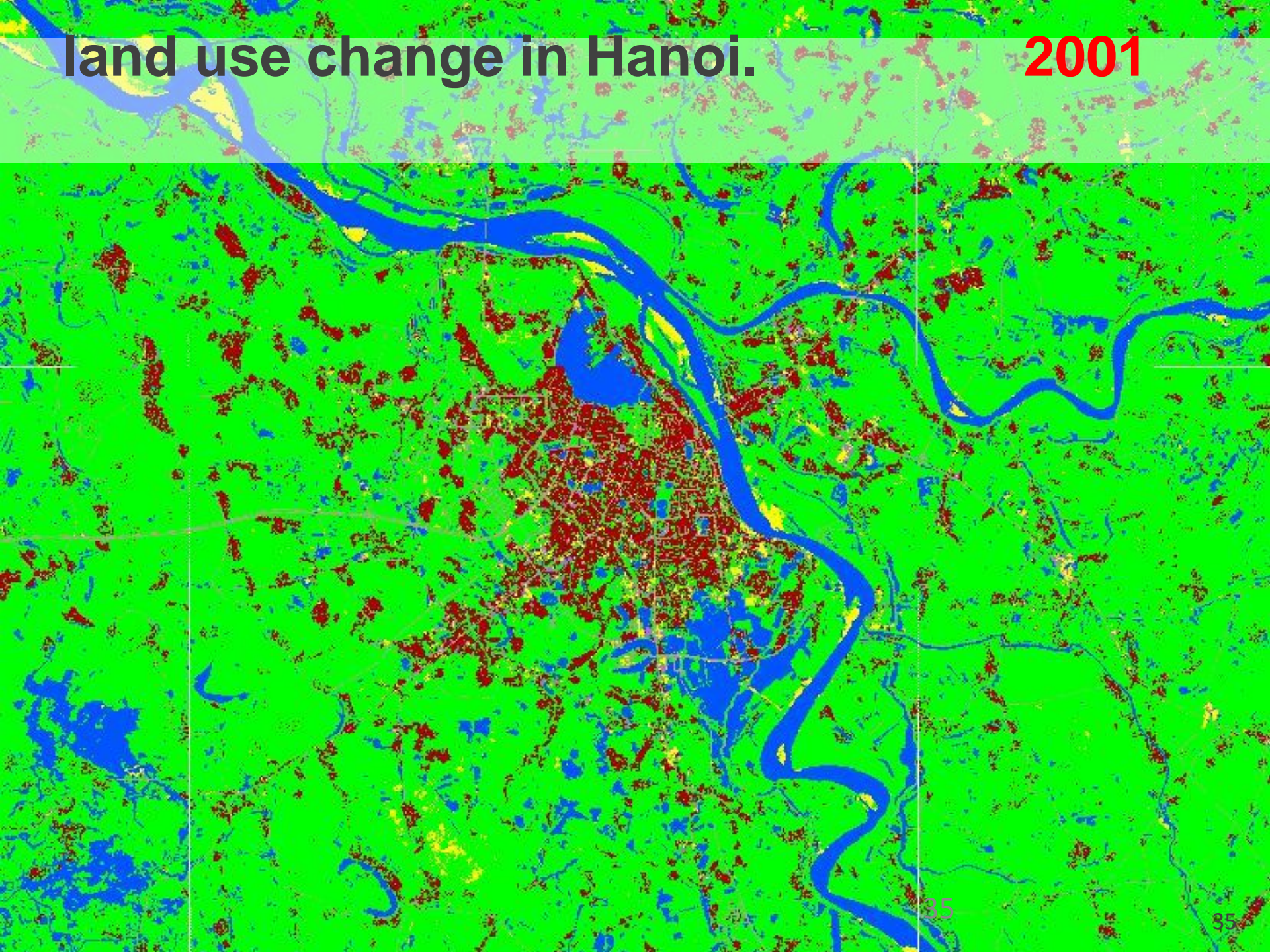
land use change in Hanoi.

1996



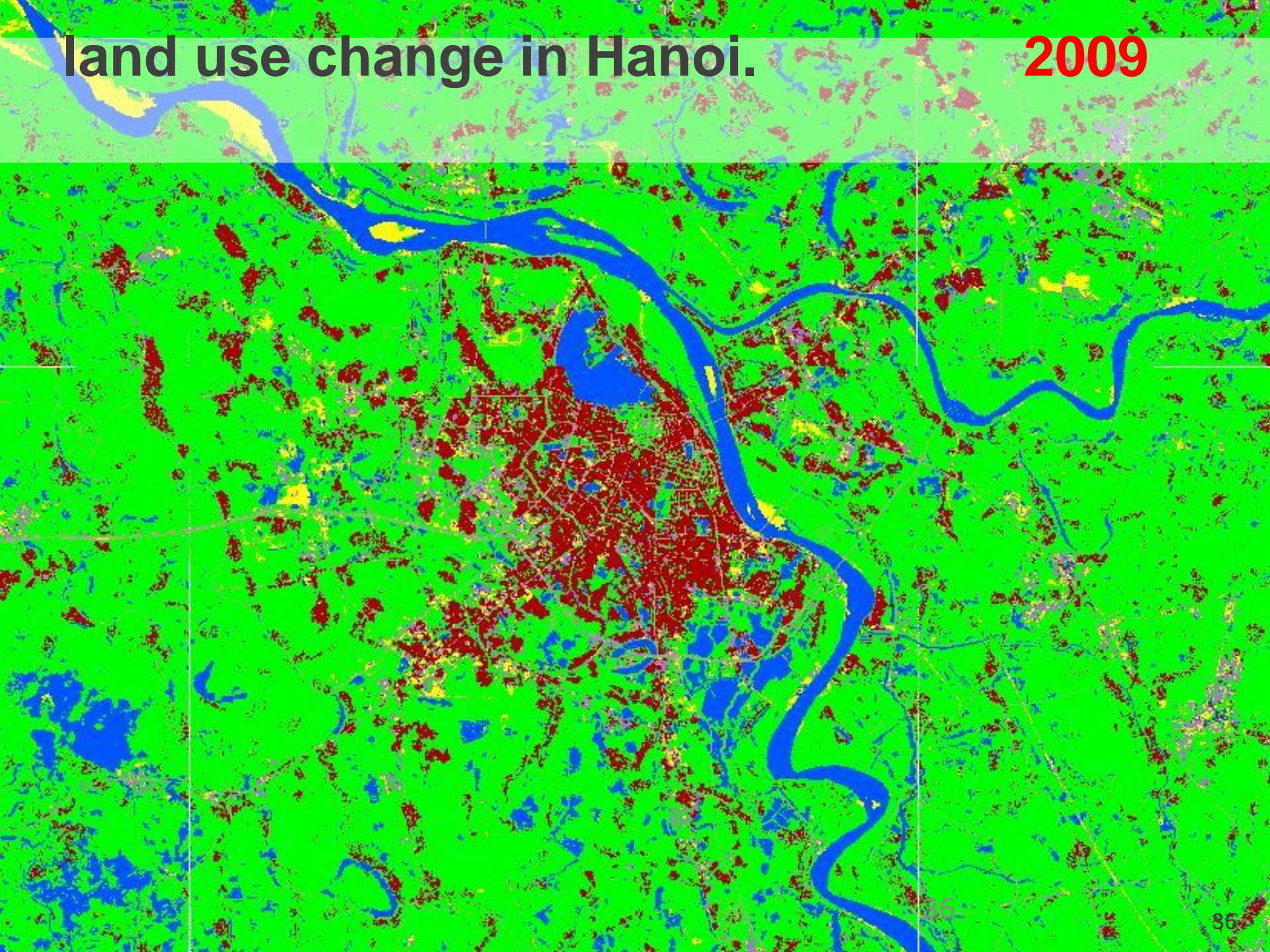
land use change in Hanoi.

2001



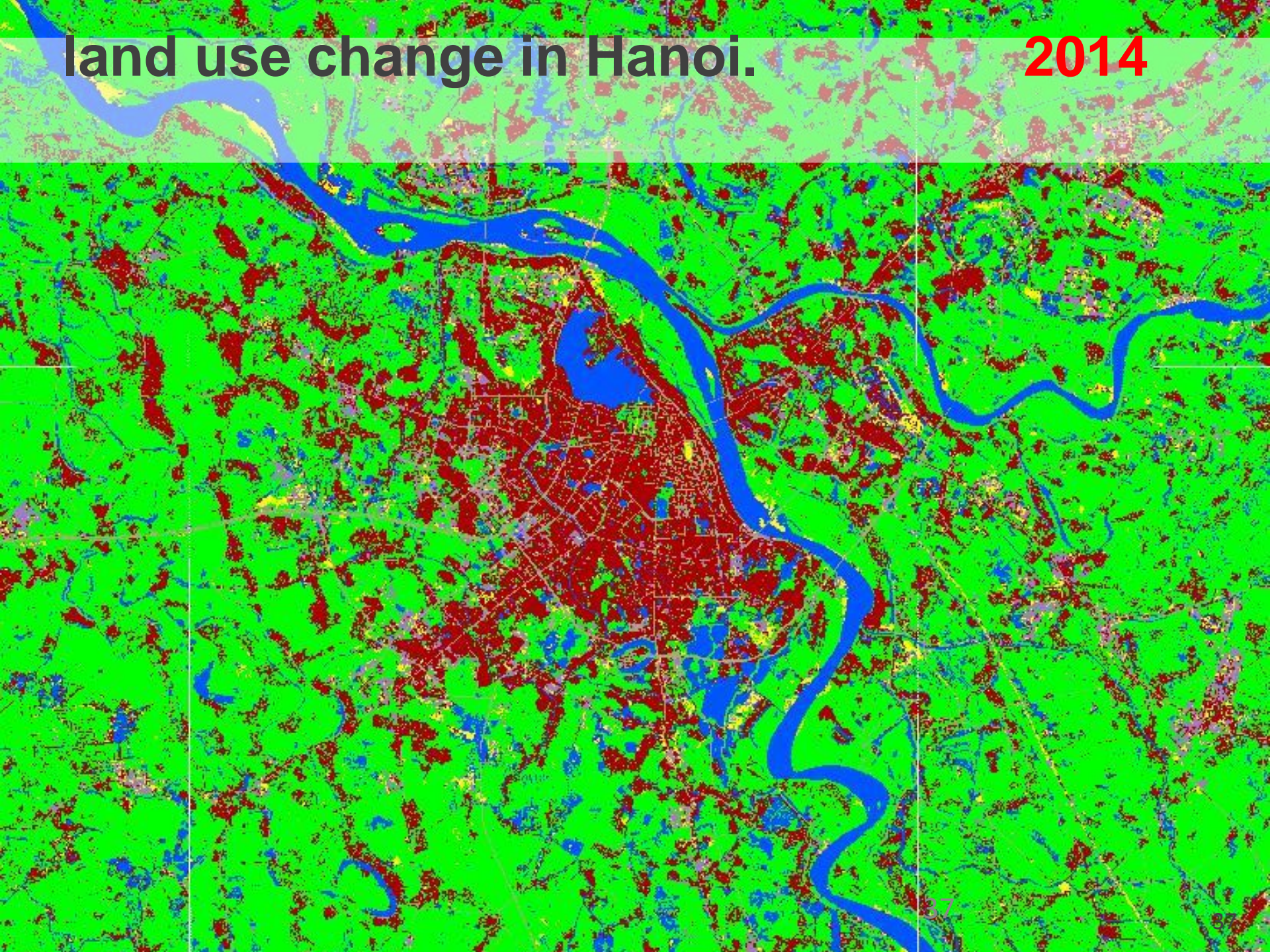
land use change in Hanoi.

2009

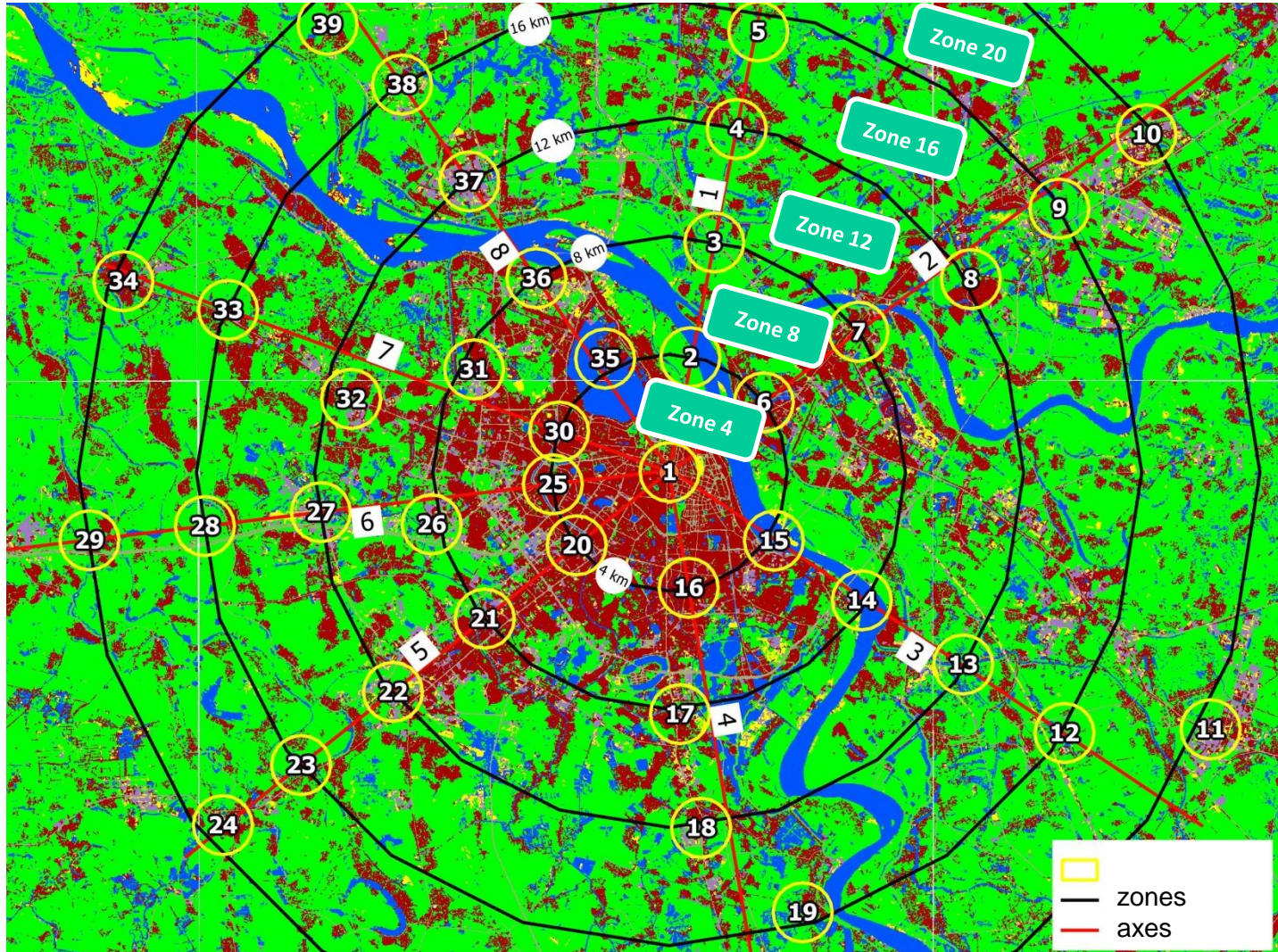


land use change in Hanoi.

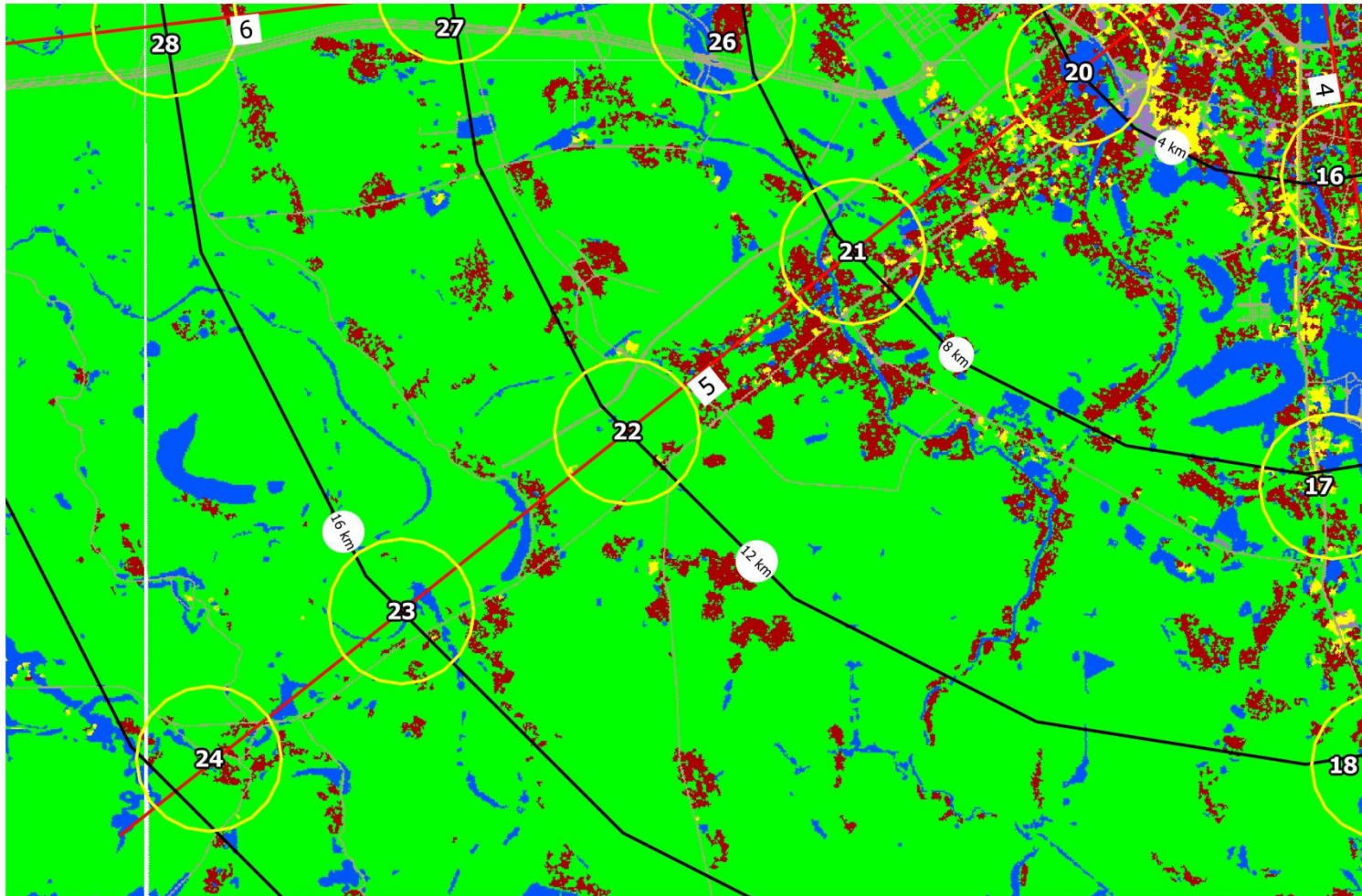
2014



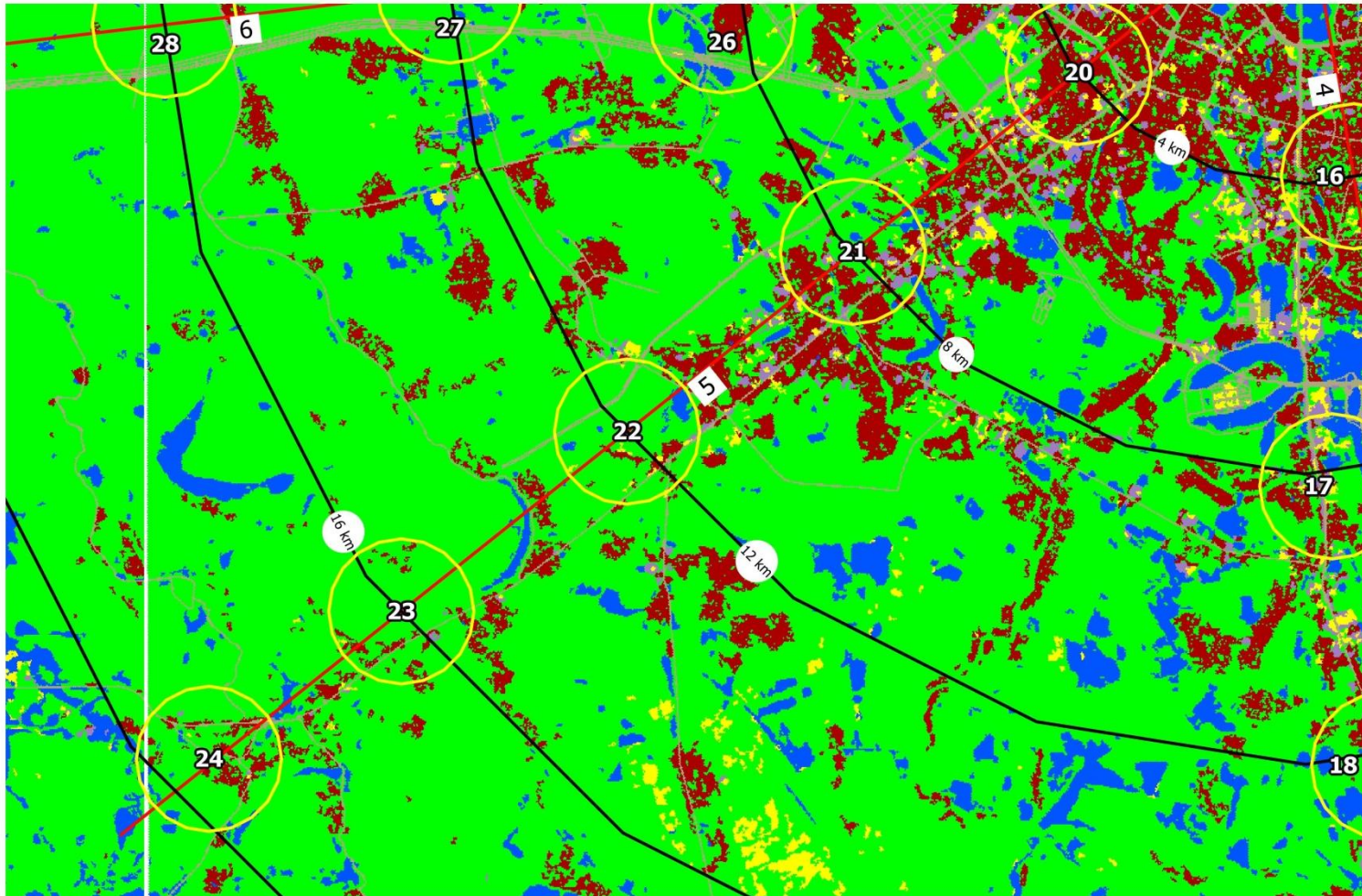
# Analysis of urban development



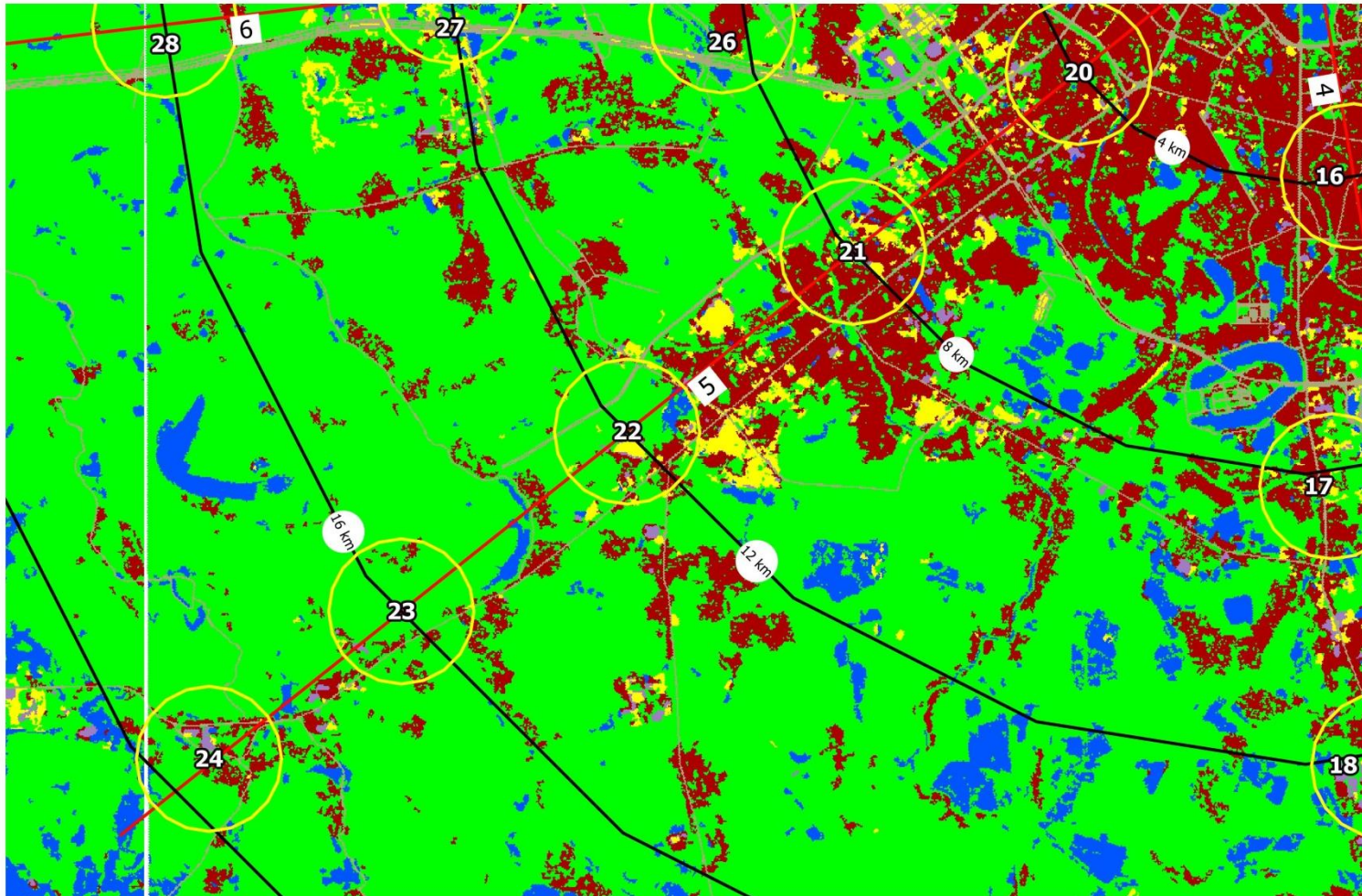
# comparison of different axes. 1993



# comparison of different axes. 2001

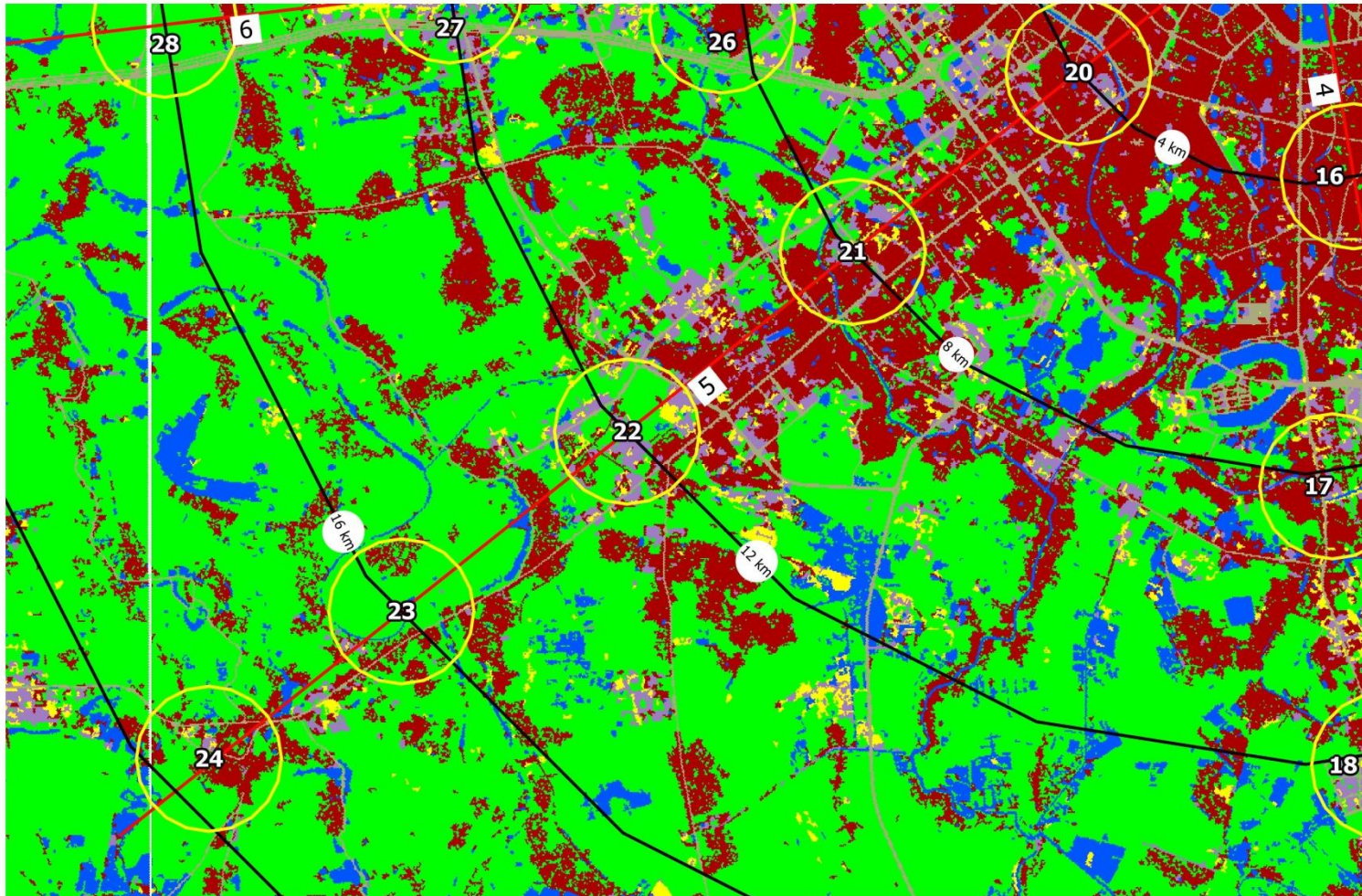


# comparison of different axes. 2007





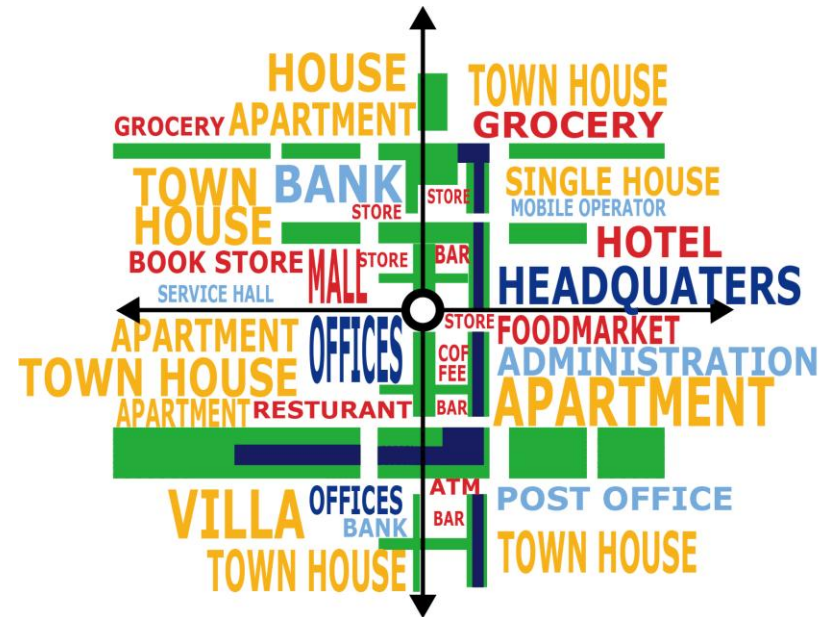
# comparison of different axes. 2014



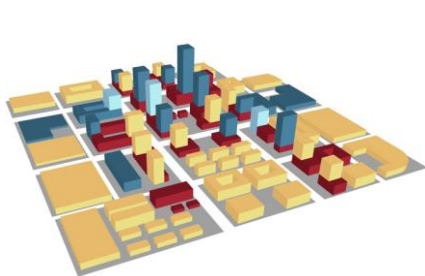
## Transit Oriented Development (TOD)

Five criteria:

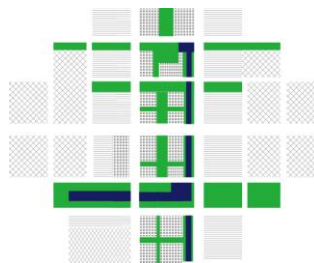
- Increased **Density** around stations
- **Diversity** of functions and services
- Quality of Urban **Design**
- Minimize **Distance** to transit
- **Destination** accessibility



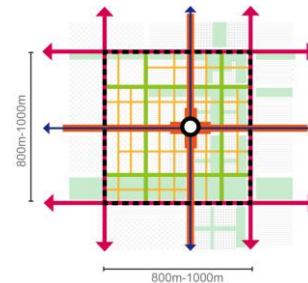
*Density*



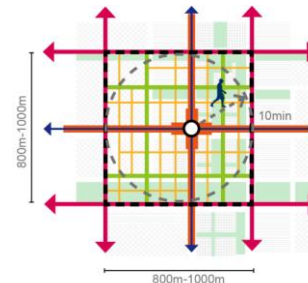
*Diversity*



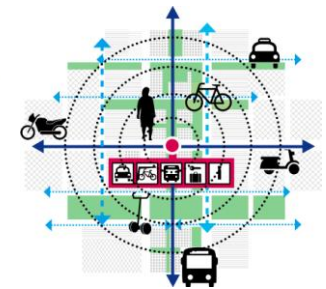
*Design*



*Distance*

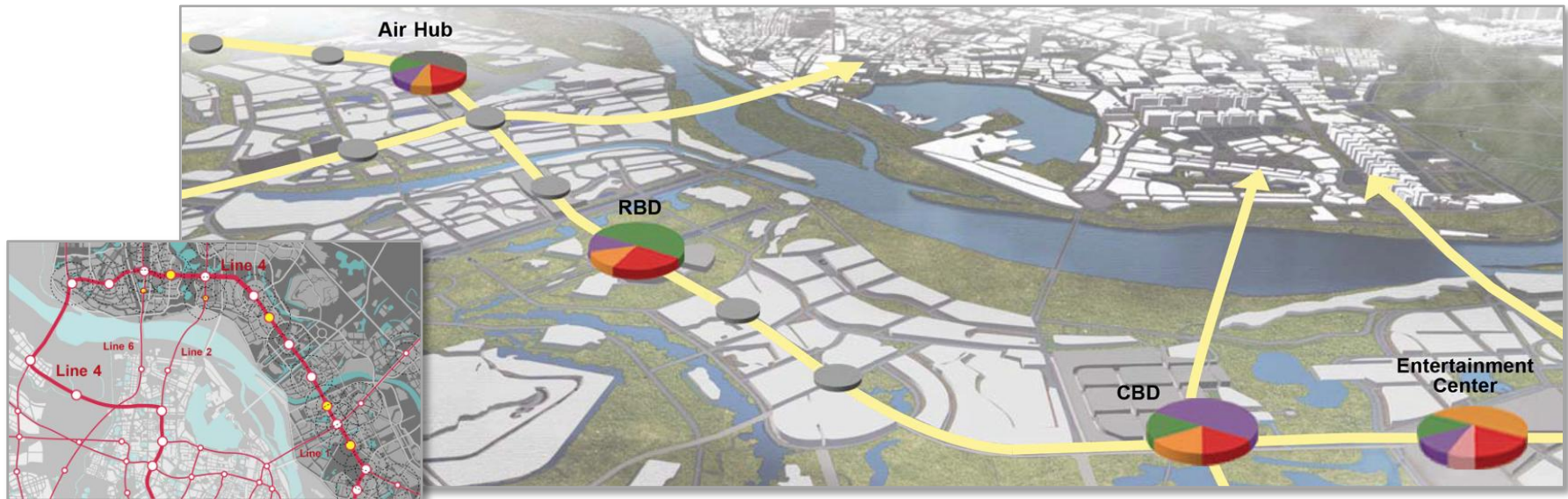
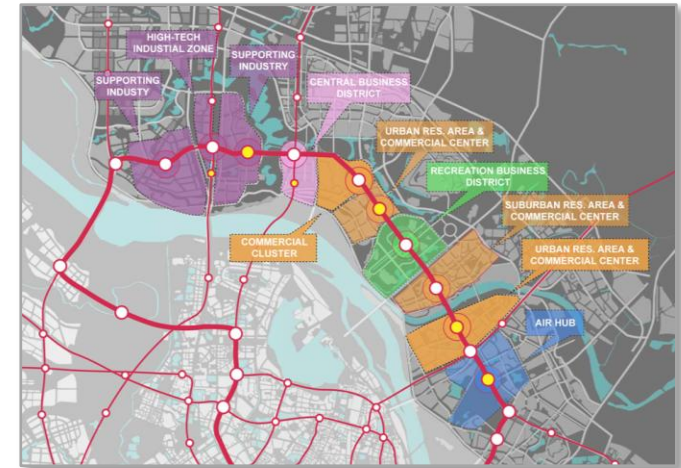


*Destination*



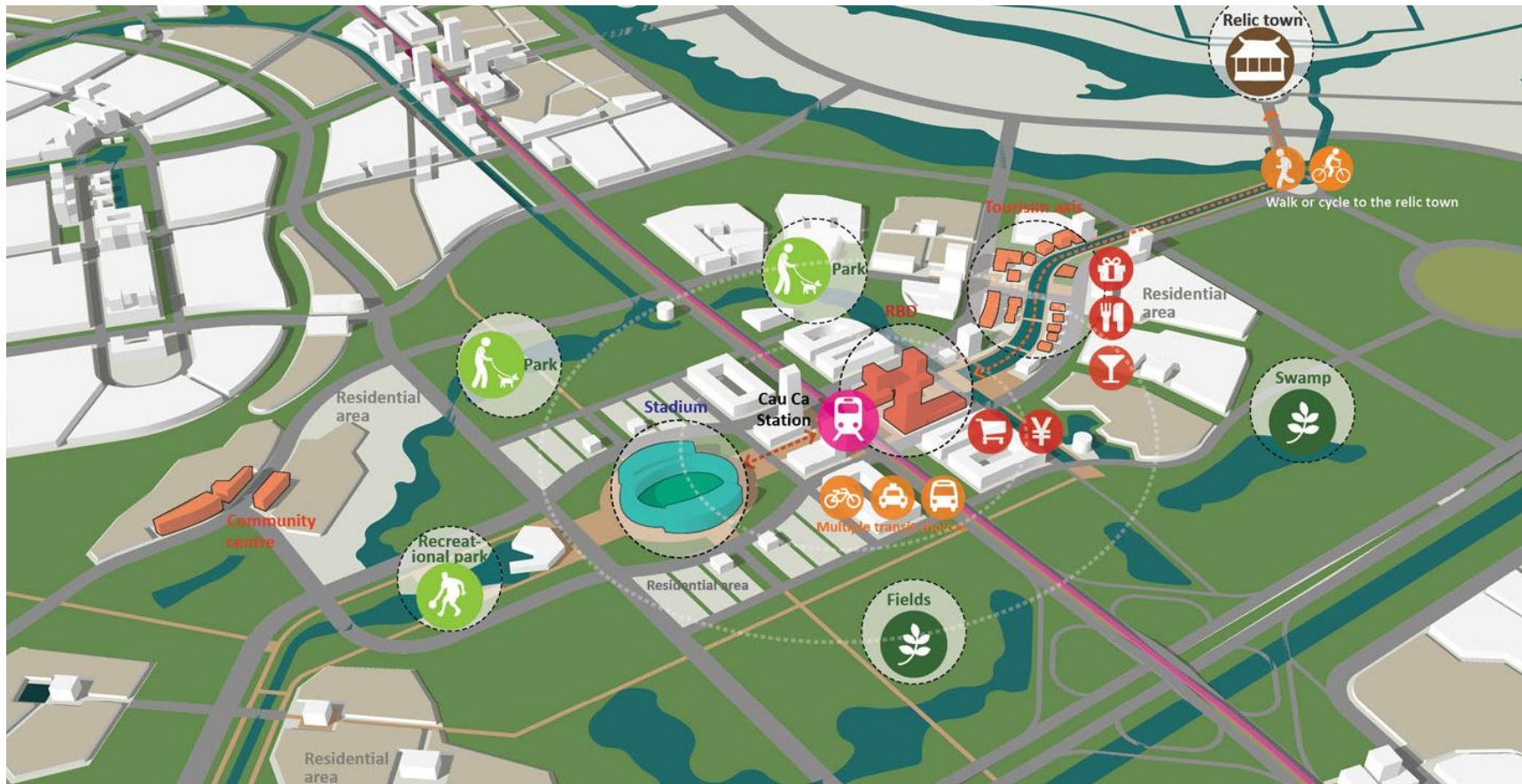
## Conceptual Masterplan

- Additional metro stations
- Moved stations to the center of existing settlements
- Creating interlinked sub-centers
- Defining core areas by defined character / theme
  - the core areas were supported by mixtures of different use with varying proportions
- Interlinked green network “glues” structure together



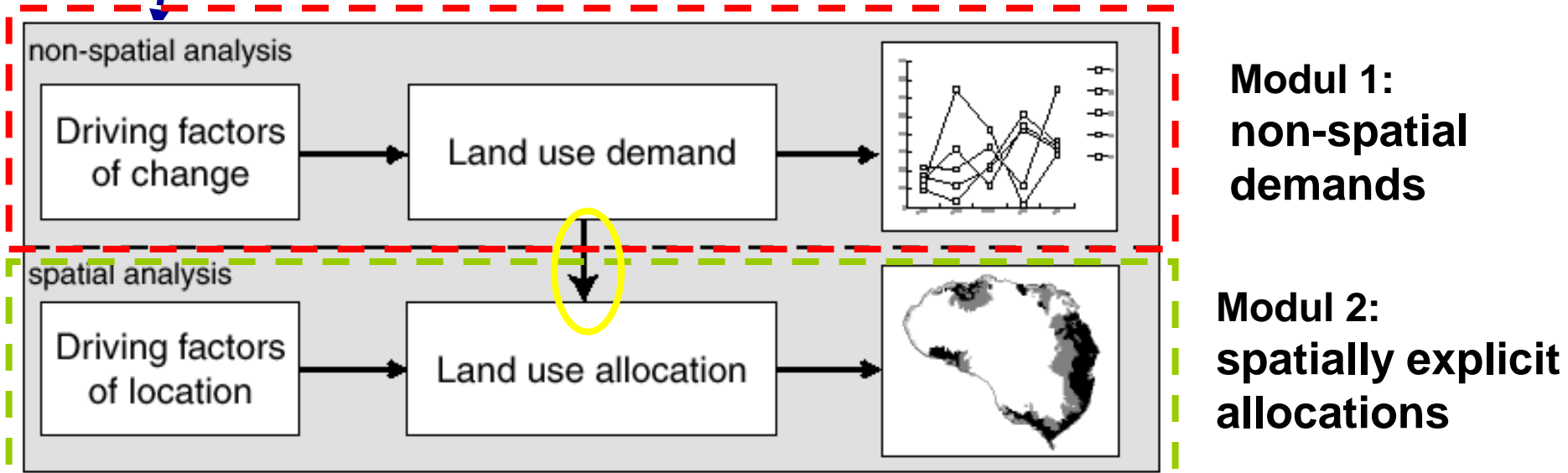
## Conceptual Masterplan - selected core area

- Public transport hinge serves National Stadium and touristic link to relic site
- Integration of existing villages in a new settlement pattern



## Structure CLUE-Model

- Demand for housing, mobility,...



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

(Verburg et al. 2002)

# Model approach for urban dynamics in Hanoi

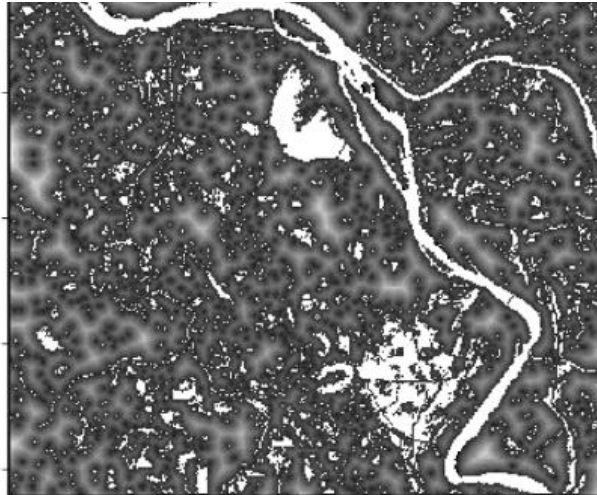
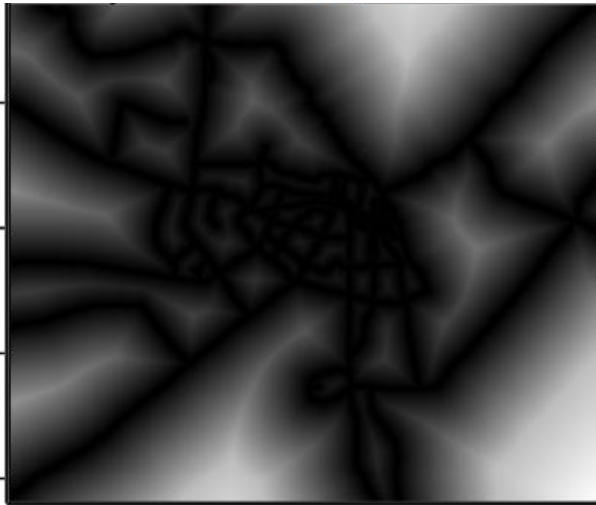


## Parameters influencing urban dynamics Hanoi

Distance to roads

Distance to water

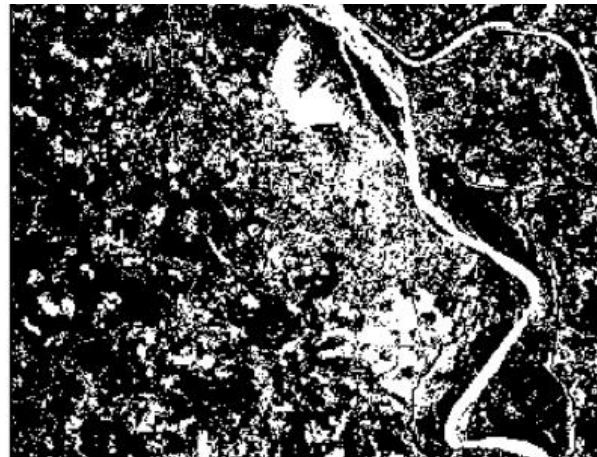
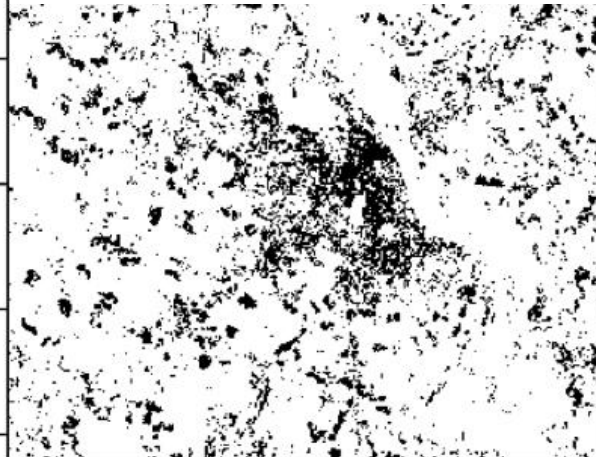
Distance to centres



urban areas

vegetation

sand / barren land



# Model approach for urban dynamics in Hanoi

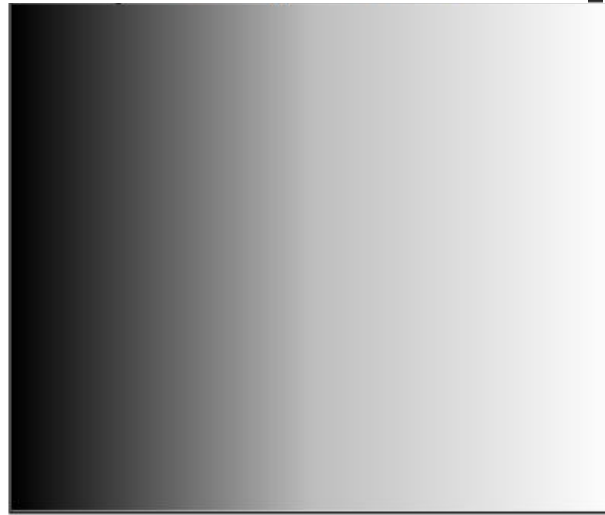
## Parameters influencing urban dynamics



water



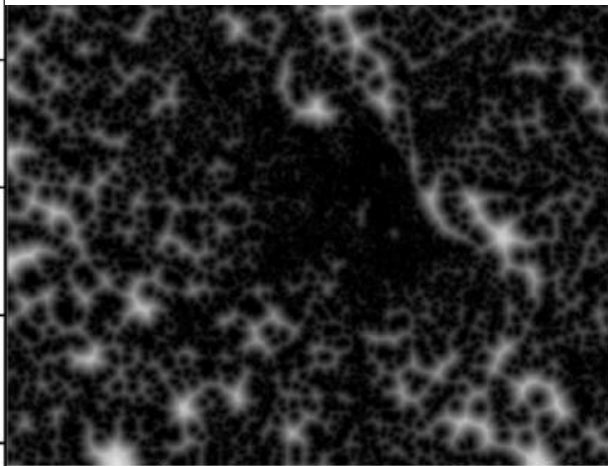
easting coordinates



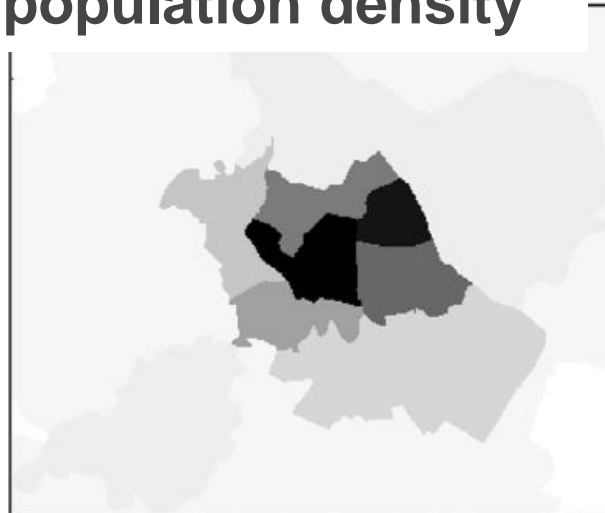
northing coordinates



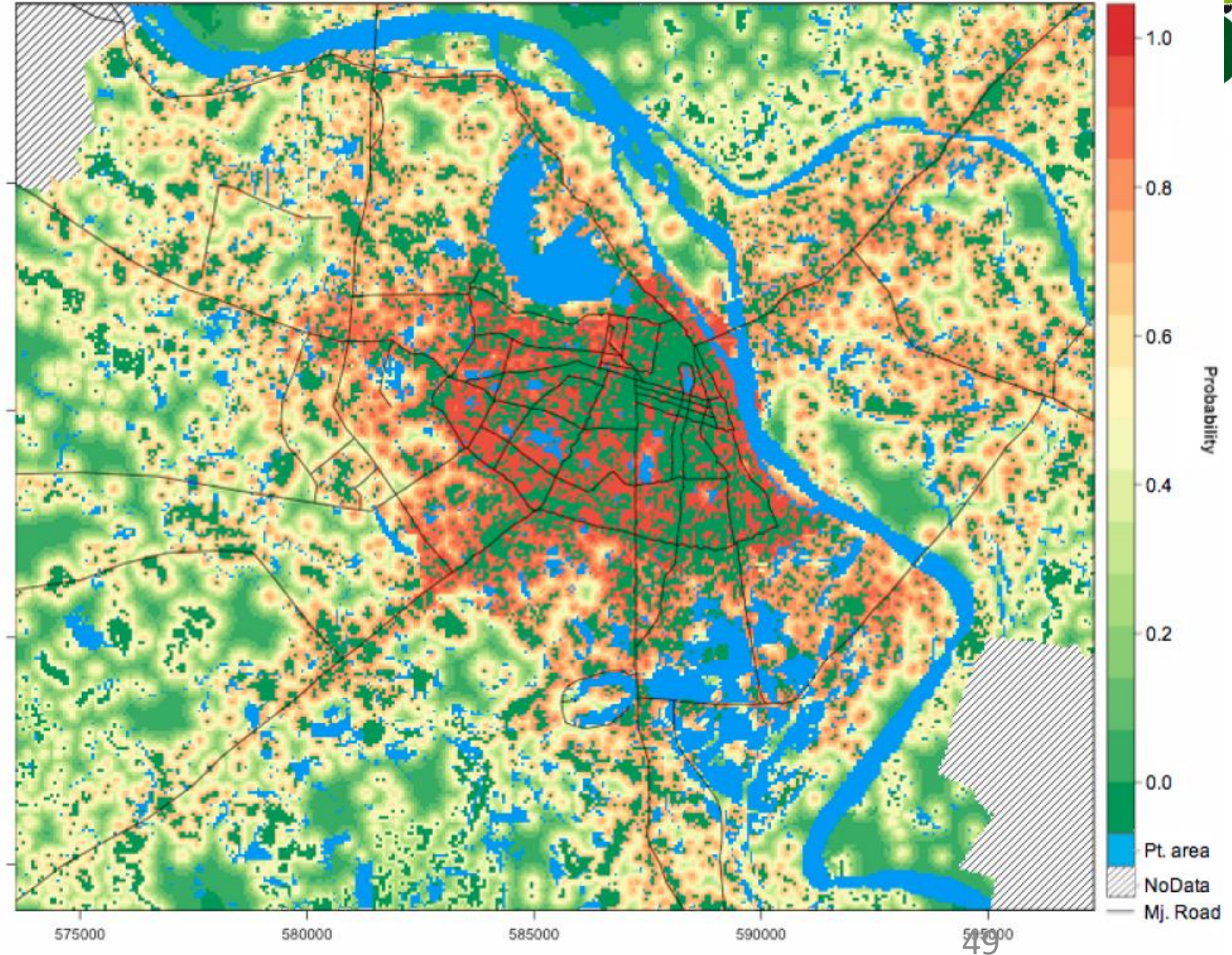
distance to urban



population density



# Probability map for conversion to Urban



# Conclusions

- Running real-time traffic information system
- Well-adapted traffic management strategies
- Sound policy recommendations on urban development
- Showcases of energy-efficient urban and transport planning
  
- The local government, authorities, and planners will be able ...
  - to measure traffic conditions,
  - to test GHG reduction impacts of proposed policy measures, and
  - to well monitor the performance of transport infrastructure/services

Thank you for your attention

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