USF UNIVERSITY OF SOUTH FLORIDA | School of Global Sustainability

UNESCO-IHE Institute for Water Education

SWITCH

Cities of the Future

Kala Vairavamoorthy

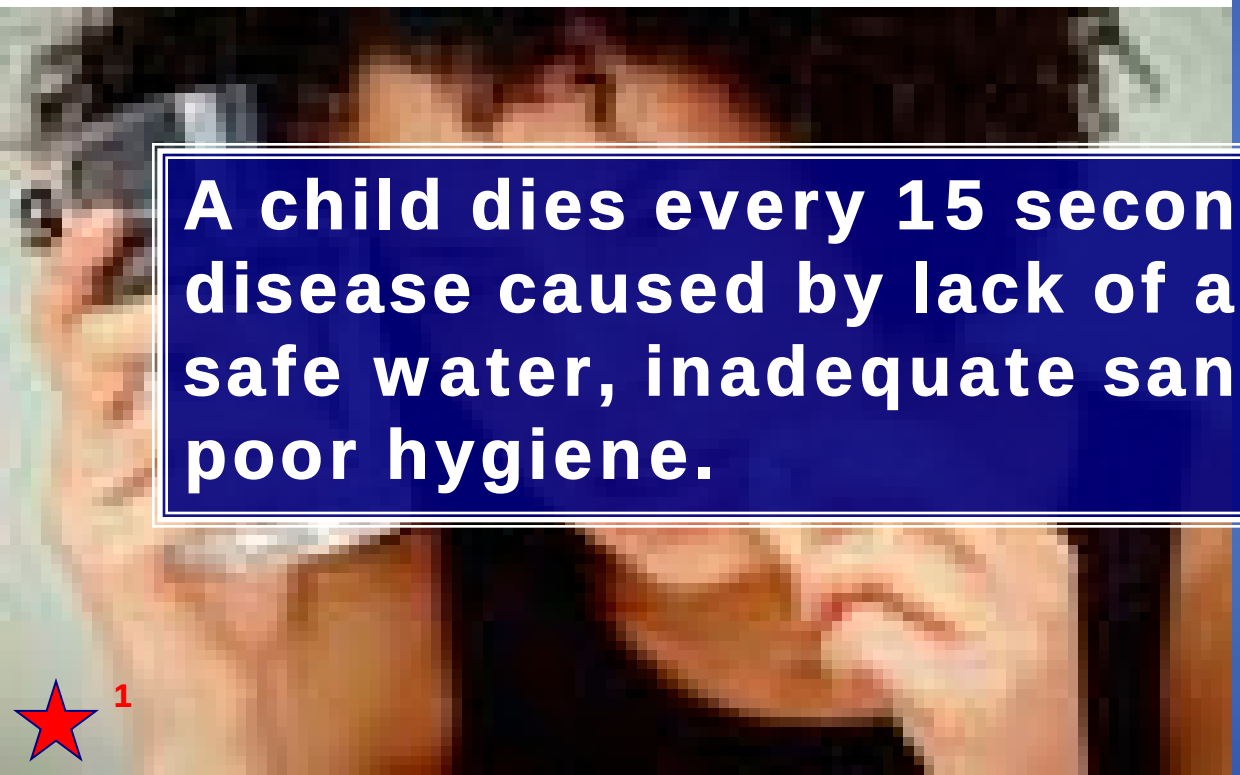
Sustainable Water Management in Cities

17 Dec 2010 – Zaragoza, Spain

Water is Life!

10,000 to 20,000 people mainly children die every day from water-related diseases.

Water is also Killer no. 1



A child dies every 15 seconds from a disease caused by lack of access to safe water, inadequate sanitation and poor hygiene.

Response - Good News and Bad News

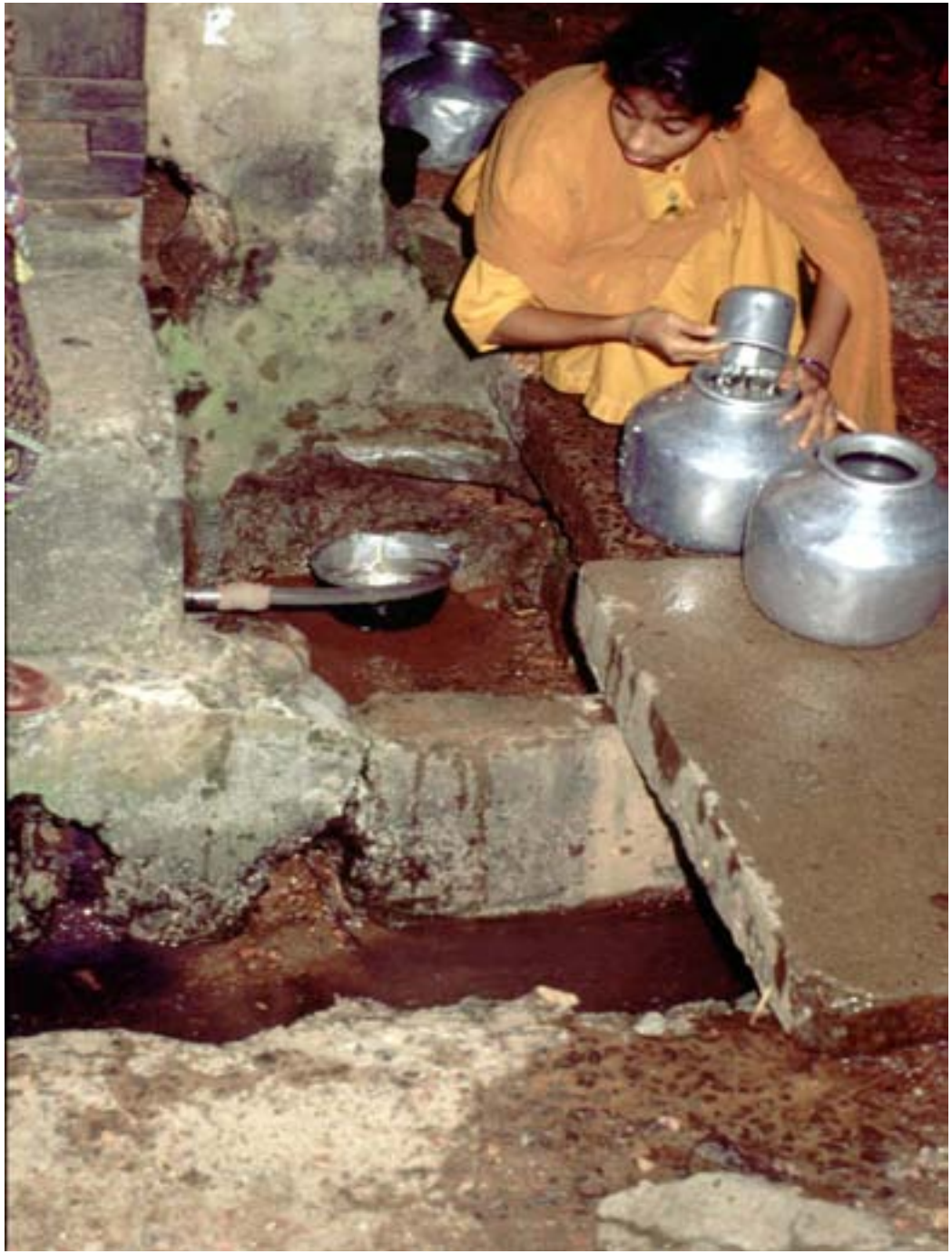
‘Open the loop’ - linear supply and disposal

Good News

- Upper income countries have revolutionized public health outcomes
- Also have made major progress in mitigation of environmental damage

The Bad News

- Systems built for narrow objectives with little resilience – not suited to the challenges ahead
- Extraordinarily resource intensive
- Unaffordable to 2/3 of the planet



24-Hour Water Availability - Asia

Mumbai

- 4% of the population receive water > 8 hrs/day
- 33% receive water > 4 hrs/day
- 42% receive water for just 3 hrs/day
- 21% receive water < 3 hrs/day (often only 1 hr)

Chennai

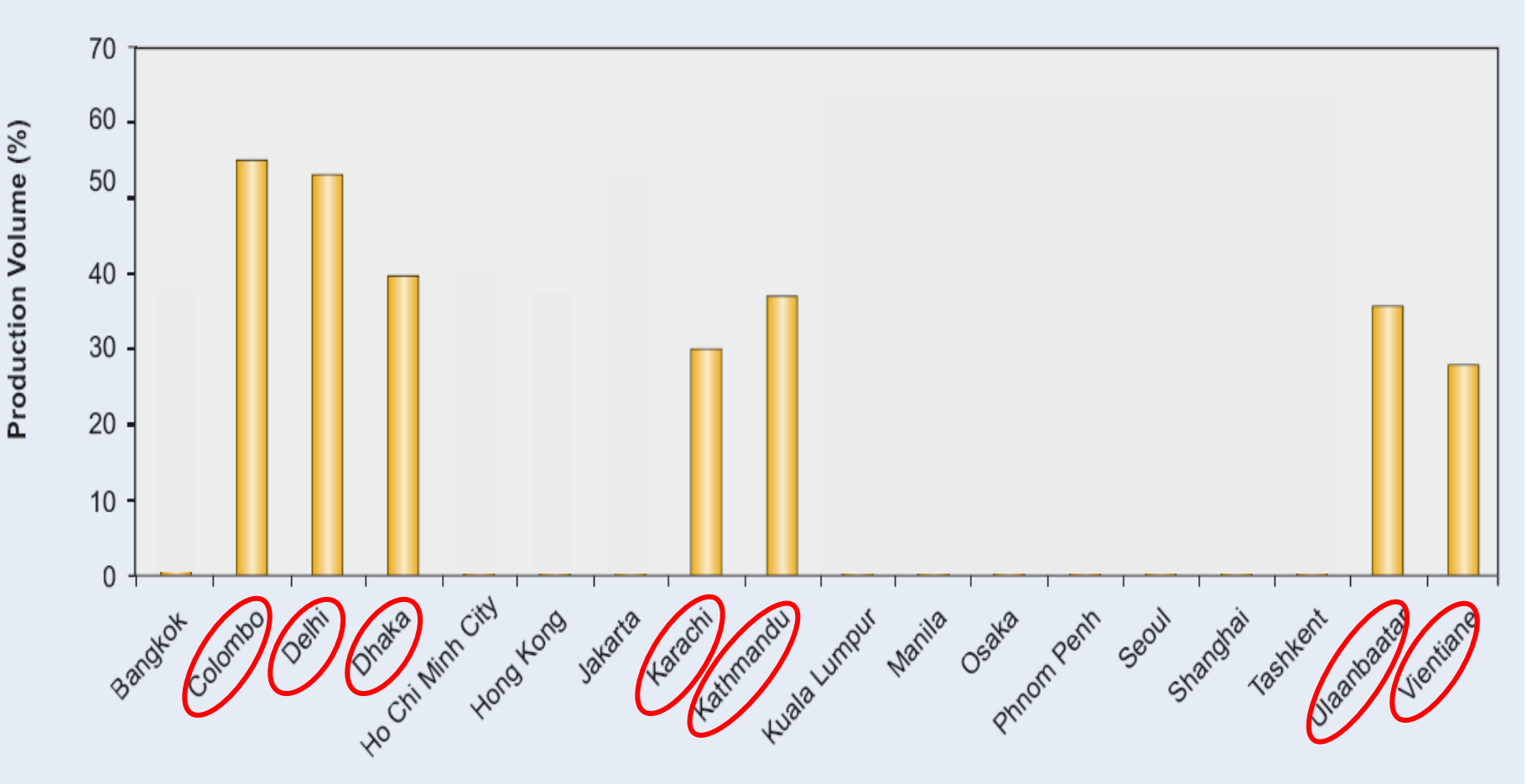
- Overall shortage of water
- Insufficient pressures (many areas had zero pressure)
- Inequitable distribution of water
- Very short duration of supply
  - 2 hours a day but irregular
  - Outskirts of Chennai - 1 hour each day

Source: McIntosh (2003)

24-Hour Water Availability

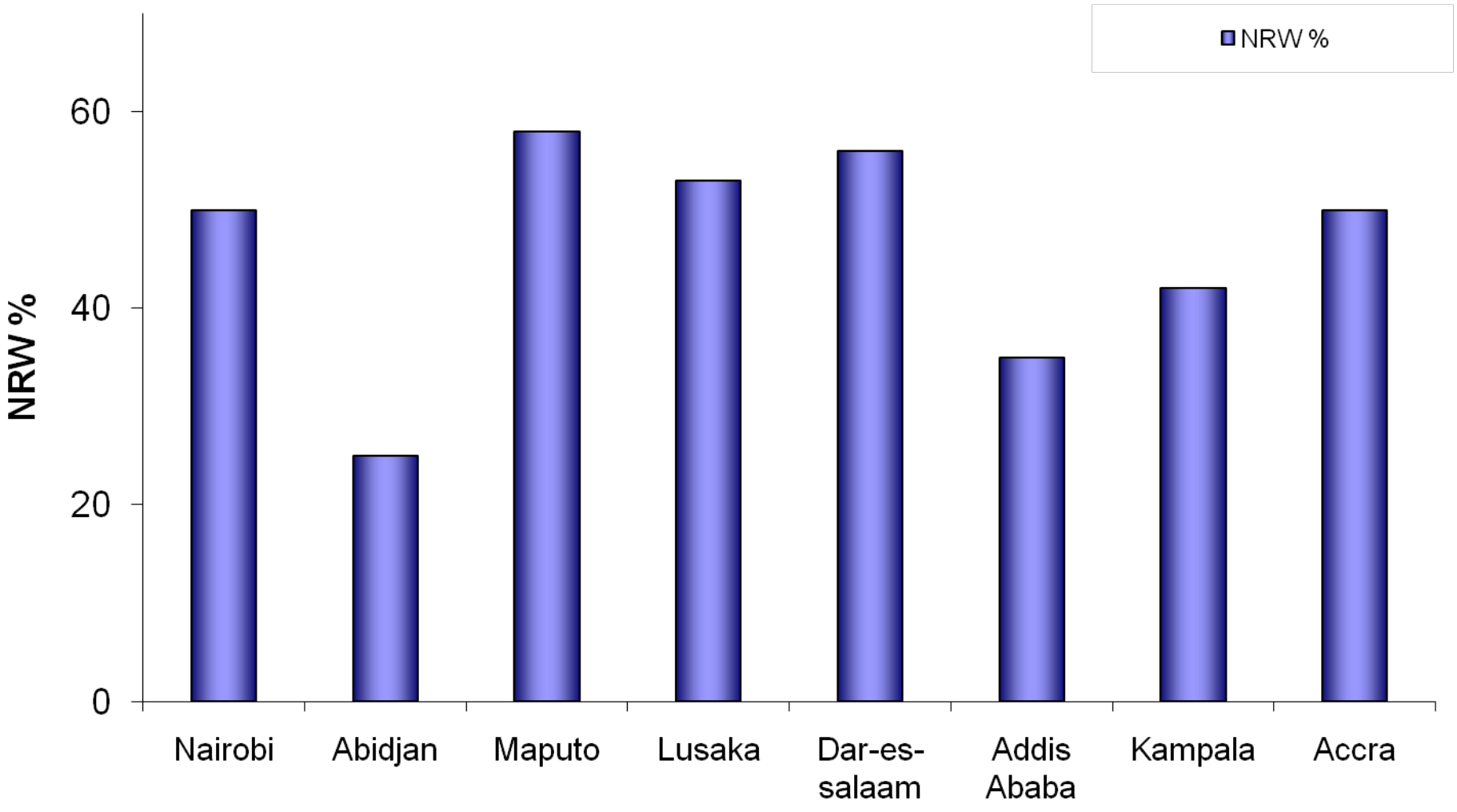
Source: McIntosh (2003)

Non-Revenue Water



Source: McIntosh (2003)

Non-Revenue Water

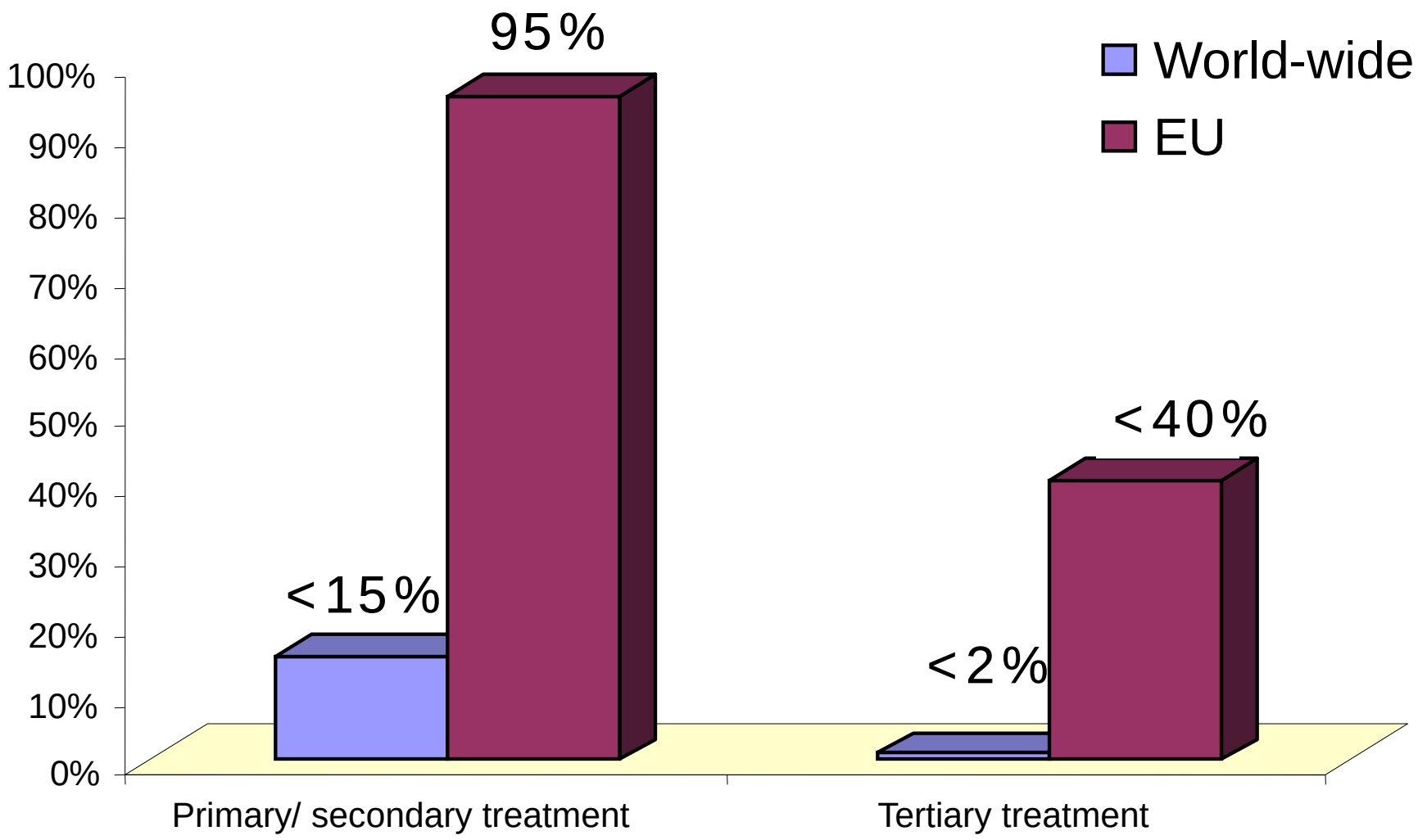


WOP Africa Utility Performance Assessment (2009)

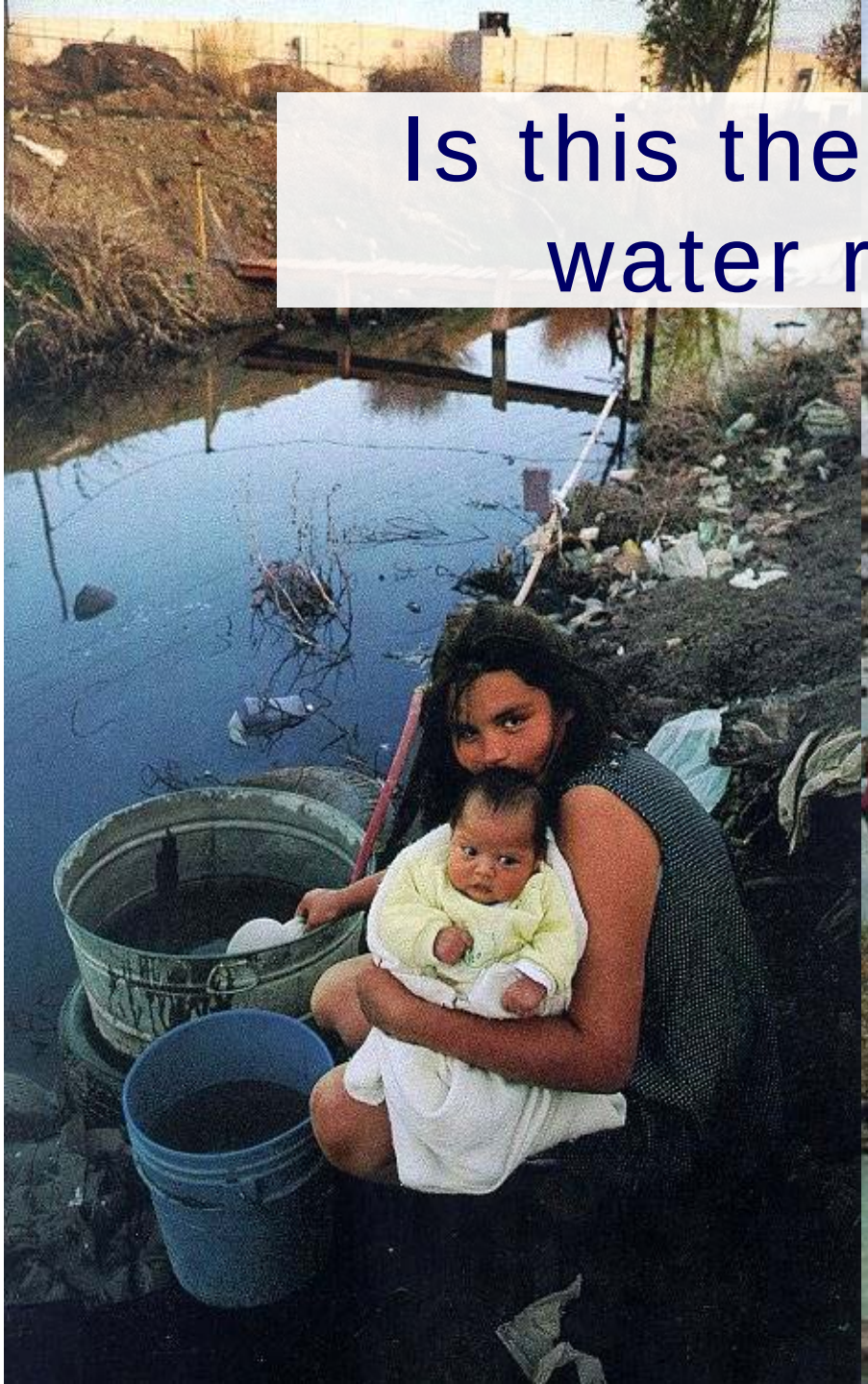
- **Out of ‘4,000’ urban municipality suppliers in India, there are now just a few demonstration zones supplying water continuously……**
- **Coping costs high – Tanker water is 10 times the cost of piped water**
- **Why should the poor have to buy their water in small bags??**

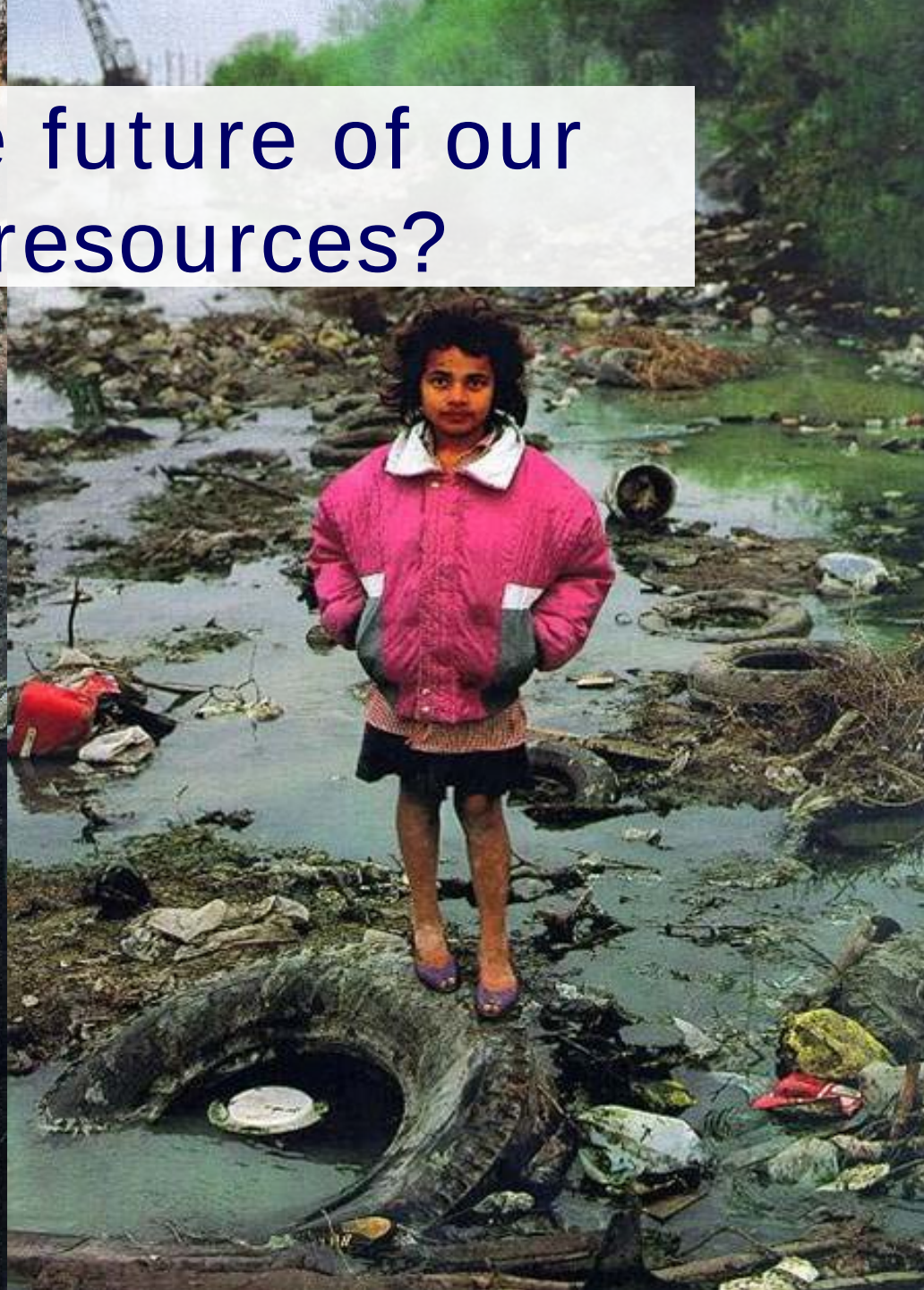
Franceys (2010)

Most wastewater is <u>not</u> treated!



Is this the future of our water resources?





Future Pressures

Hazards - New challenges

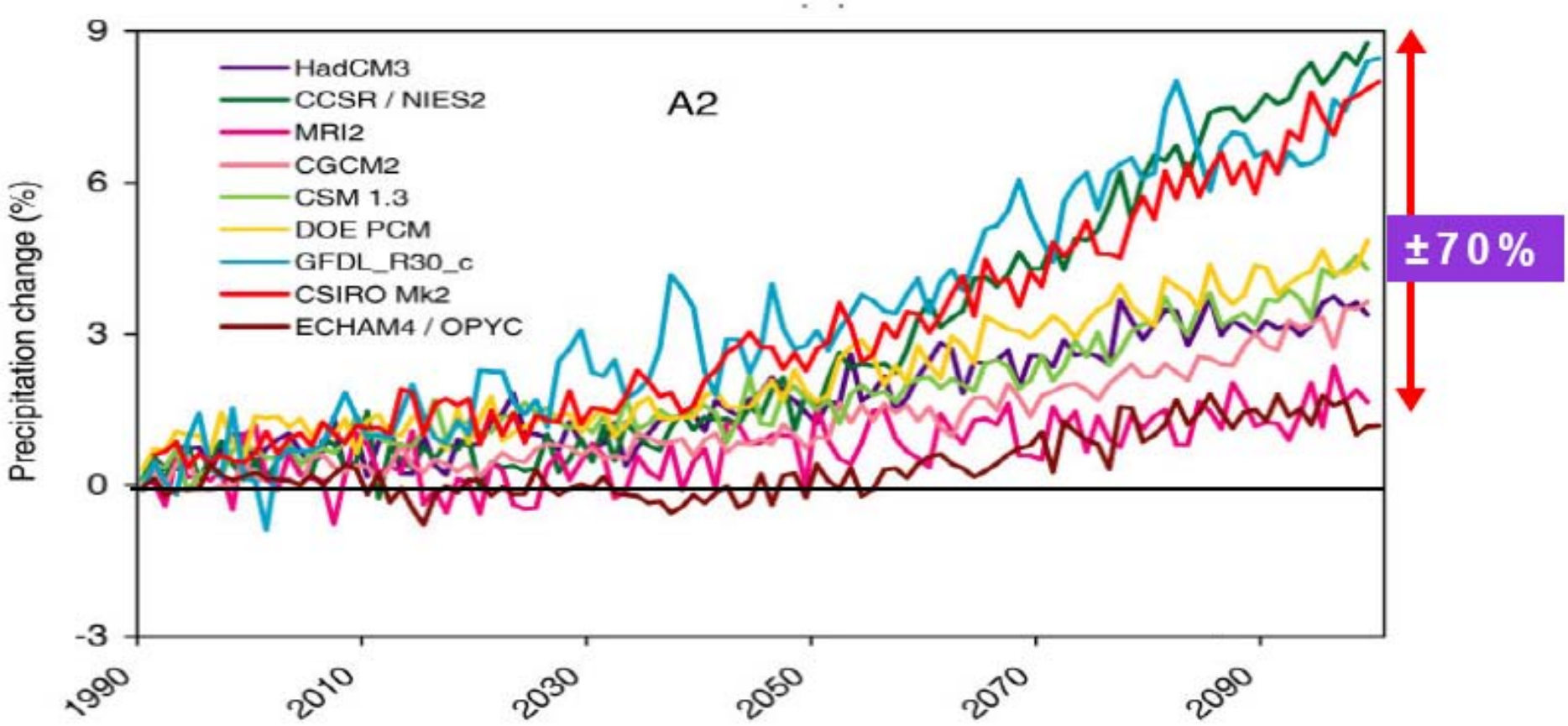
- **Entire earth system is changing!**





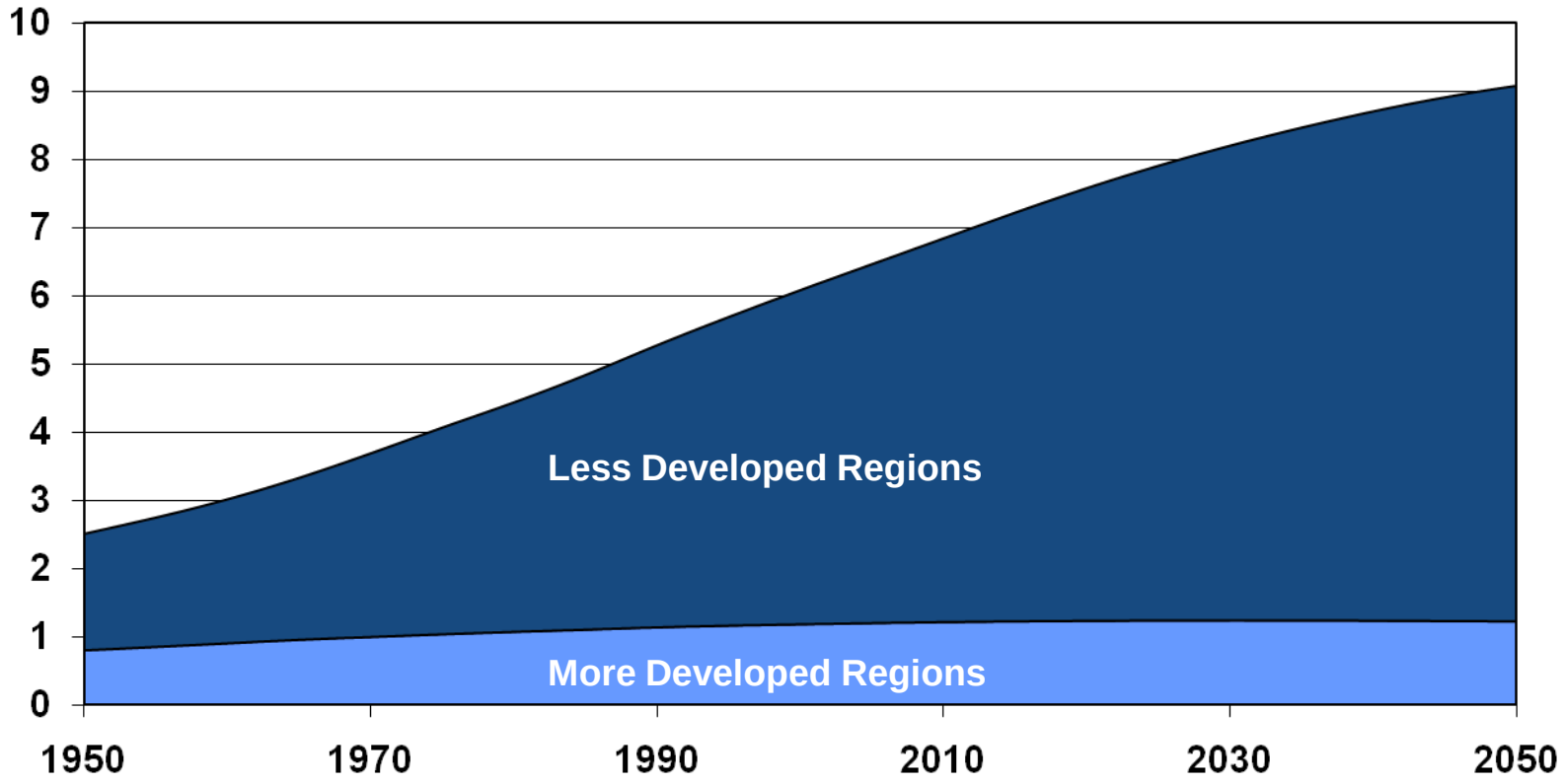


Changes - Uncertainties



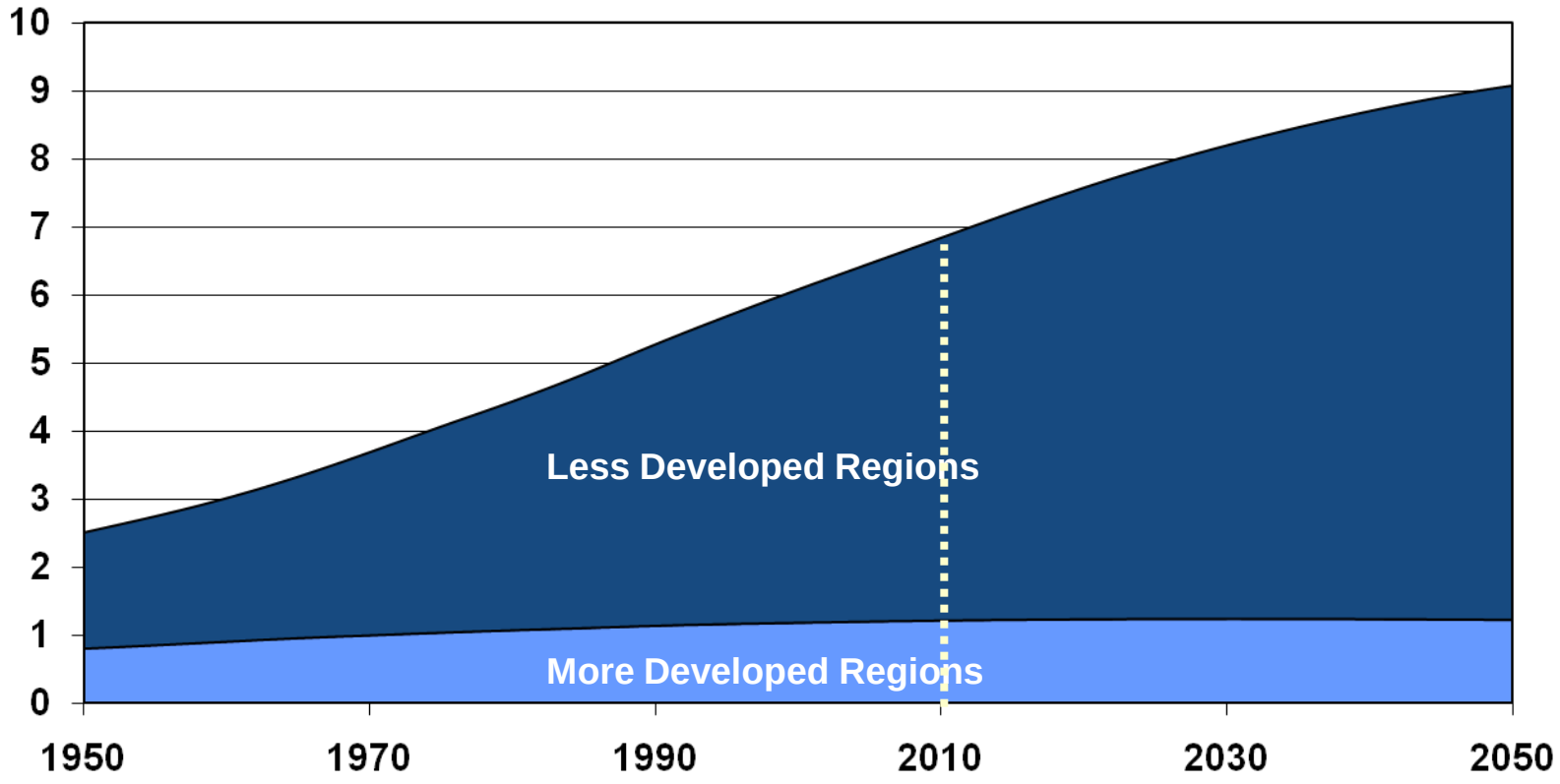
Source: Hadley Centre

World population prospects 1950 - 2050



Source: United Nations, *World Population Prospects: The 2004 Revision* (medium scenario), 2005.

World population prospects 1950 - 2050



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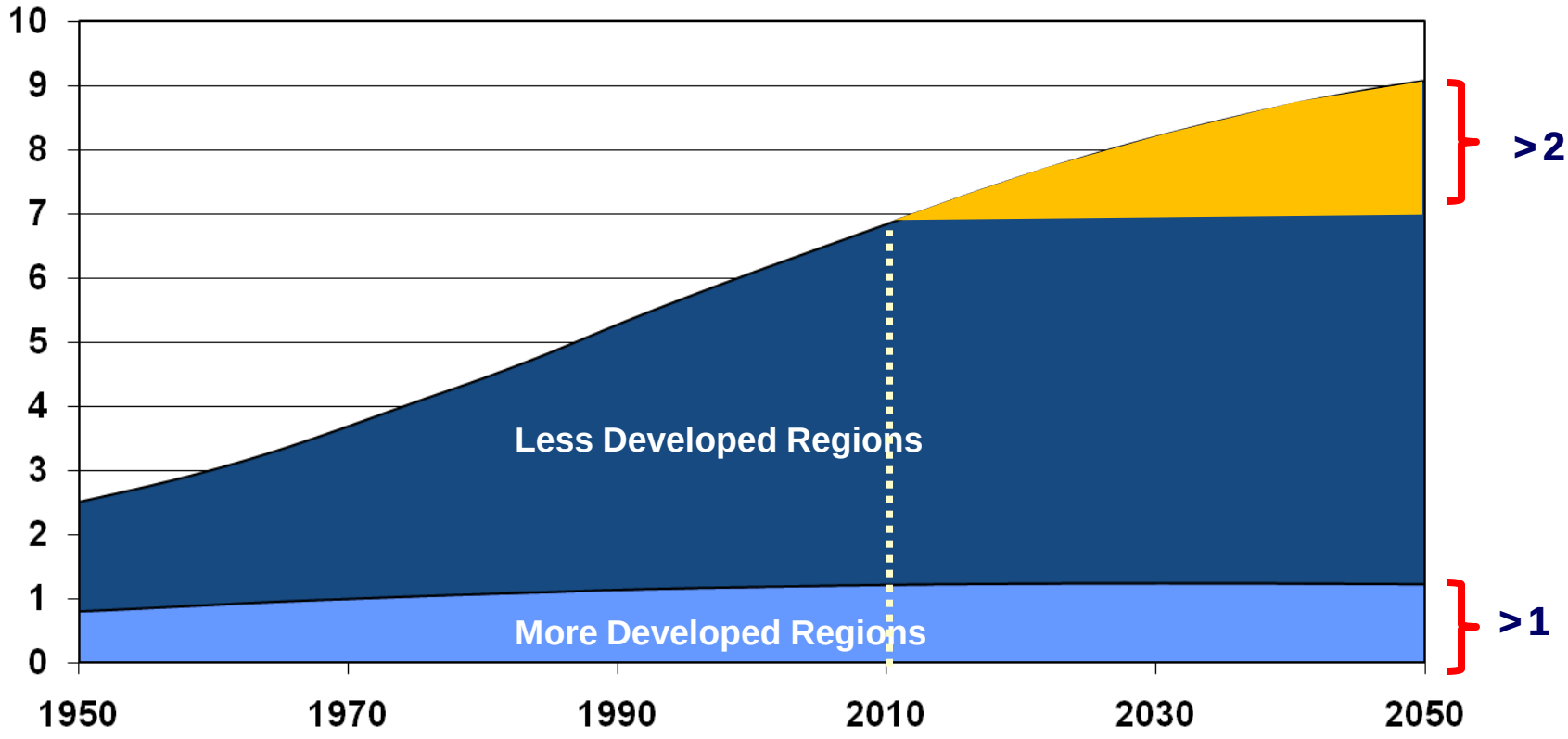

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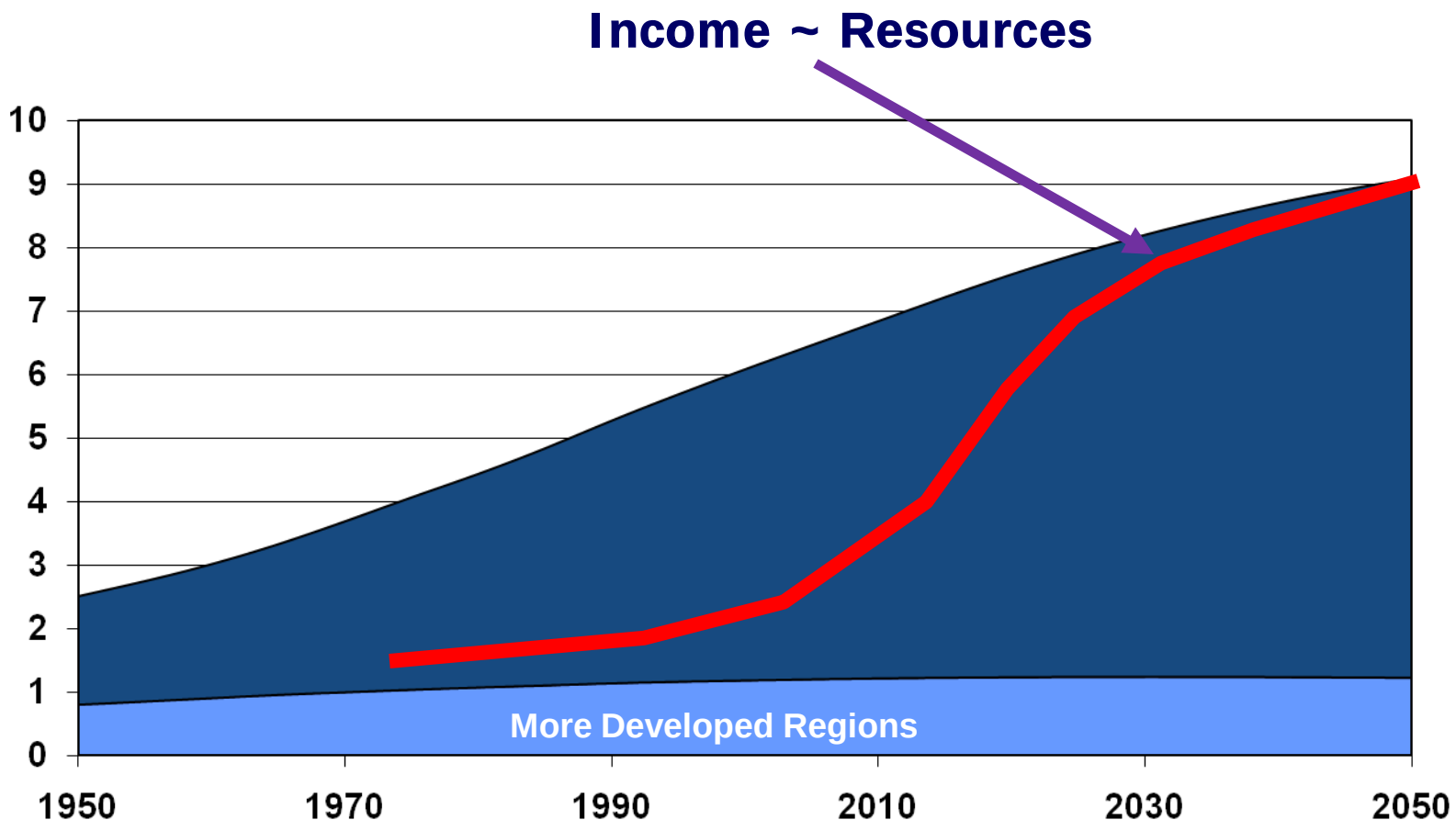

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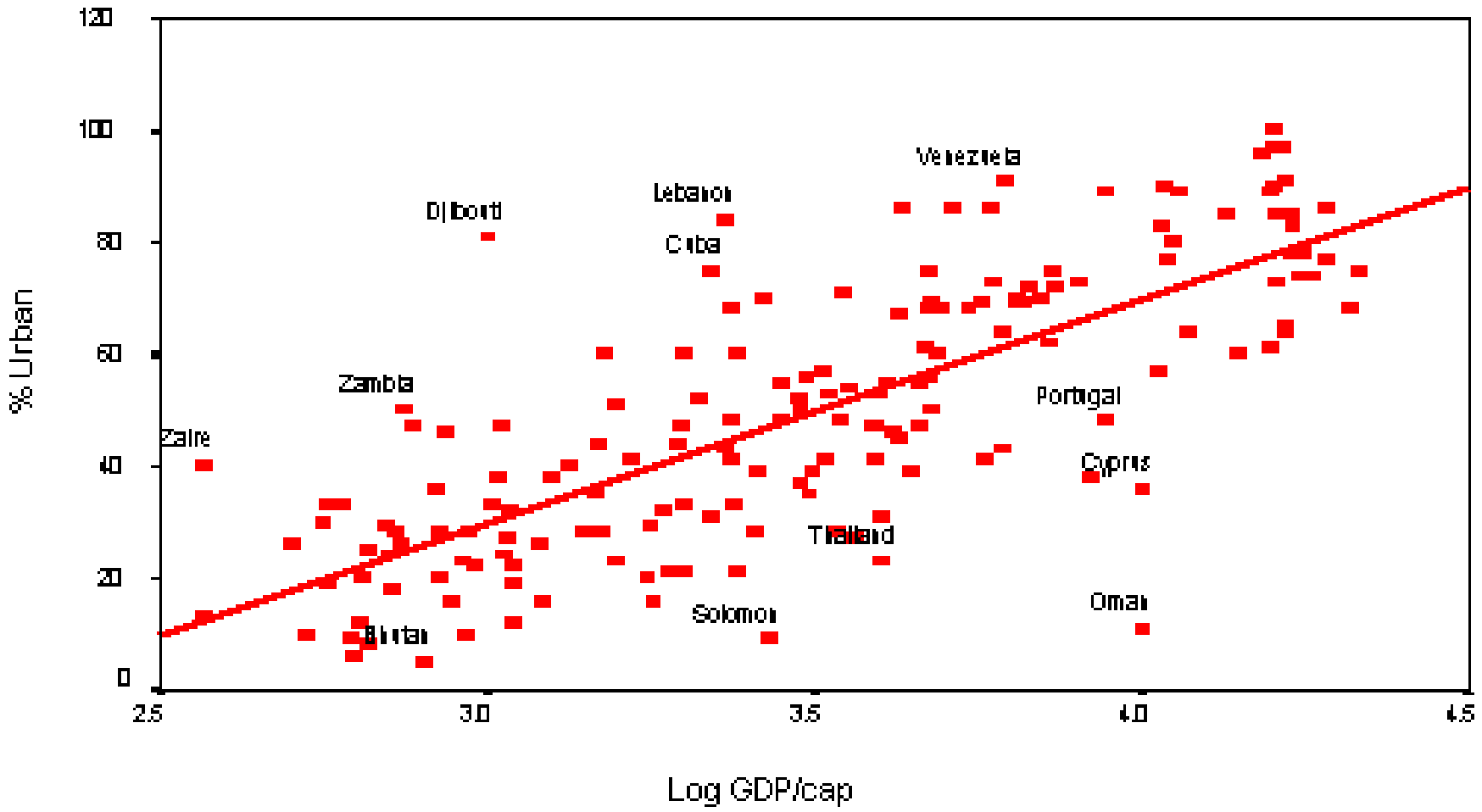
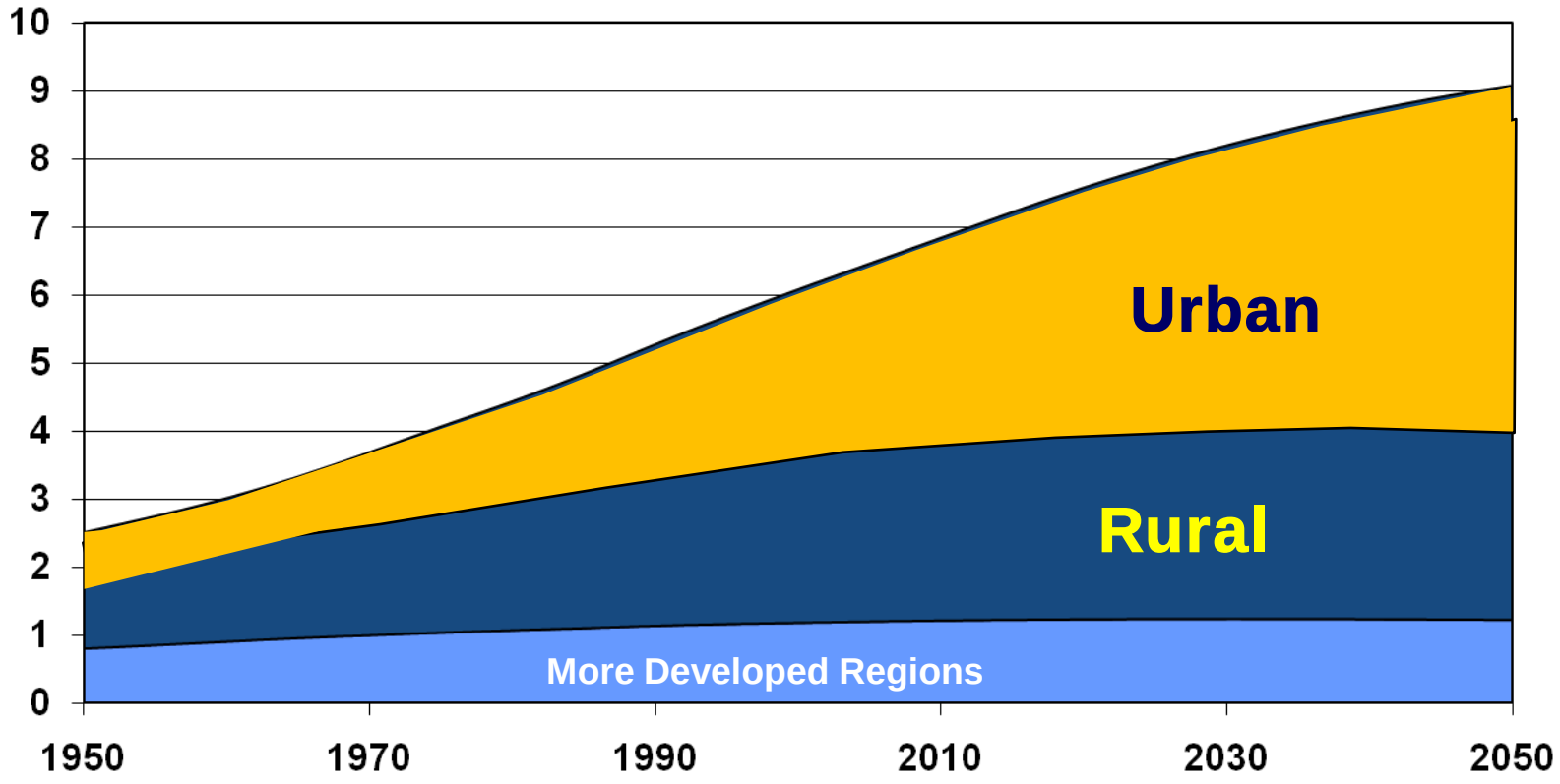
As Incomes Rises - Urbanization Increases

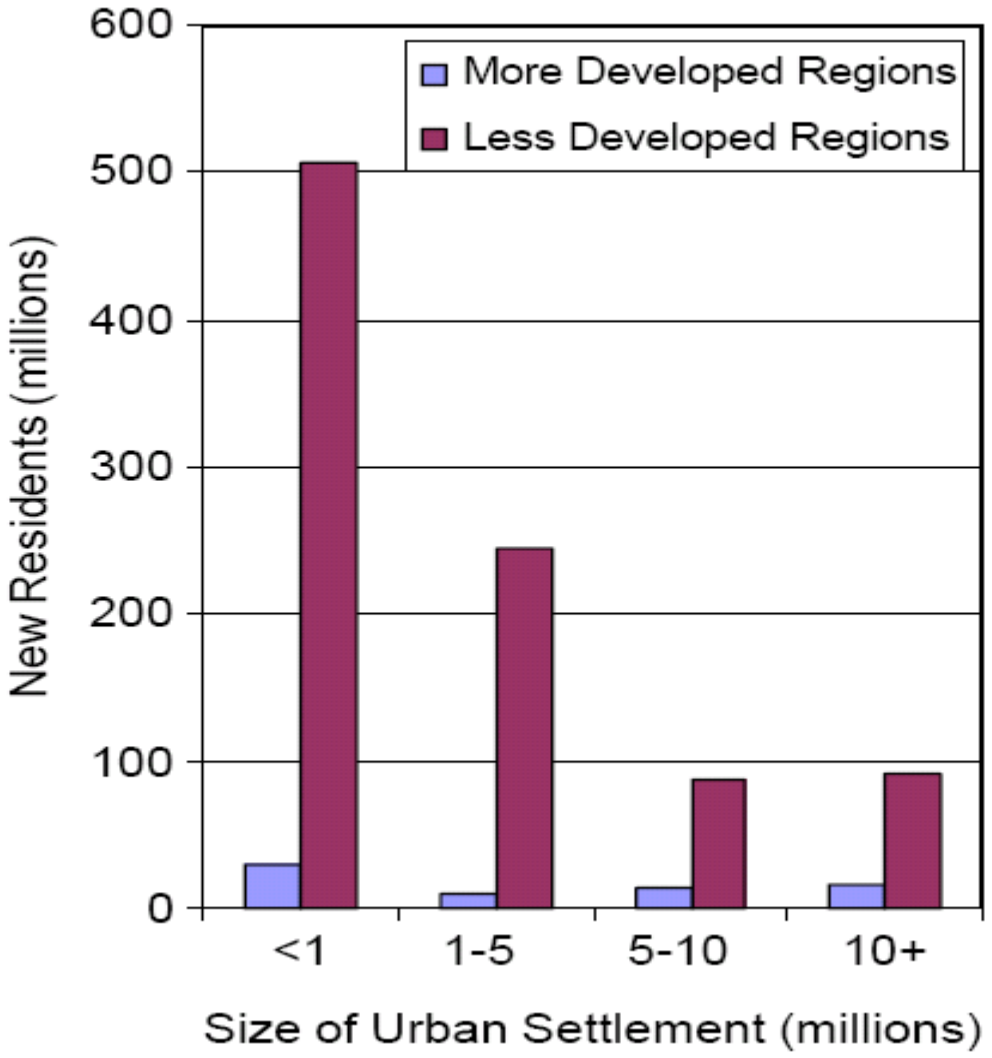


World population prospects 1950 - 2050



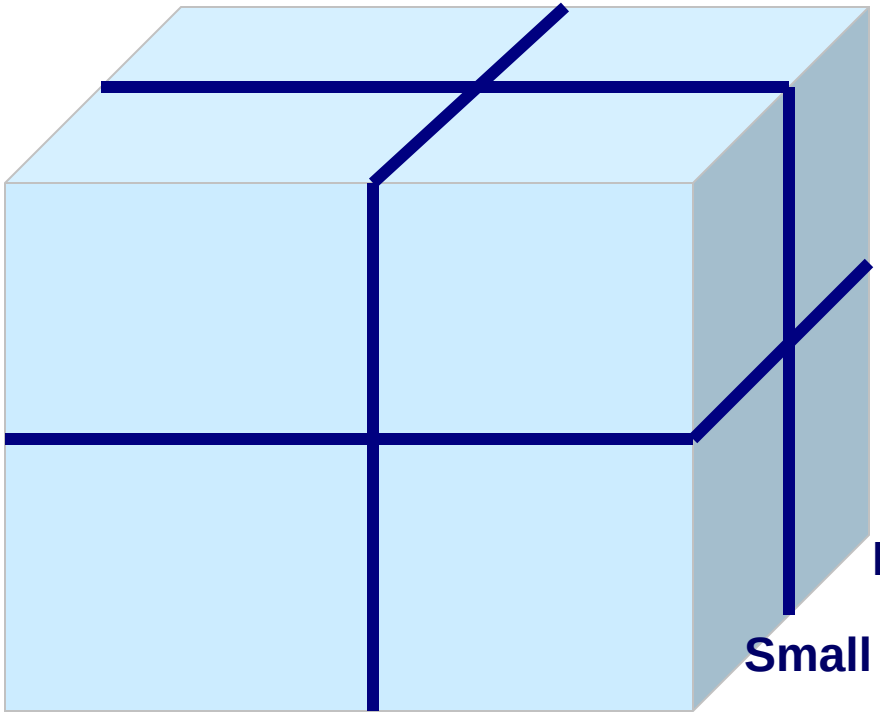
Source: United Nations, *World Population Prospects: The 2004 Revision* (medium scenario), 2005.

Number of urban residents added to the urban milieu between 2000 and 2015



Source: UN (2003)

The Application Space



Let's Tally Up

Population Growth + Urbanization

\+ Rising Standards (Health, Environ)

\+ Climate Change

= **Major Change and Uncertainty**

The Gap in Most Countries

What We Need

- Systems that can be incrementally designed, implemented and upgraded (adaptable systems)
- Closed loop systems that can facilitate reuse and energy recovery - *'all water good water'*
- Urban landscape that "mimics" natural systems

What We Currently Install

- Systems with fixed, centralized designs (concrete systems with little evolutionary ability)
- Systems that treat stormwater as waste and place WW treatment plants far from households (severely restricting reuse opportunities)

Imperative for Change ?

"One of the main barriers to turning knowledge into action is the tendency to treat *talking* about something as equivalent to actually *doing* something about it."....

Knowing-doing gap (Pfeffer and Sutton)

Way Forward

Way Forward

- Learning Alliances
- Greater Integration
- Adaptive/Flexible Approaches

Way Forward

- **Learning Alliances**
- **Greater Integration**
- **Adaptive/Flexible Approaches**
- **Security Through Diversity**

Learning Alliances

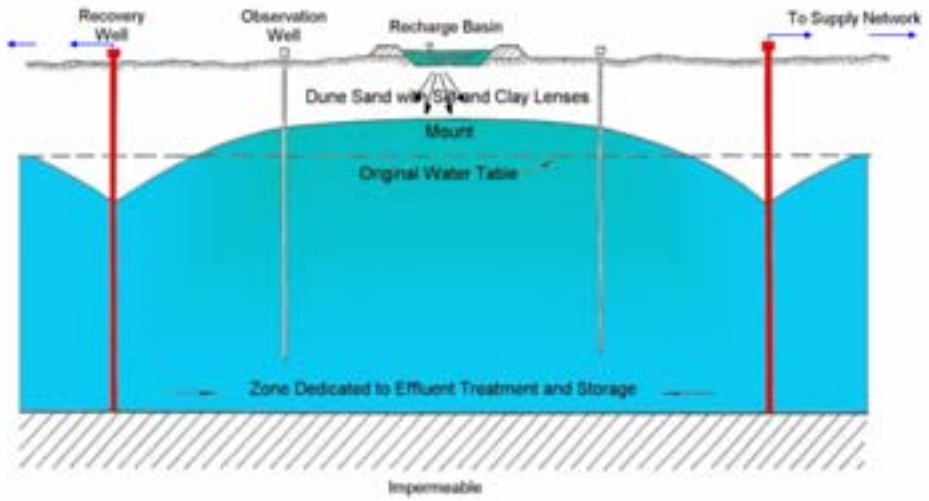
Lessons Learnt

- Improved collaboration among all professionals who influence the shape of the urban space (not a question of whose “vision” wins)
- Greater focus on understanding integrated systems performance – using CityWater in Bham, Alex..
- Strategic planning is providing a useful focus in many cities – most SWITCH cities
- Demonstrations provide the strongest potential for realizing action research and need to be given more priority.

How to put water in the minds of people?

Game Changers

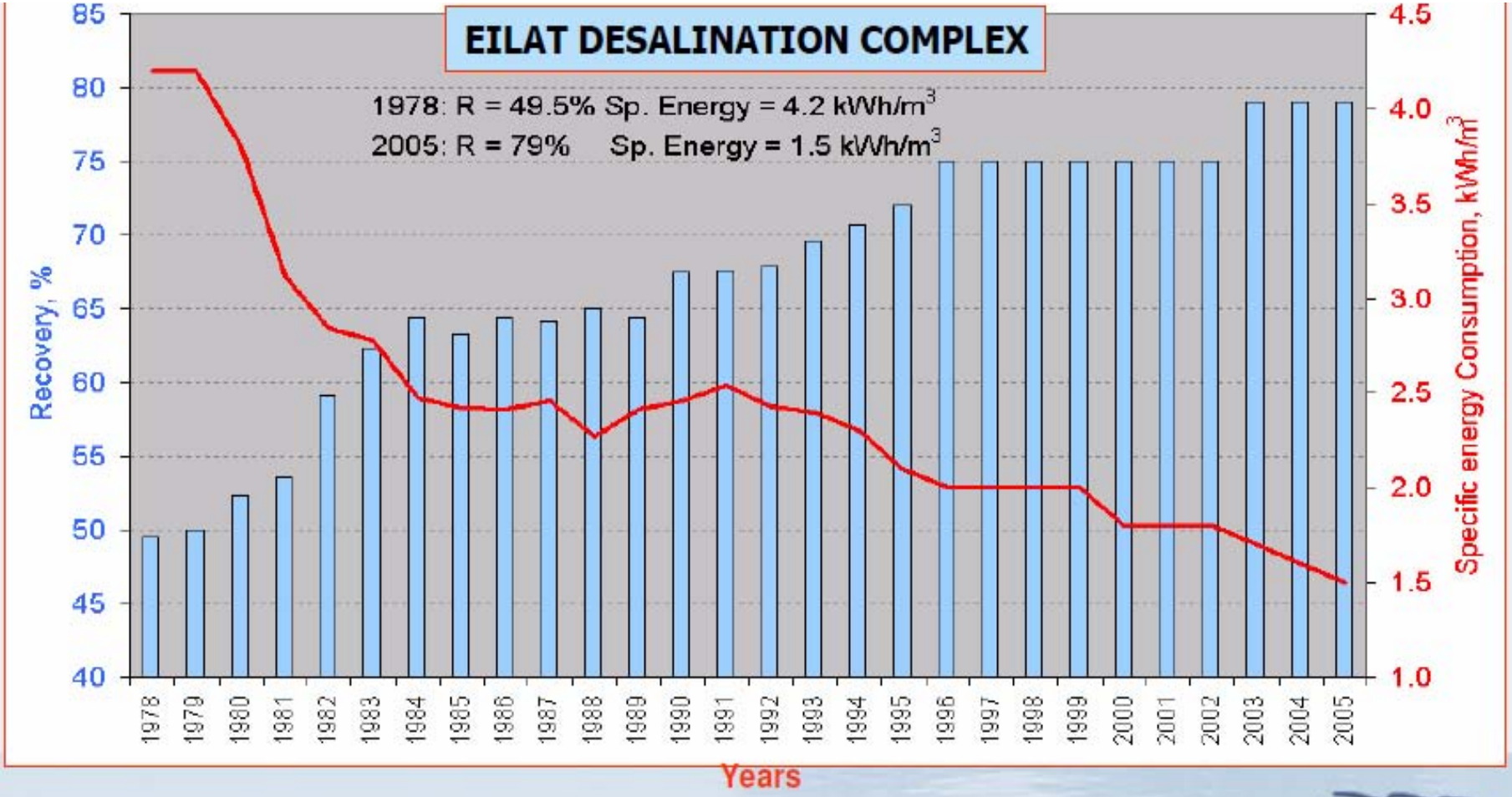
Natural Treatment Systems



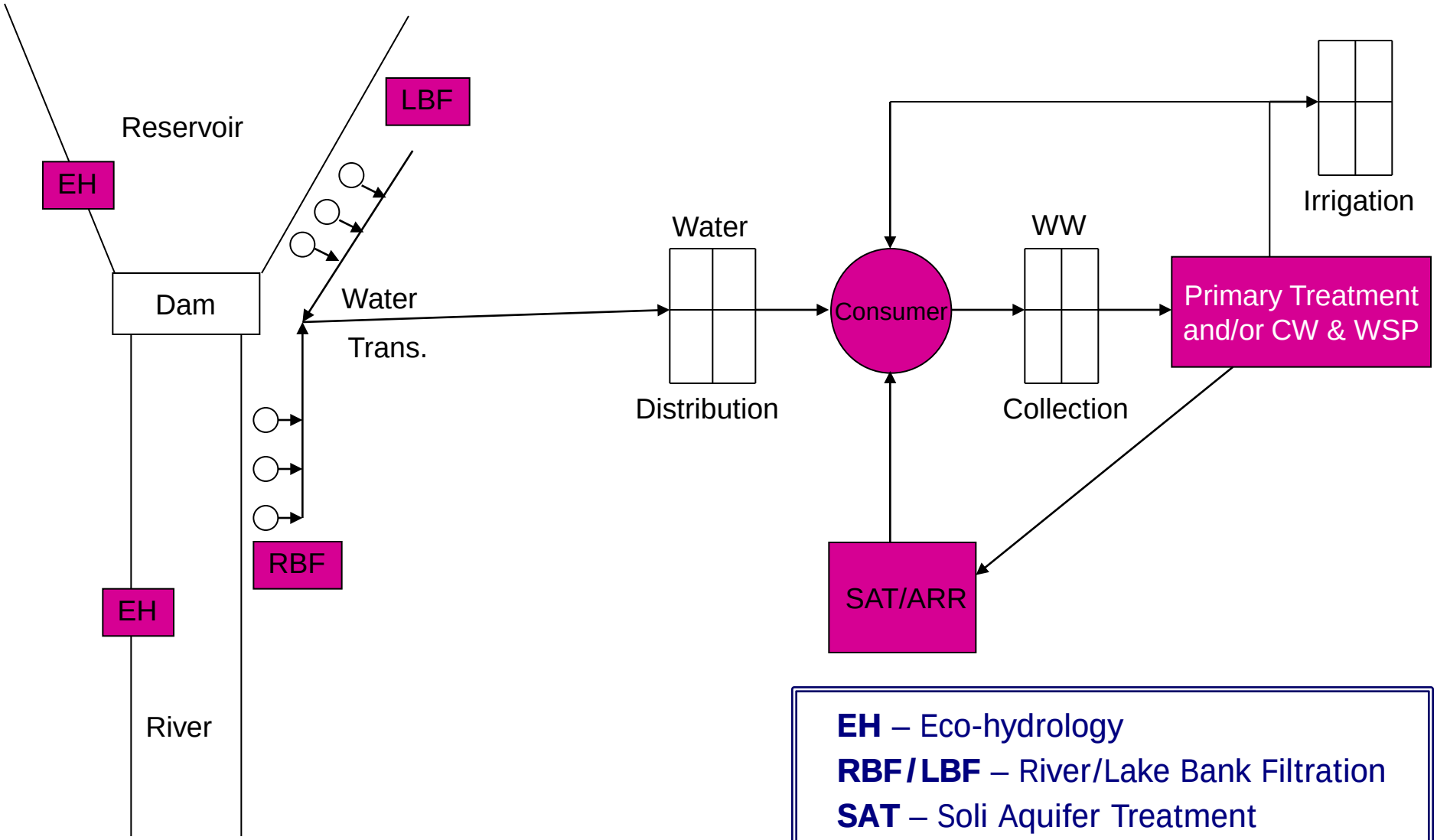
Recharge - Recovery Scheme

Membranes

Improvements in Technology



More is needed than simply improving component parts

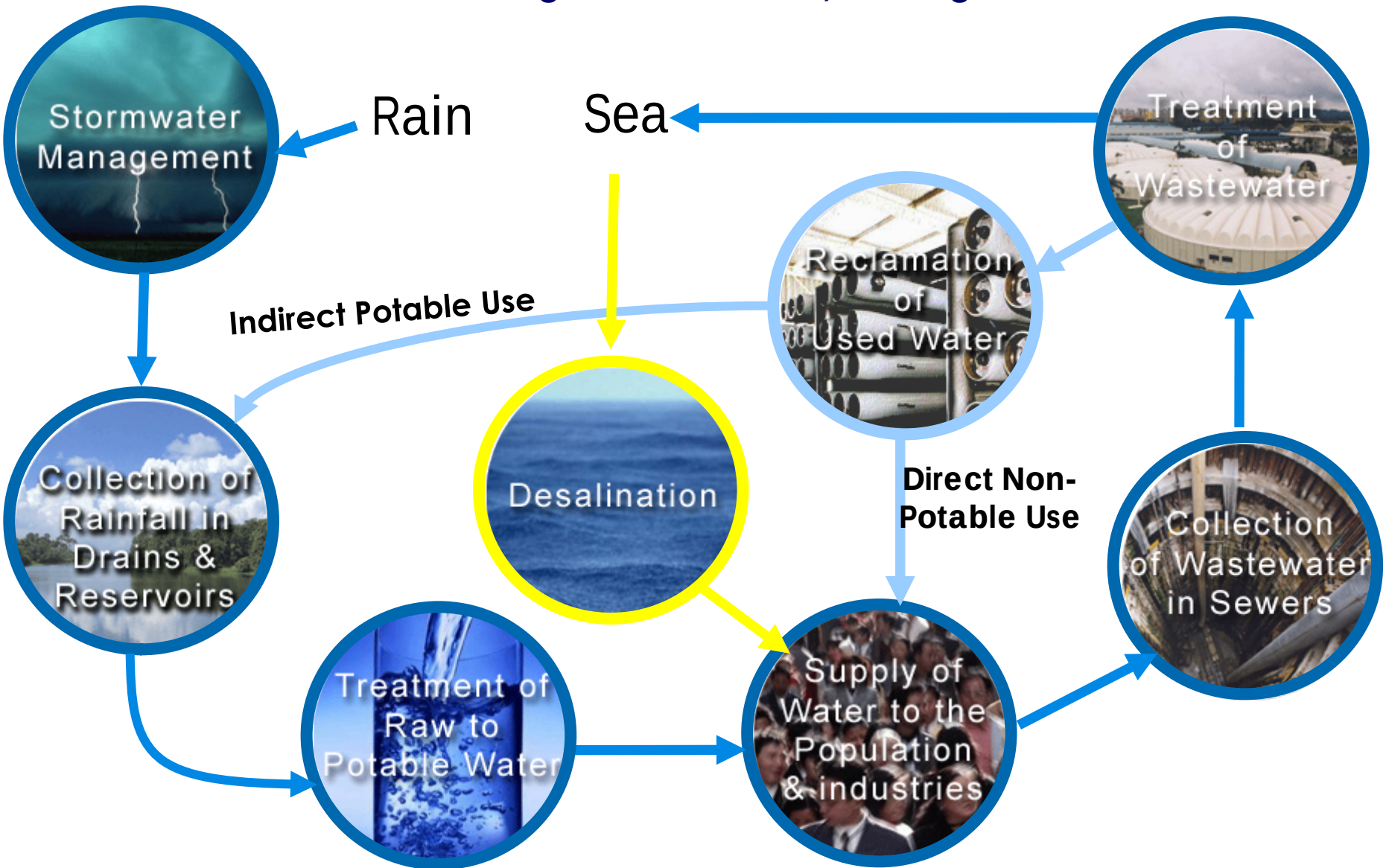


EH – Eco-hydrology
RBF / LBF – River/Lake Bank Filtration
SAT – Soli Aquifer Treatment
ARR – Artificial Recharge

Integrating the Water Loop : Water for All

PUB manages the complete water cycle

From sourcing, collection, purification and supply of drinking water, to treatment of used water and turning it into NEWater, drainage of storm water



FOUR NATIONAL TAPS

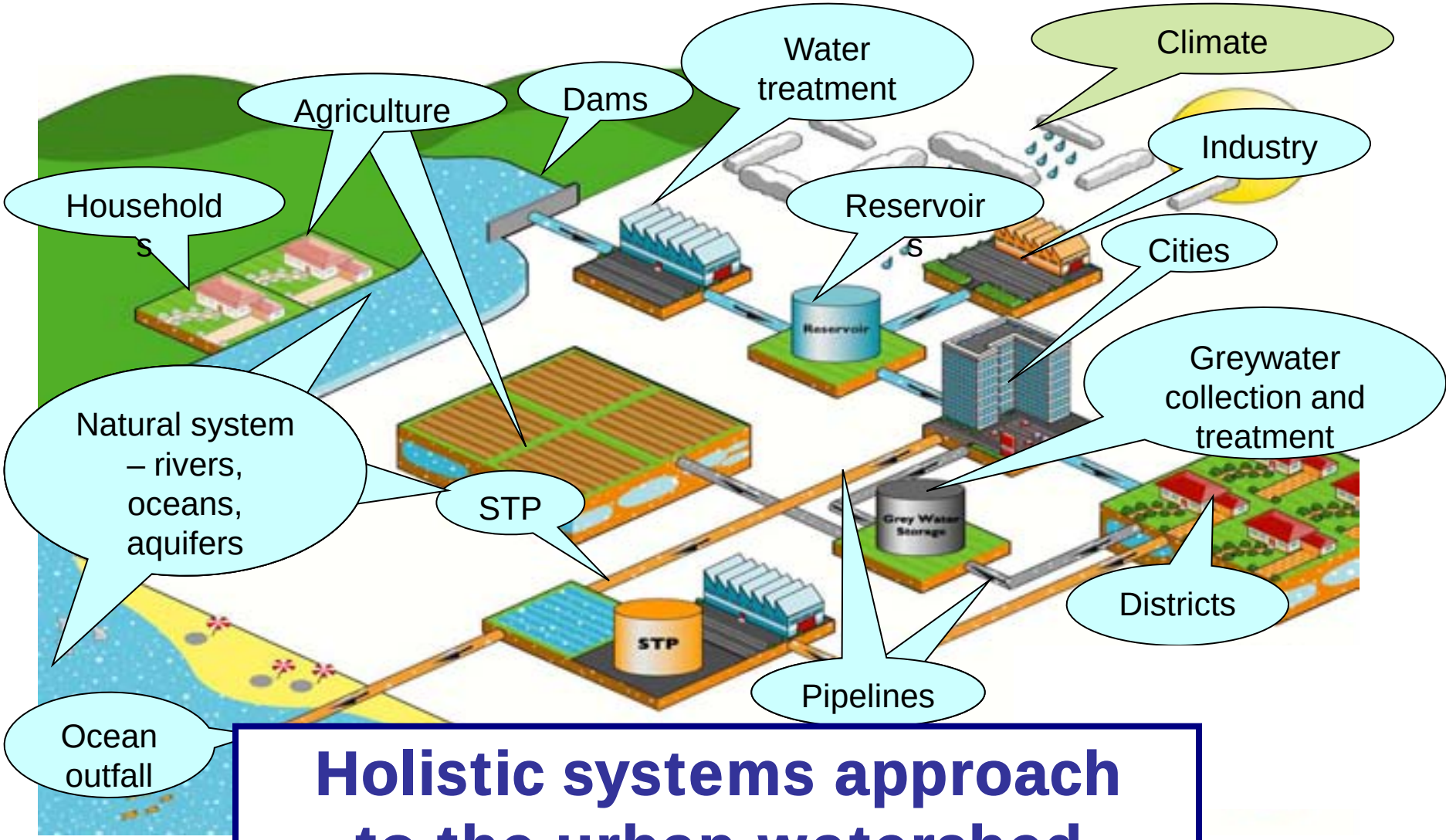
Way Forward

- Learning Alliances
- Greater Integration
- Adaptive/Flexible Approaches

Way Forward

- Learning Alliances
- **Greater Integration**
- Adaptive/Flexible Approaches
- Security Through Diversity

City of the Future - Integration



Holistic systems approach to the urban watershed

SWITCH City Water

SWITCH

CITY WATER

A knowledge and information sharing platform to support global and integrated urban water planning

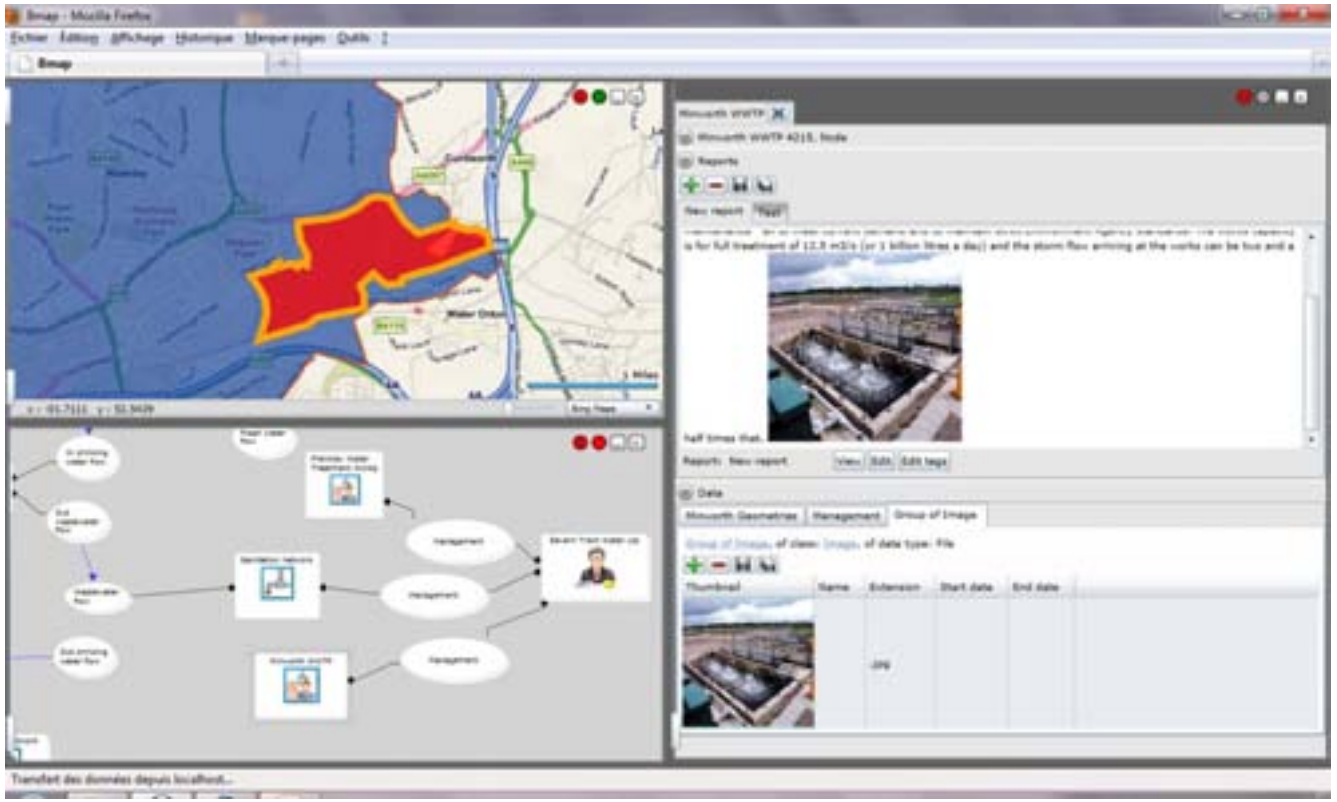
offering

A Combined Information System,

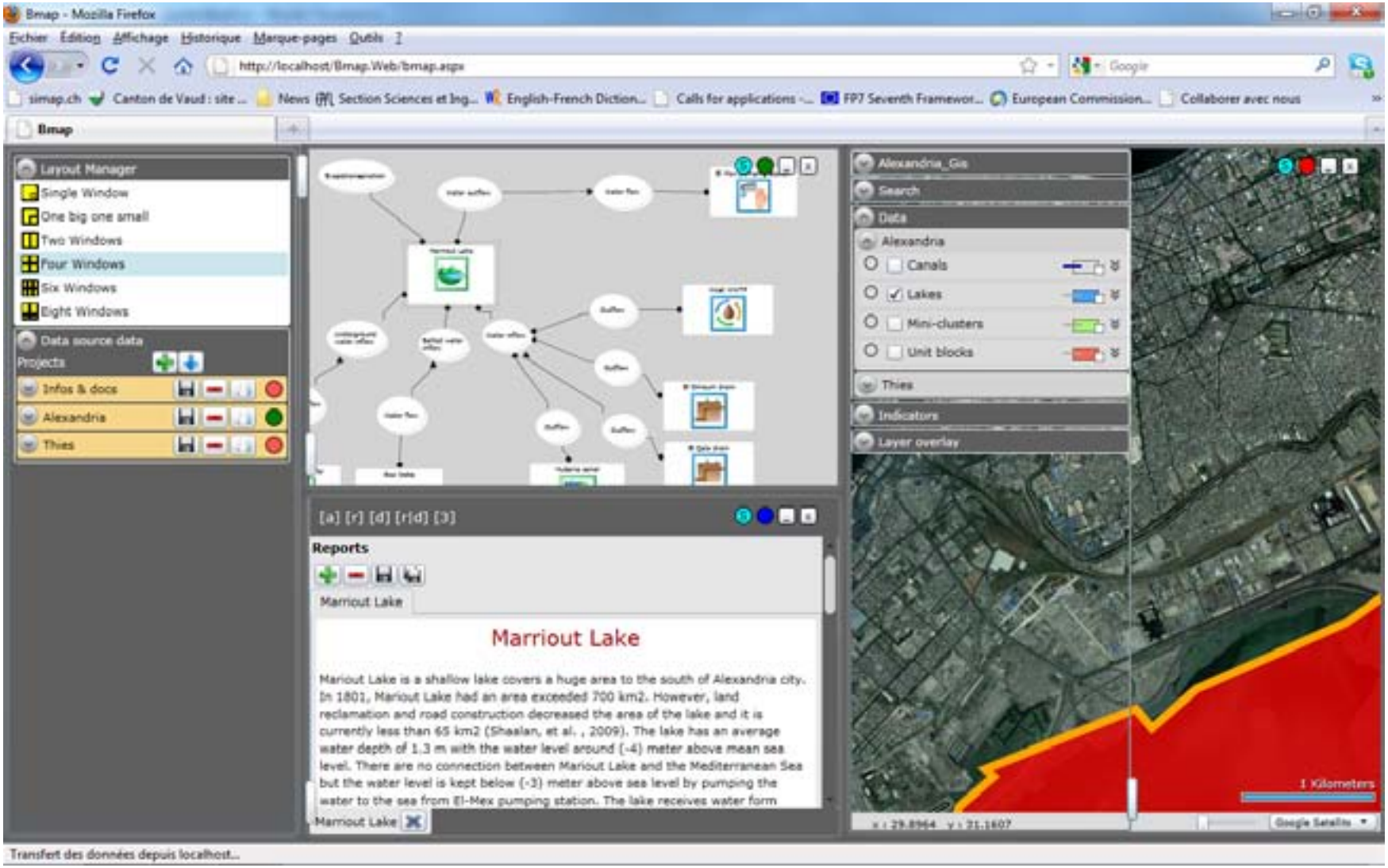
- Generic Database
- Geographic Viewer
- Reporting tool
- Systemic Viewer
- And more...

Linked to a Set of Screening Models

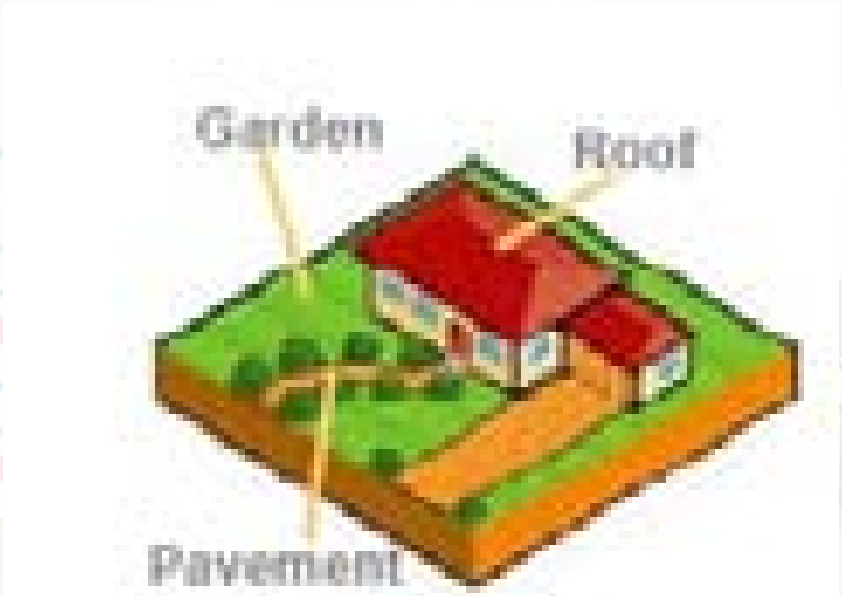
- City Water Balance
- City Water Economics
- City Water Drain
- And more...



SWITCH City Water

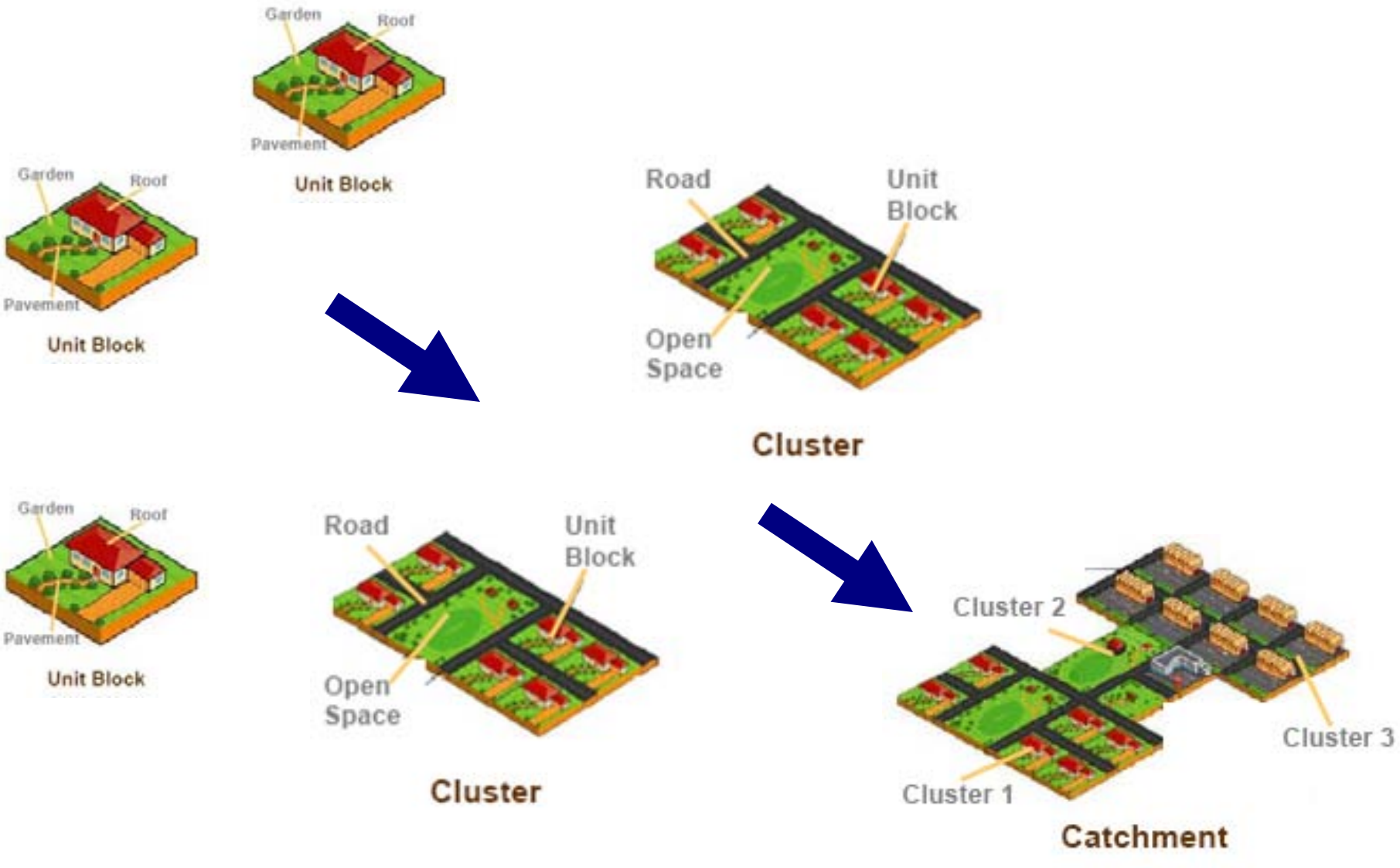


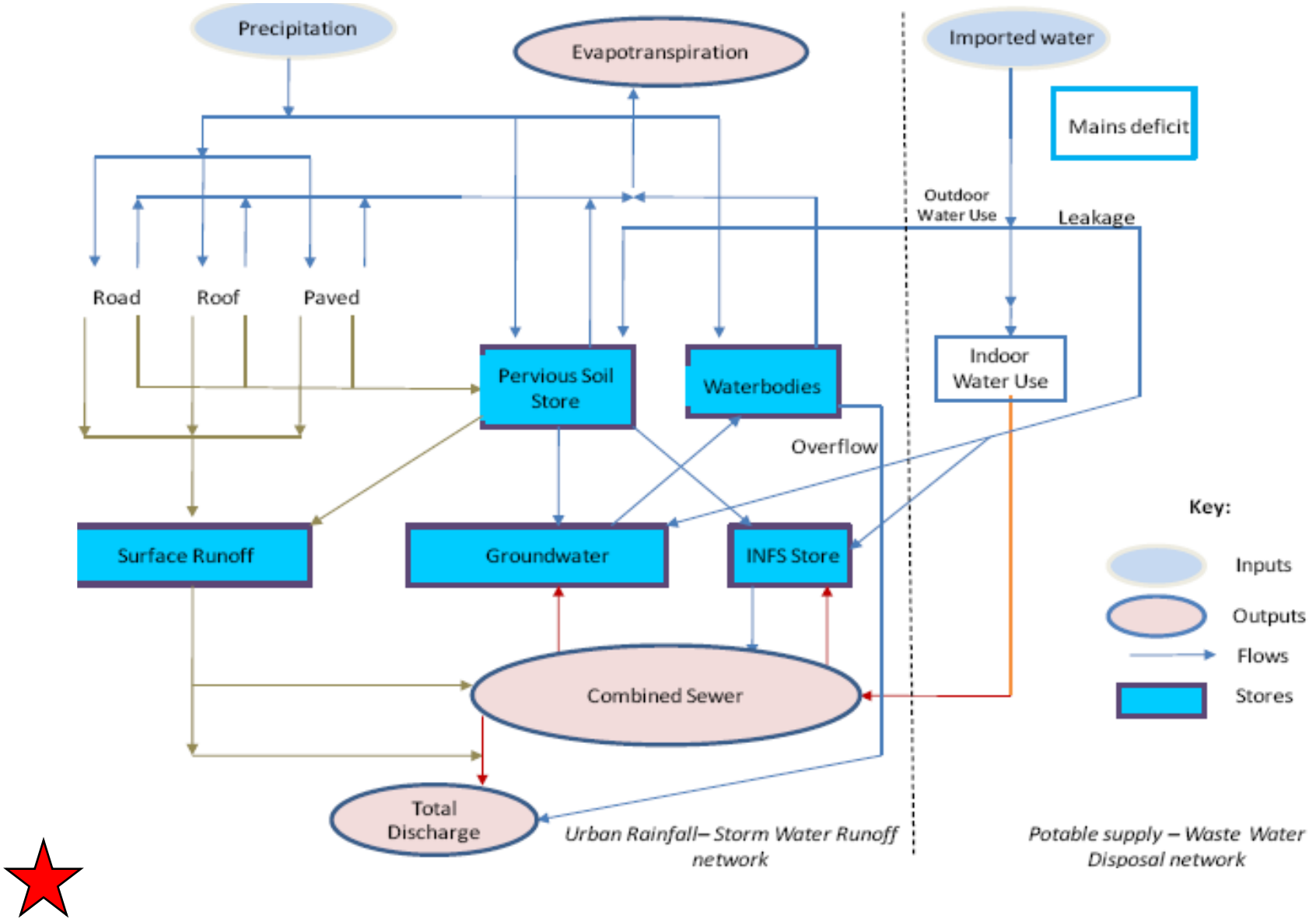
Interventions over urban water cycle



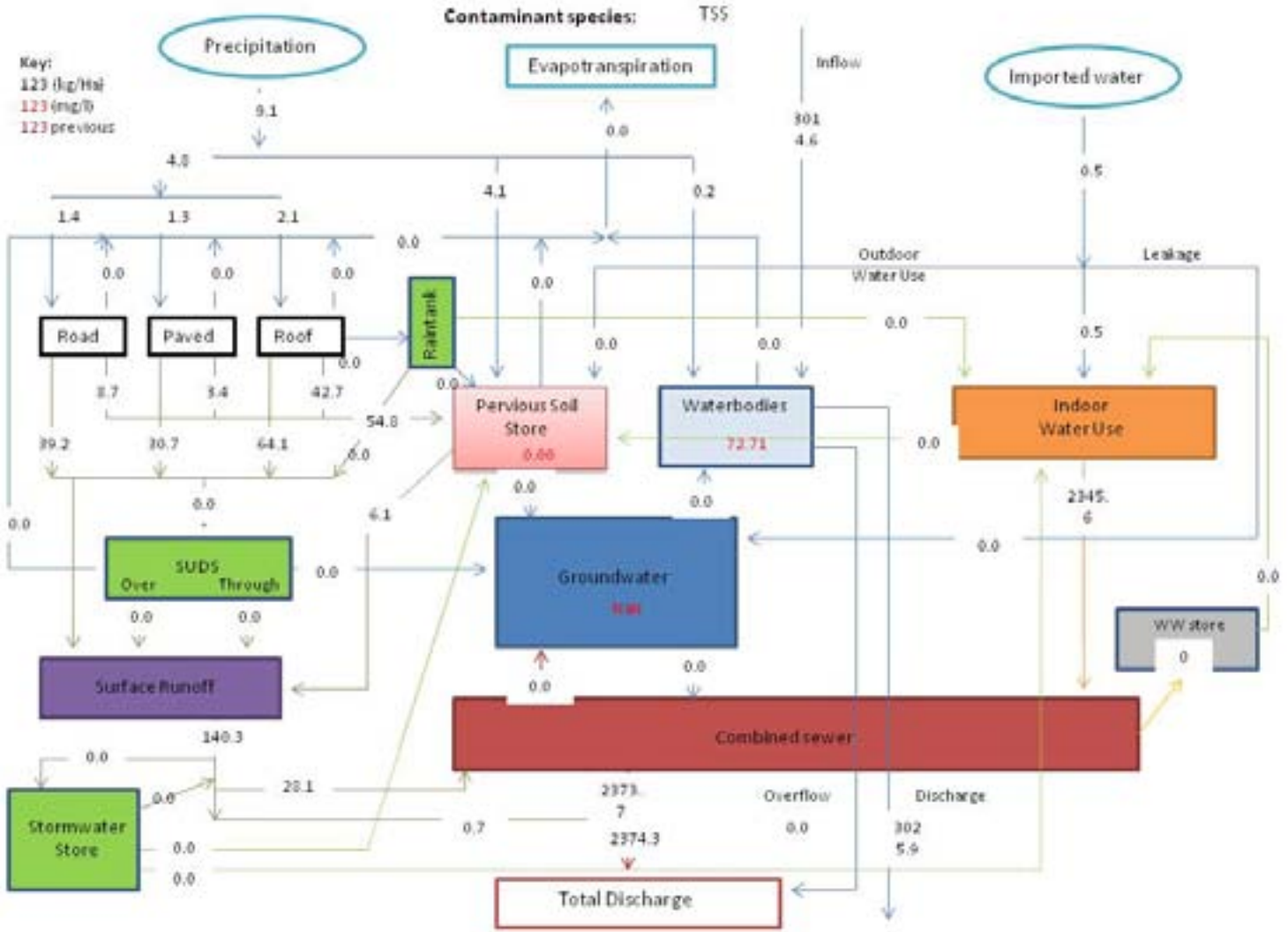
Unit Block

Interventions over urban water cycle



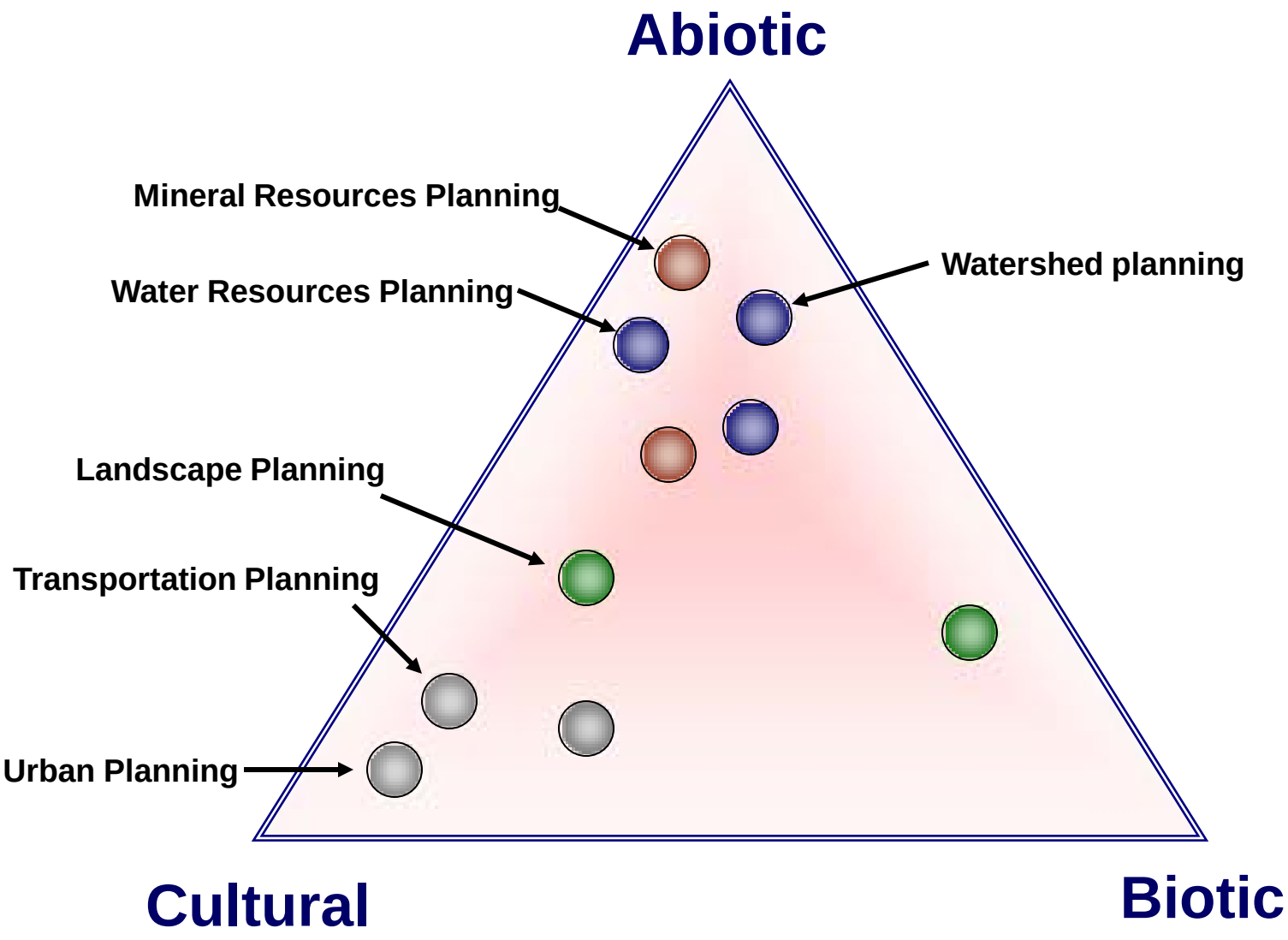

Precipitation
Evapotranspiration
Imported water
Mains deficit
Outdoor Water Use
Leakage
Road
Roof
Paved
Pervious Soil Store
Waterbodies
Indoor Water Use
Overflow
Surface Runoff
Groundwater
INFS Store
Combined Sewer
Total Discharge
Urban Rainfall– Storm Water Runoff network
Potable supply – Waste Water Disposal network
Key:
Inputs
Outputs
Flows
Stores

CWB Output – Flows



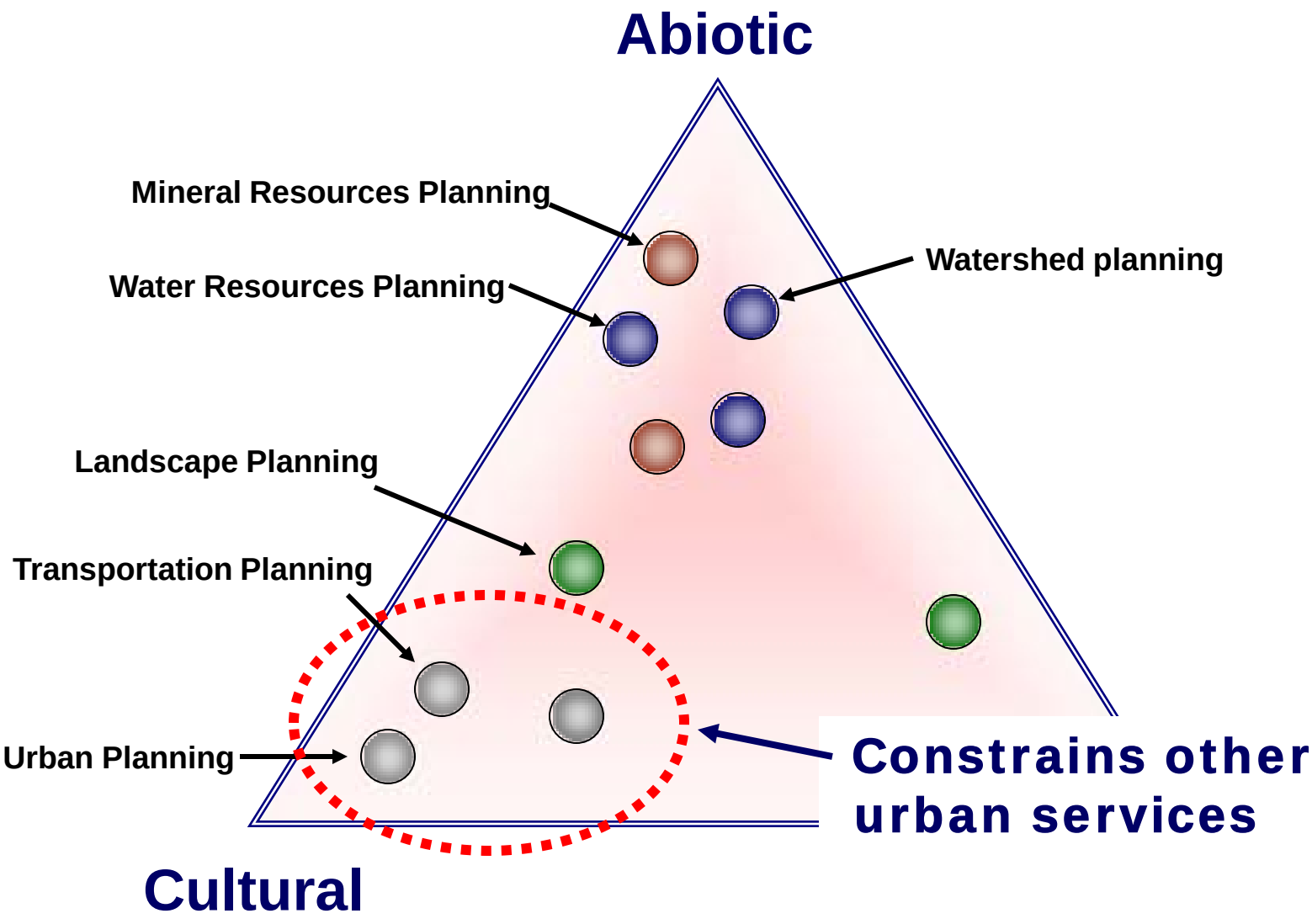
Mackay 2010

Greater Integration



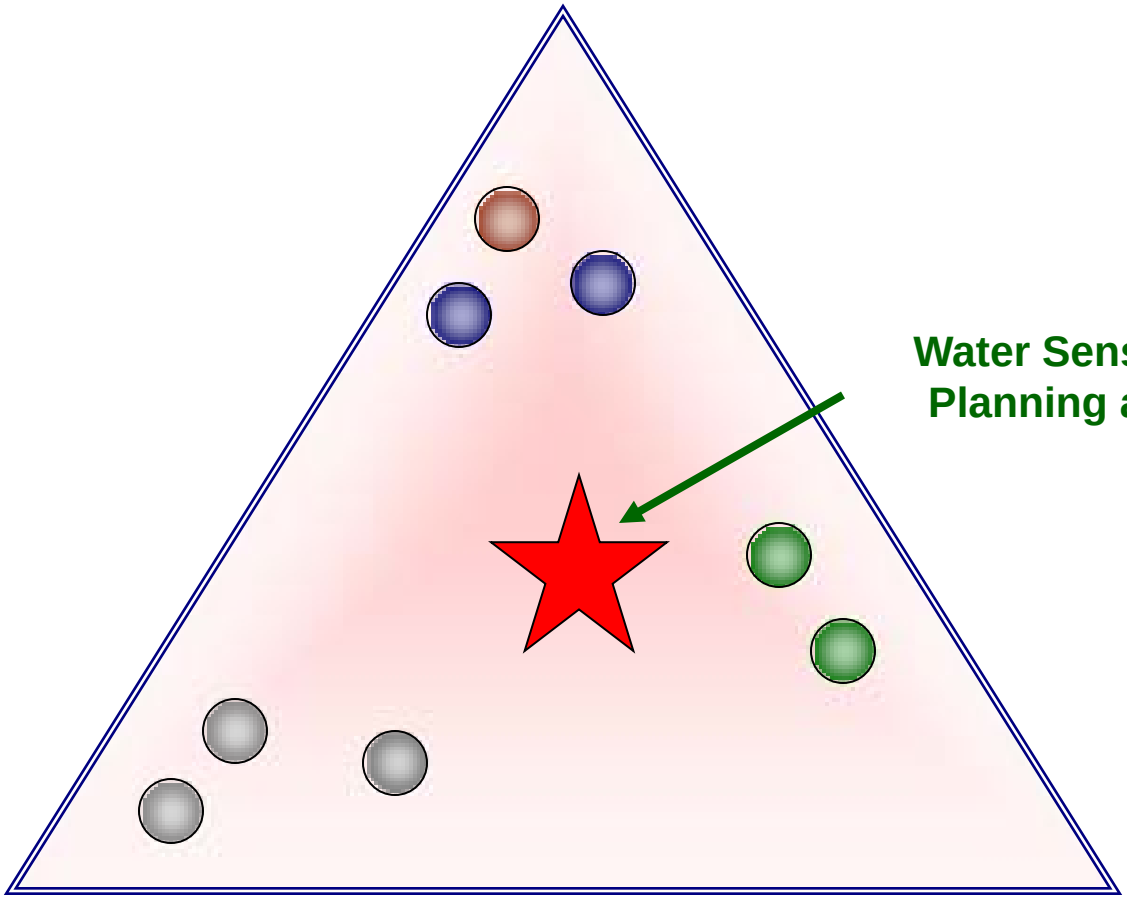
Ahern, 1995

Planning - Lack Integration



Ahern, 1995

Greater Integration

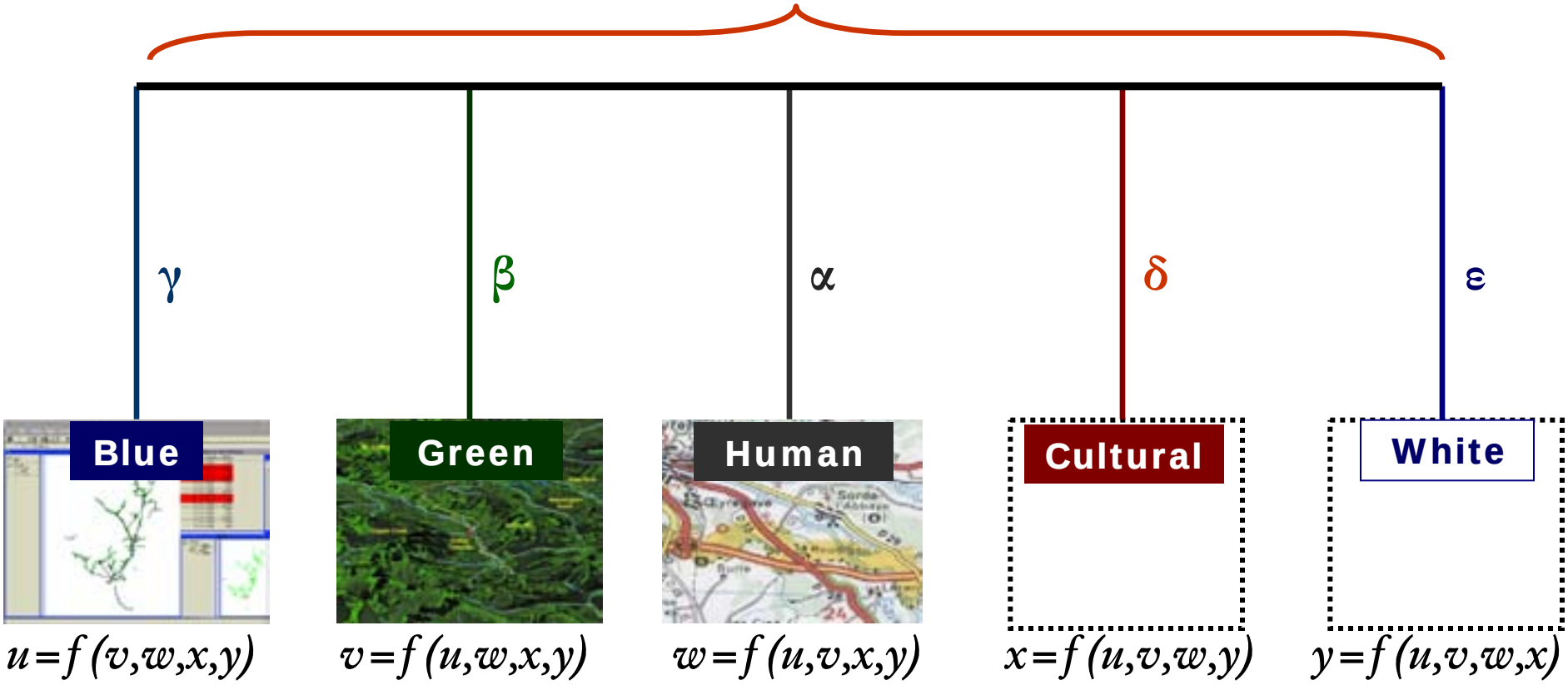


Ahern, 1995

New challenges – New Thinking

- **Multi-objective urban planning (what should drive the urban plan?)**

$$Z = (\gamma.u + \beta.v + \alpha.w + \delta.x + \varepsilon.y)$$




0.3 m³/m²


0.3 m³/m²


0.3 m³/m²


0.3 m³/m²

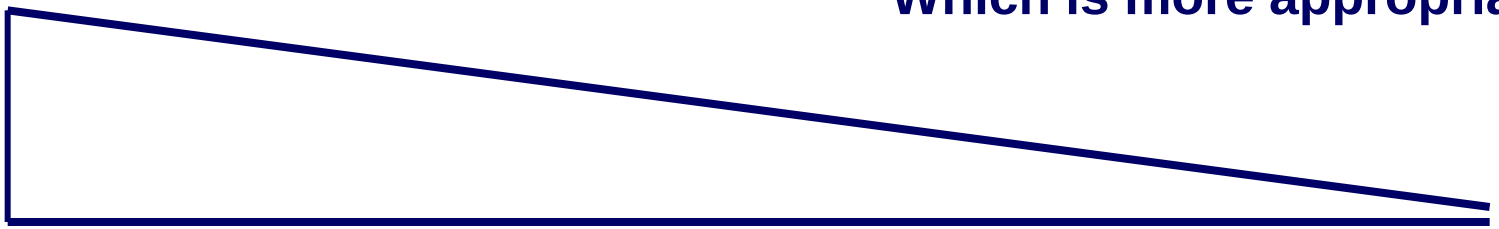
Greater Integration

Allows optimizing within a continuum of options

Which is more efficient?

Which is more sustainable?

Which is more appropriate?



Large Scale — **Nodal** — **Cluster** — **In Situ**

Need for Interfaith Dialog !

Highly Centralized

Highly Decentralized

The water sector can't do it alone

Need to create Utilities of the Future that lead innovation

- **Direct utility investments towards integration**
- **Advocate for funding, regulations and incentives**

Land planners
Architects
Developers

Gov't officials
Financiers
Energy experts

Way Forward

- Learning Alliances
- Greater Integration
- Adaptive/Flexible Approaches

Way Forward

- Learning Alliances
- Greater Integration
- **Adaptive/Flexible Approaches**
- Security Through Diversity

New challenges – New Thinking

- **Entire earth system is changing!**

Uncertainty in storm events

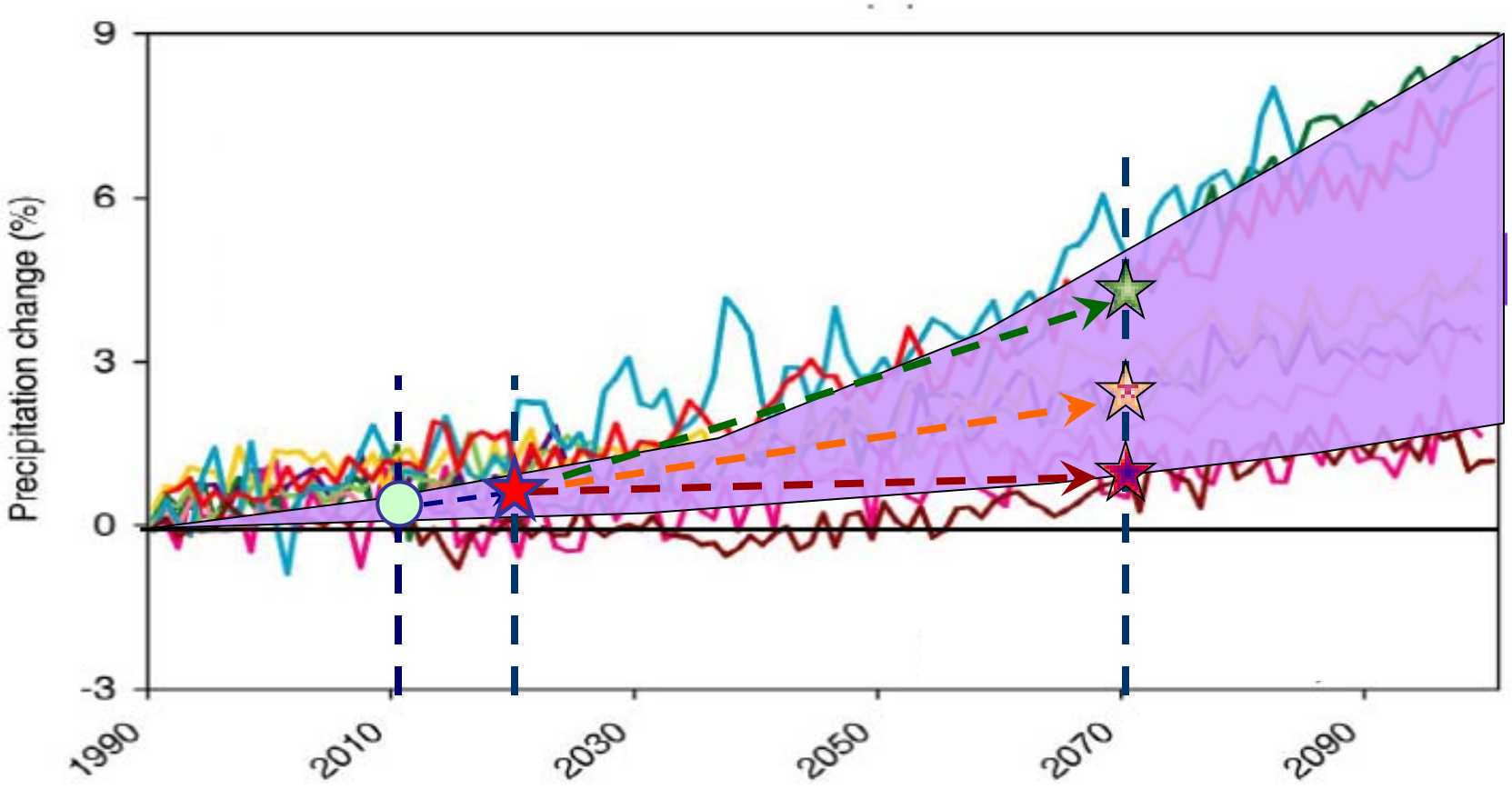
Uncertainty in runoff response

Uncertainty in carrying capacity / breakage rate

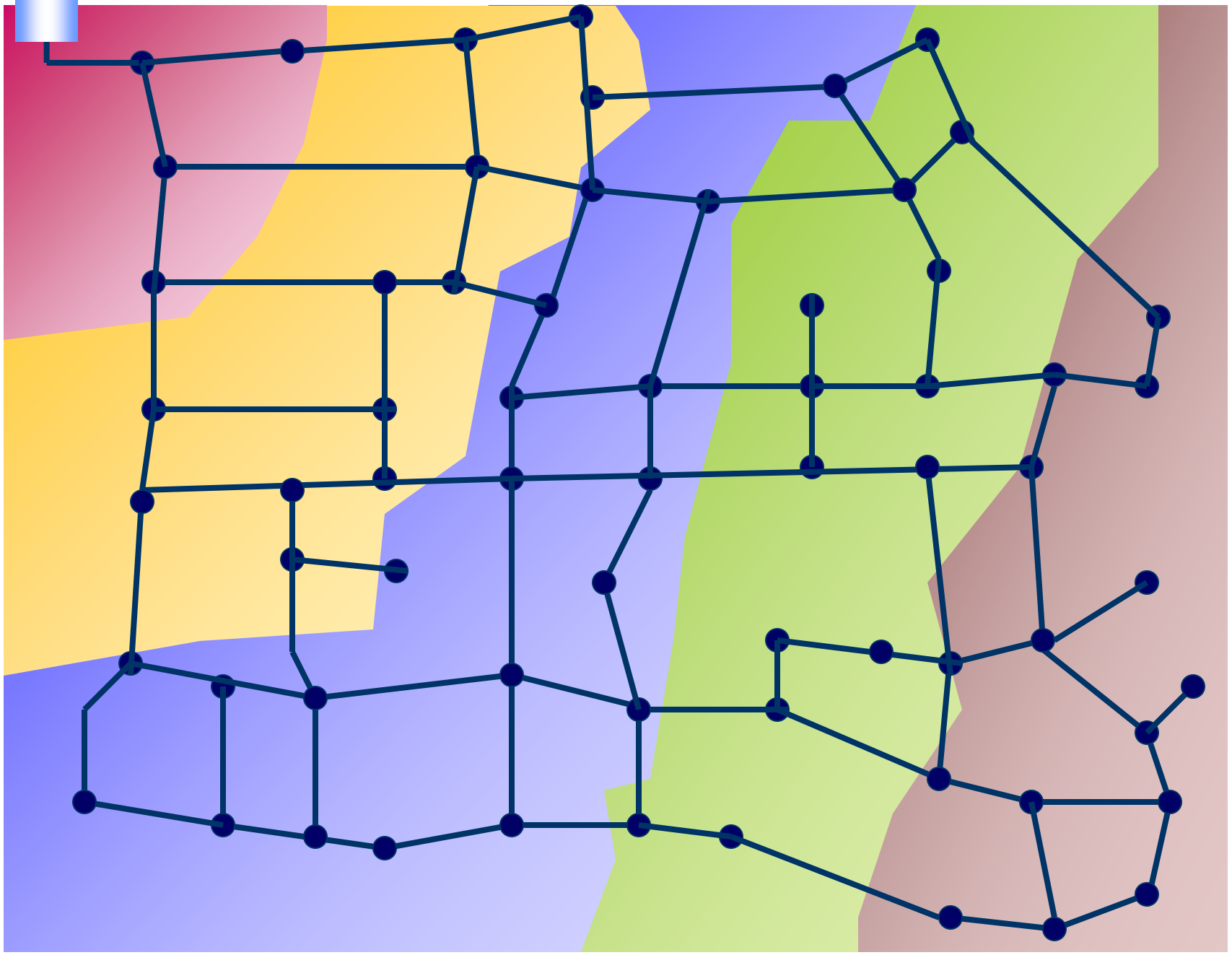
Uncertainty in demand

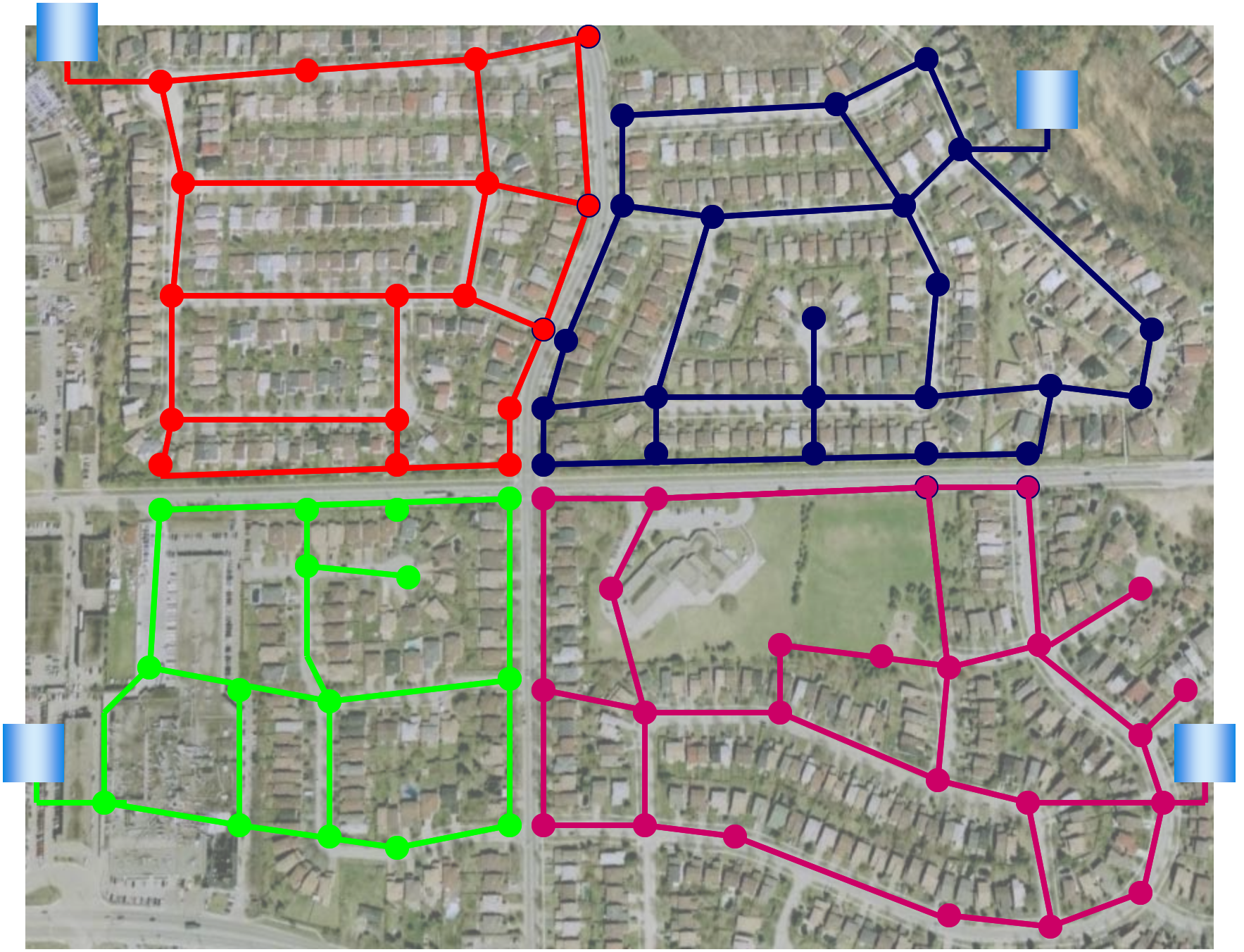
Uncertainty in quantity & quality

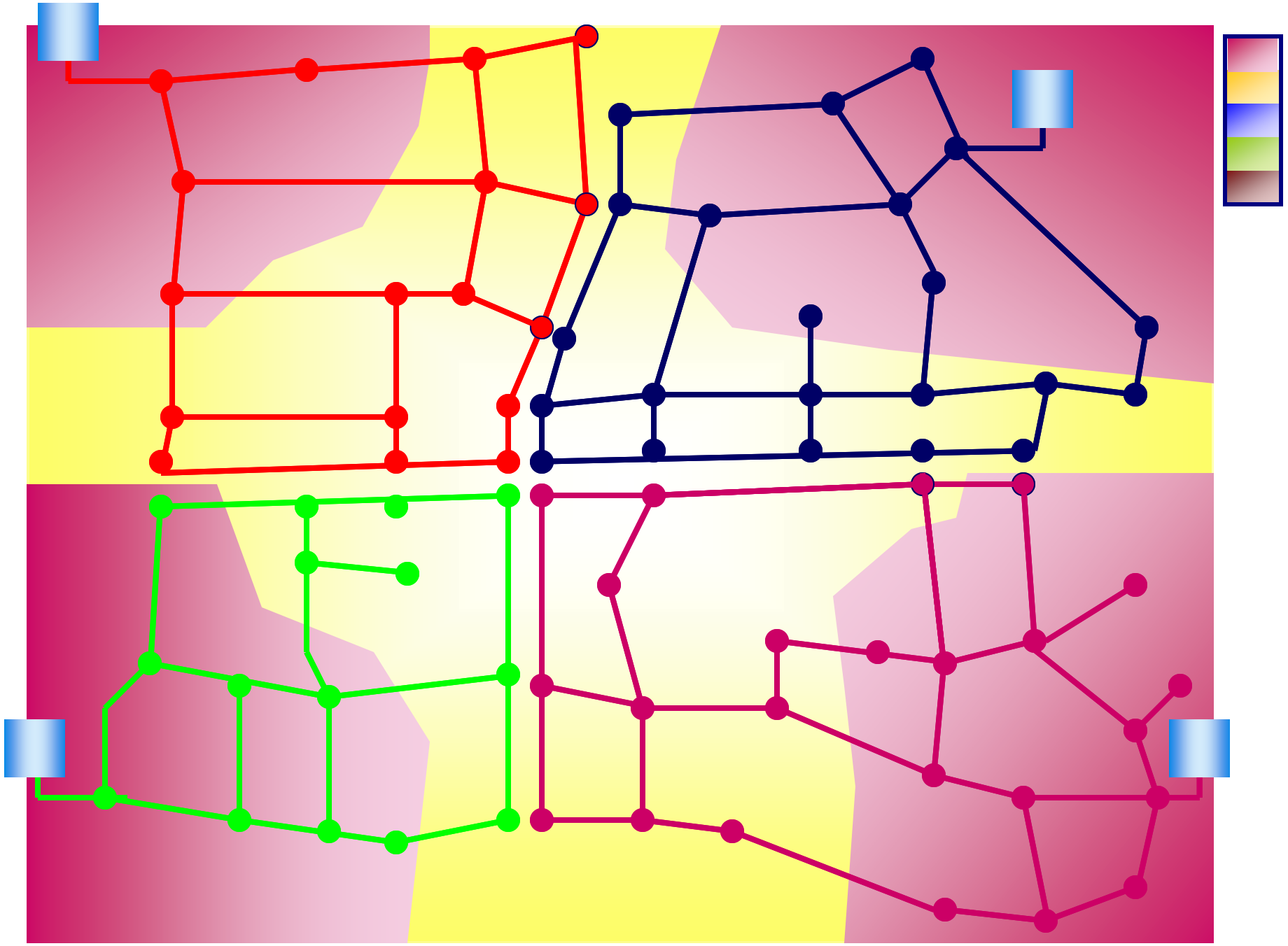
Decision Making in Uncertain World

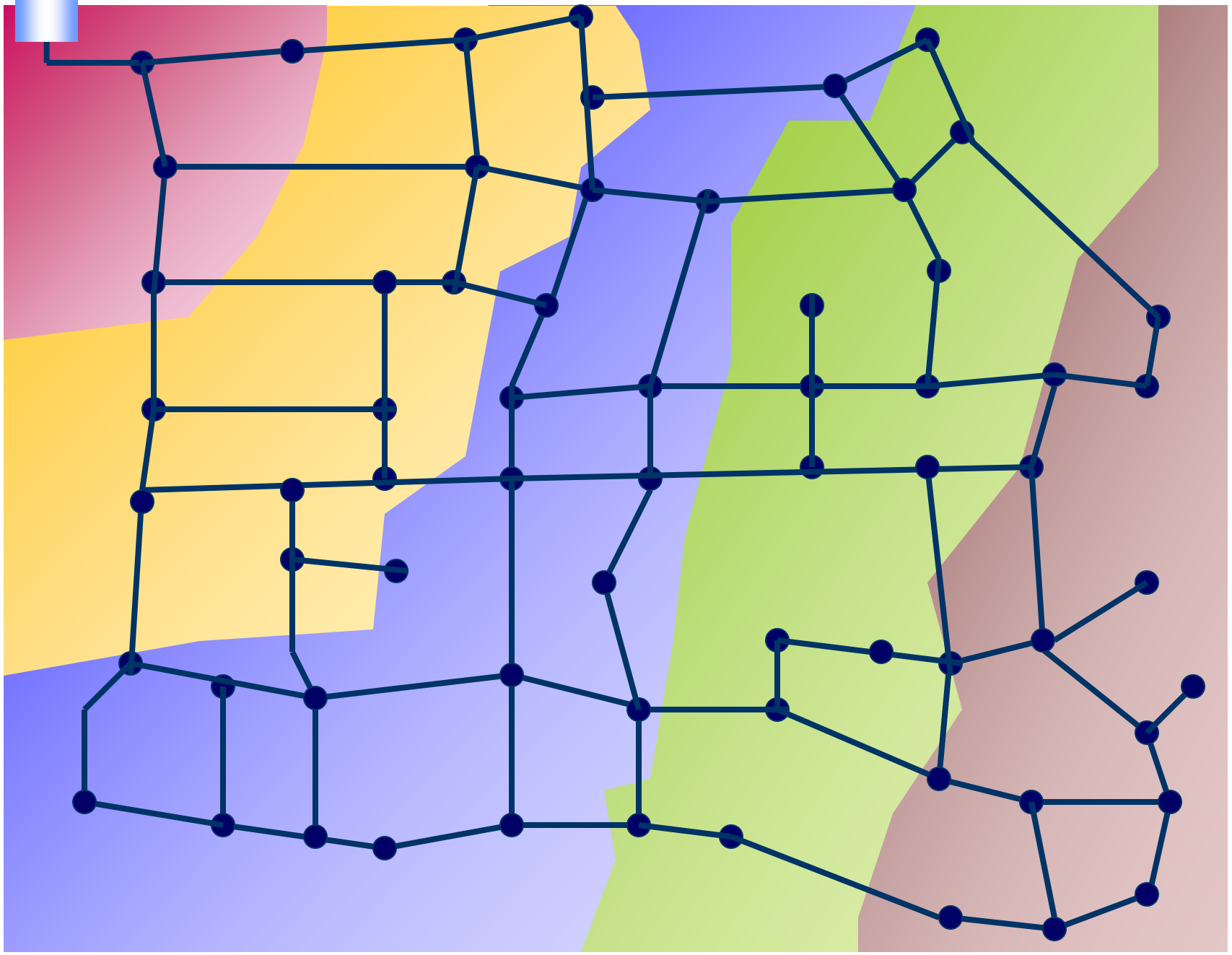


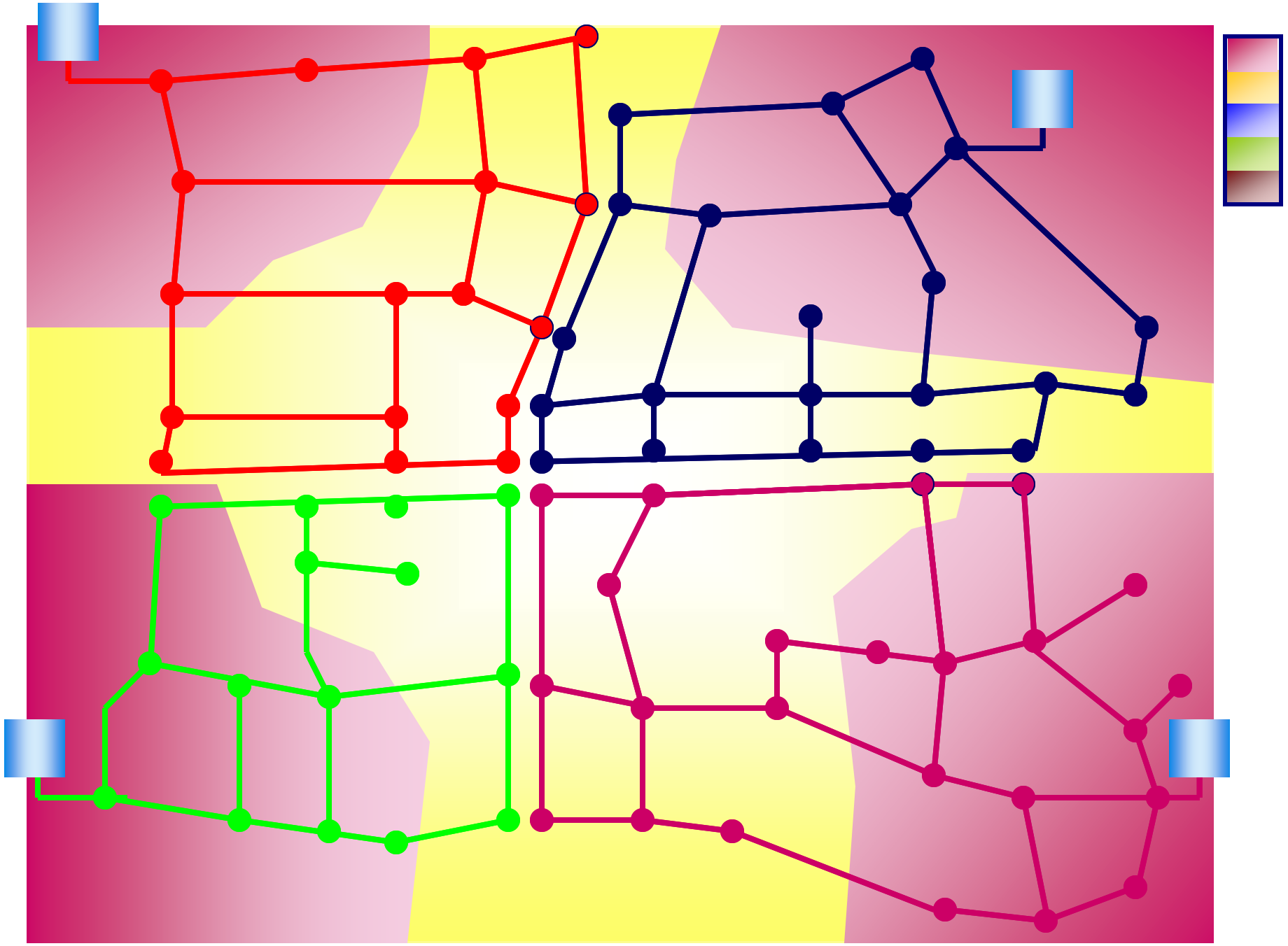
Source: Hadley Centre

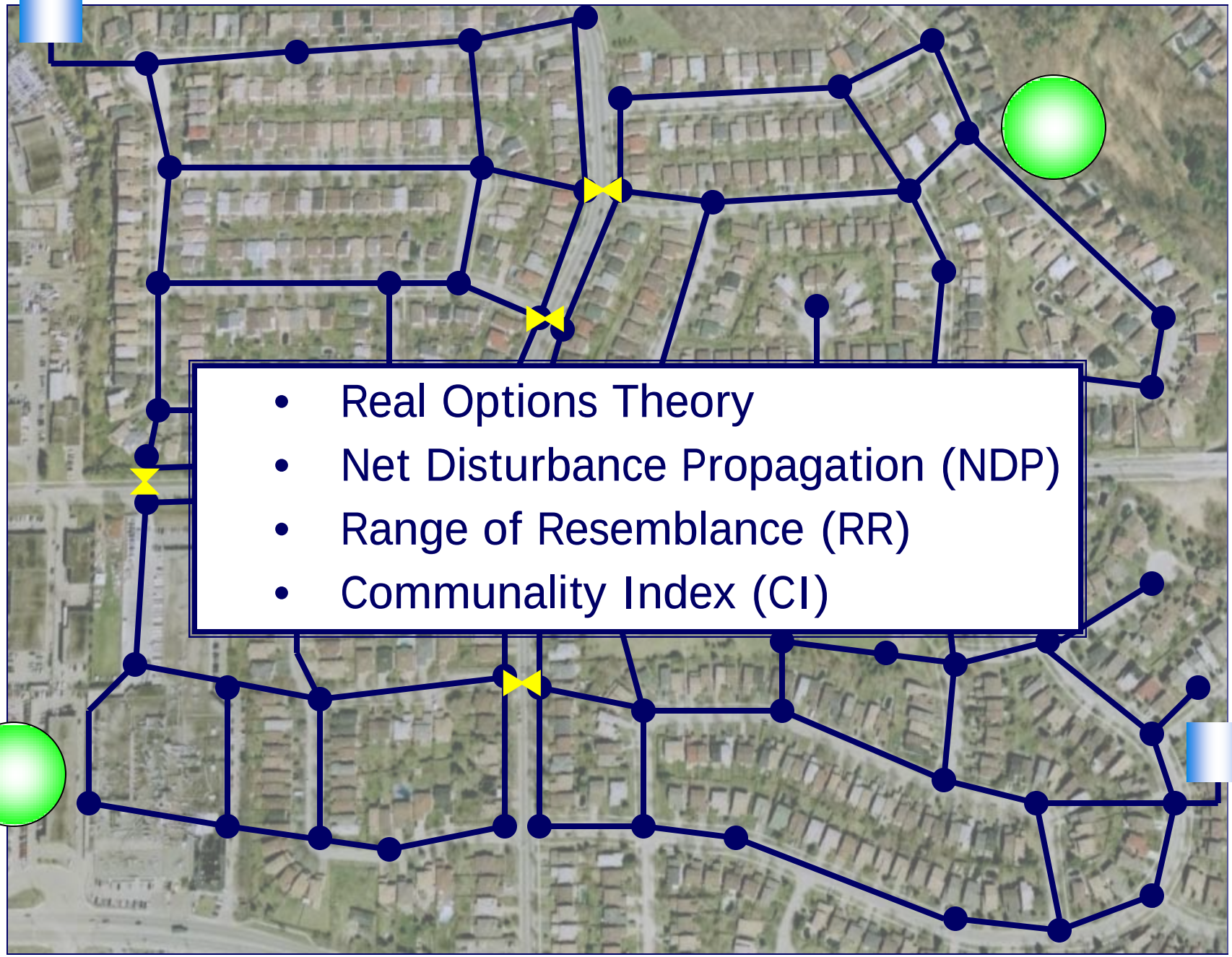




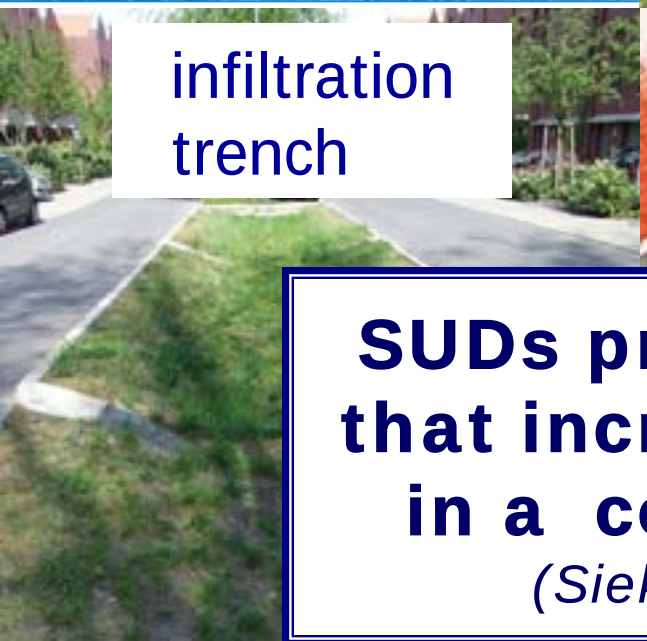


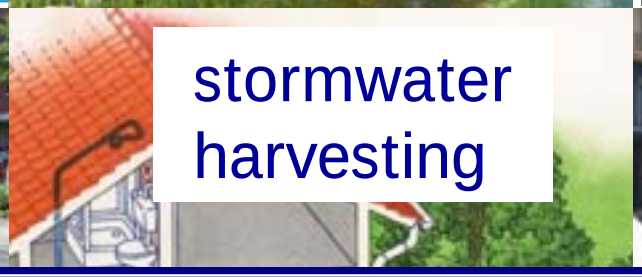





• Real Options Theory
• Net Disturbance Propagation (NDP)
• Range of Resemblance (RR)
• Communality Index (CI)

Sustainable Urban Drainage

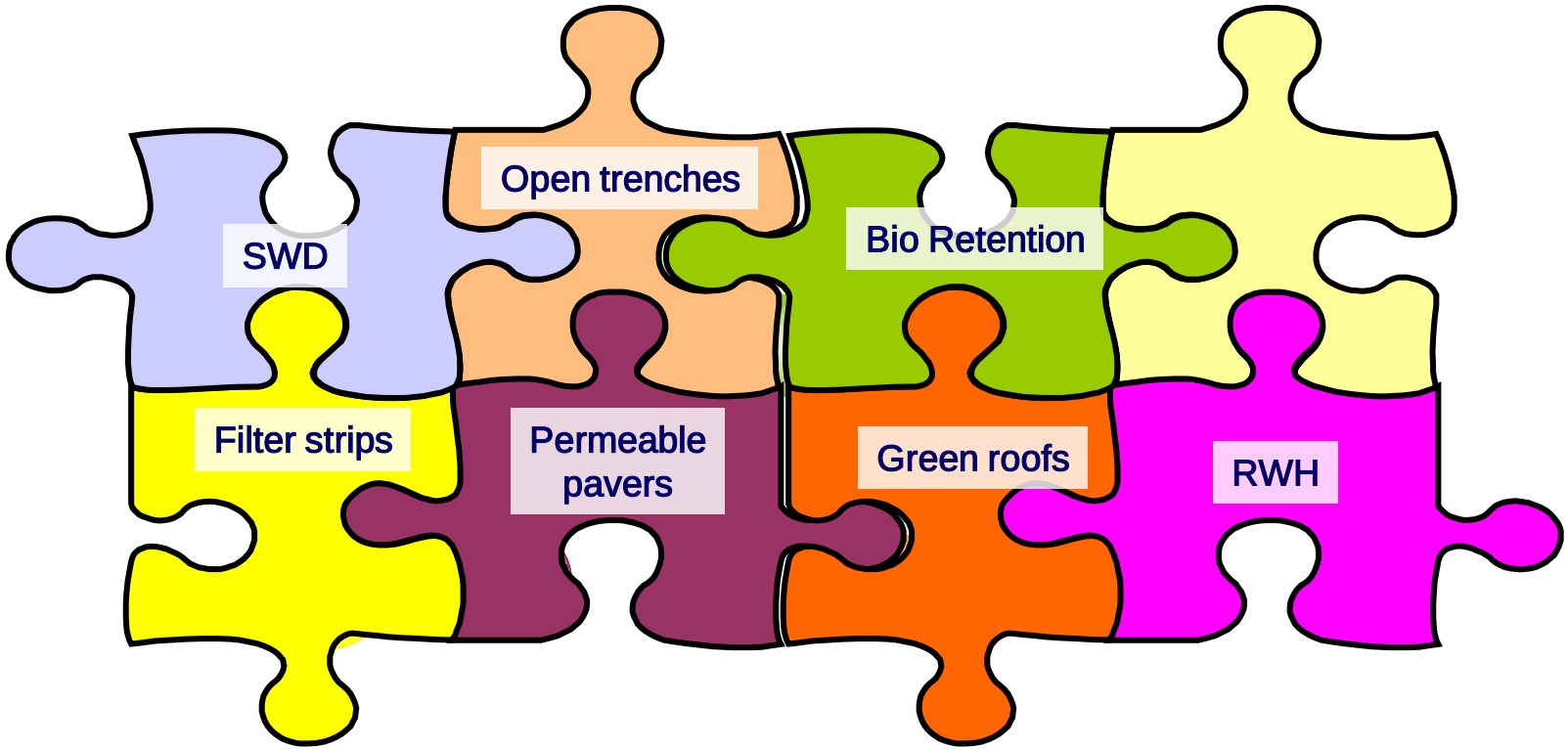




SUDs provides modular diversity that increases flexibility resulting in a complex adaptive system

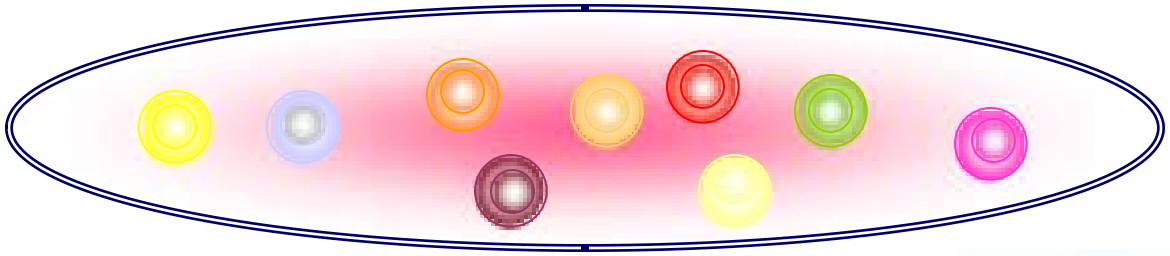
(Sieker et al., 2008, Eckart, 2008)

Examples of activities



Suite of Options

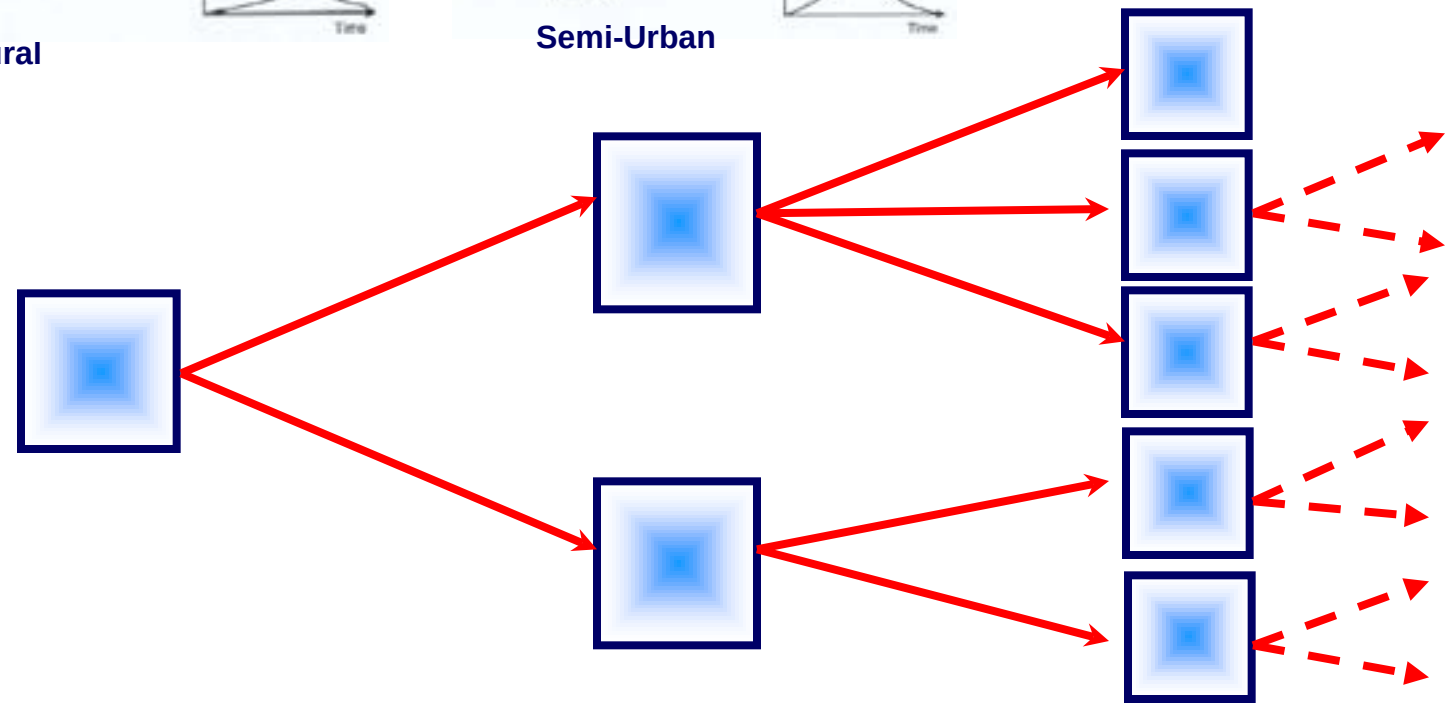
Urban Drainage Modular System



Rural

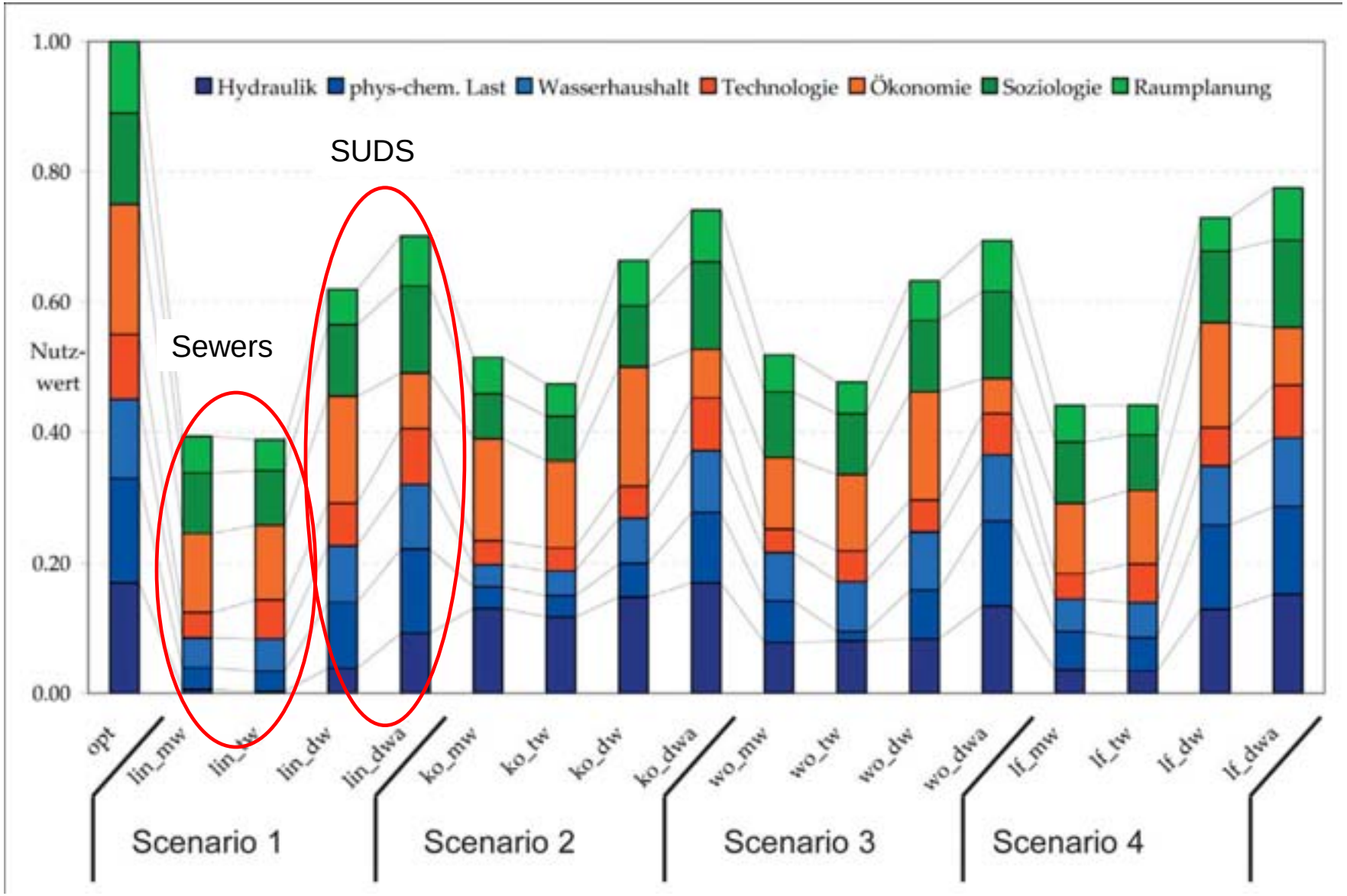
Semi-Urban

Urban



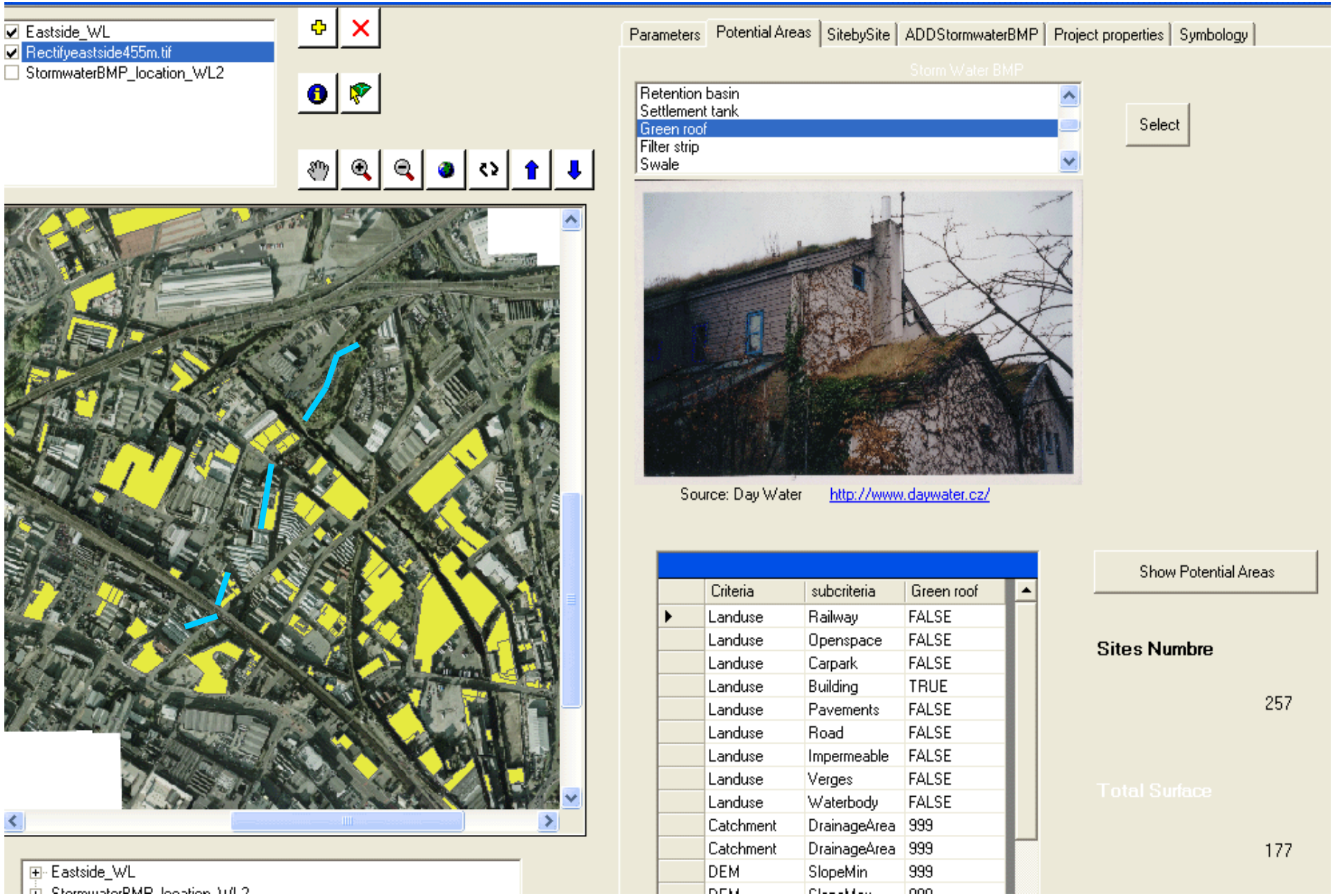
Time

Case Study: Kupferzell Germany

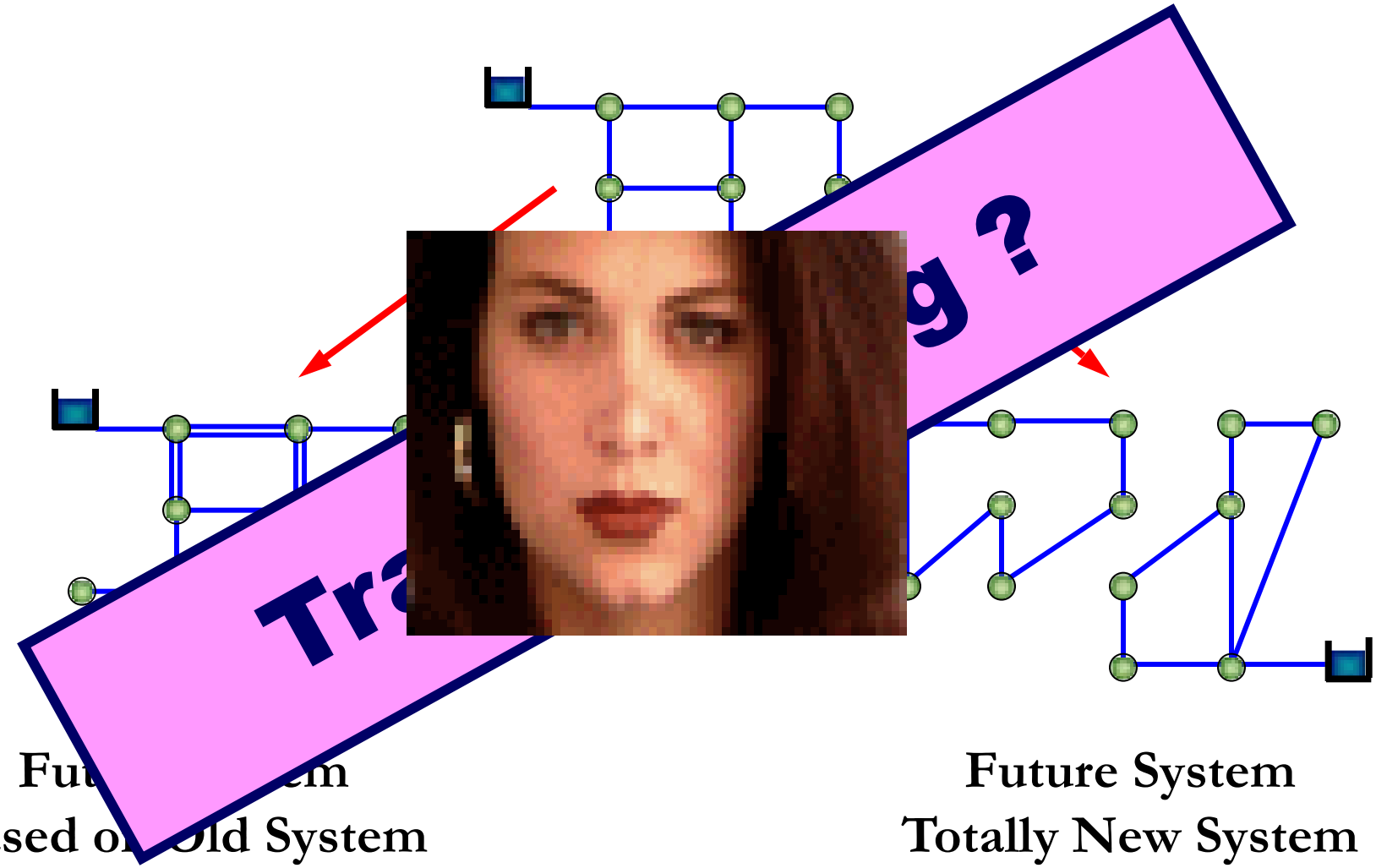


Helm 2007

Where / what to retrofit on-site???

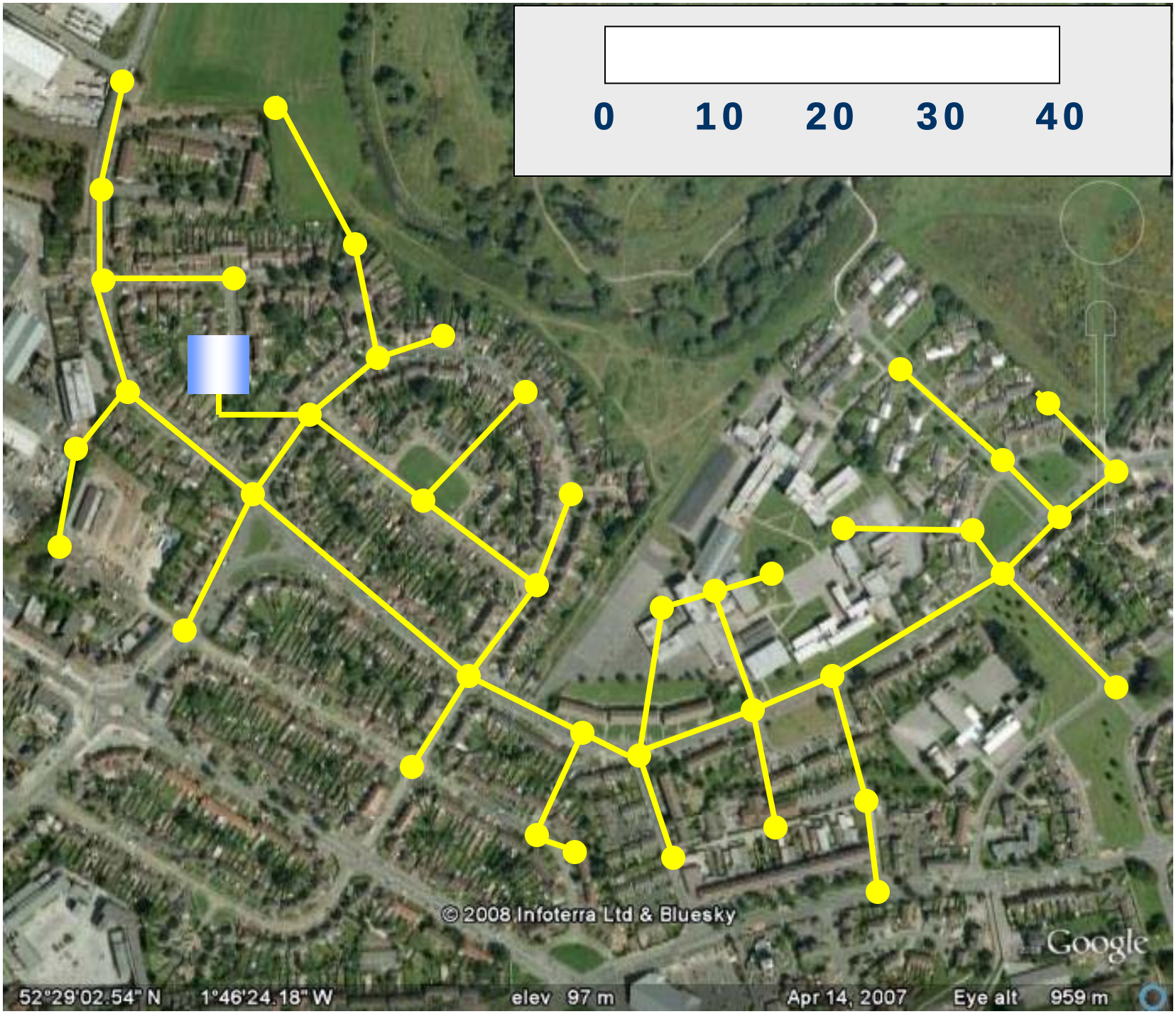


Transitioning



Future System
Totally New System

Graph Theory Transition Systems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elev 97 m
Apr 14, 2007
Eye alt 959 m


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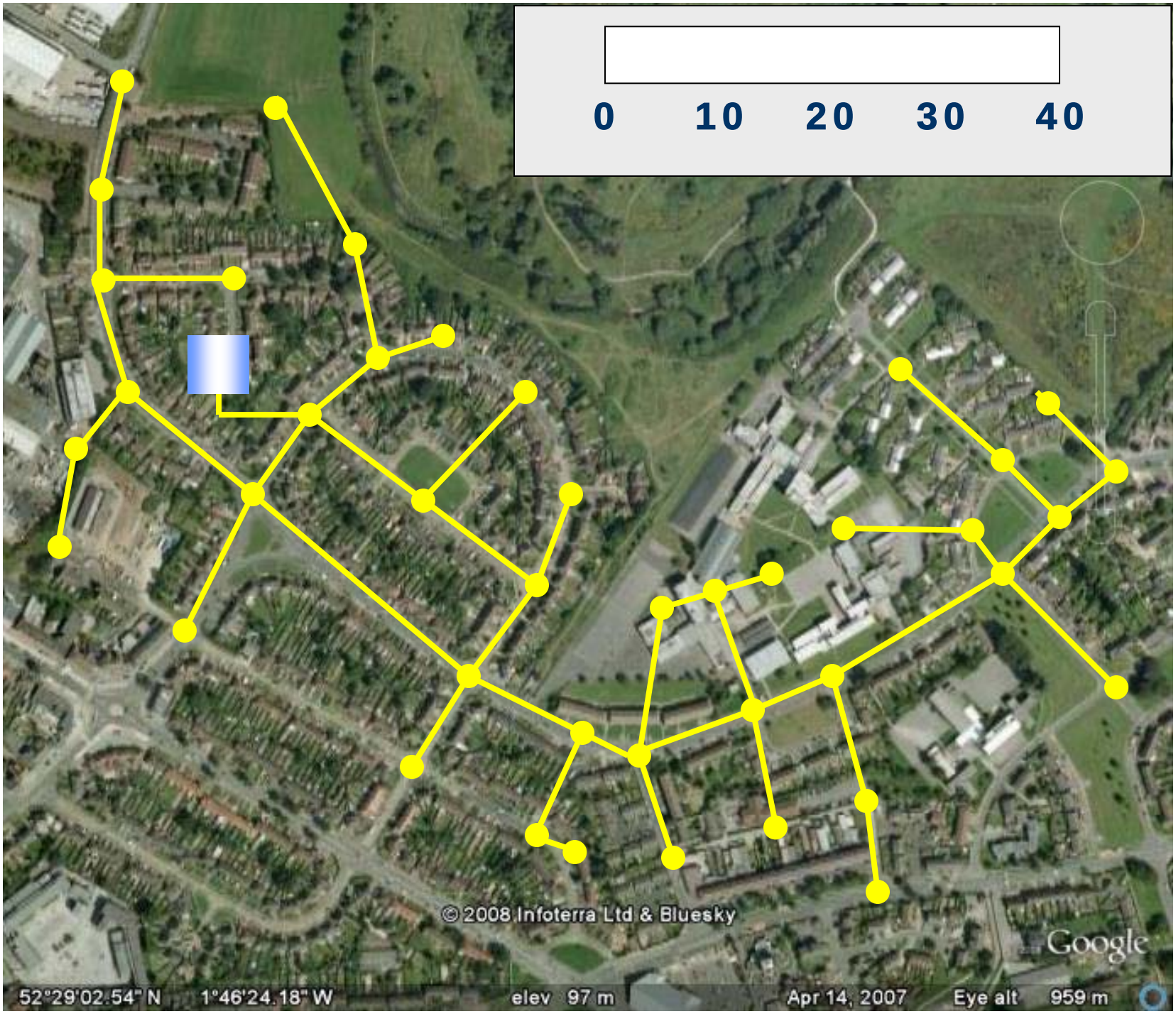
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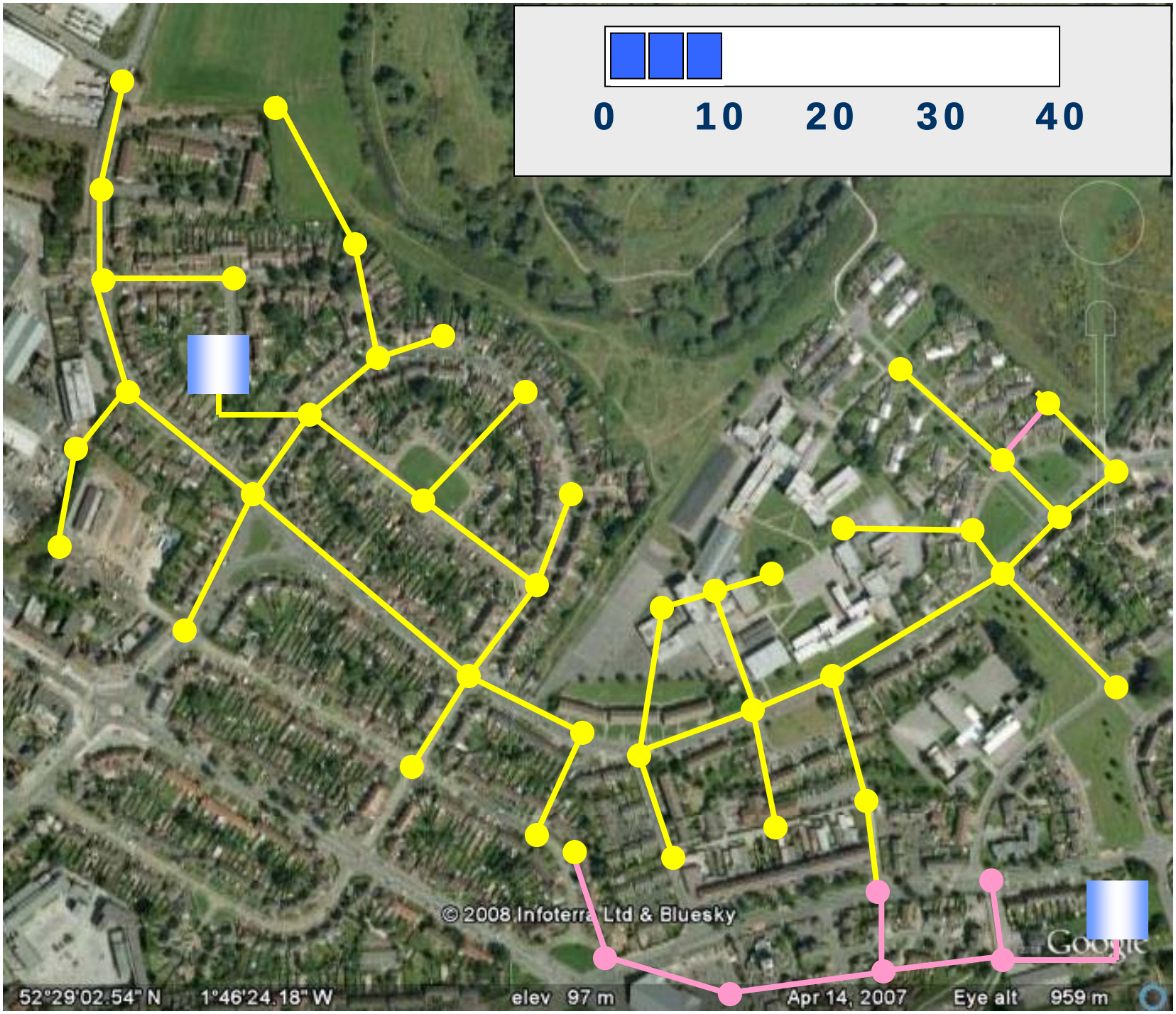
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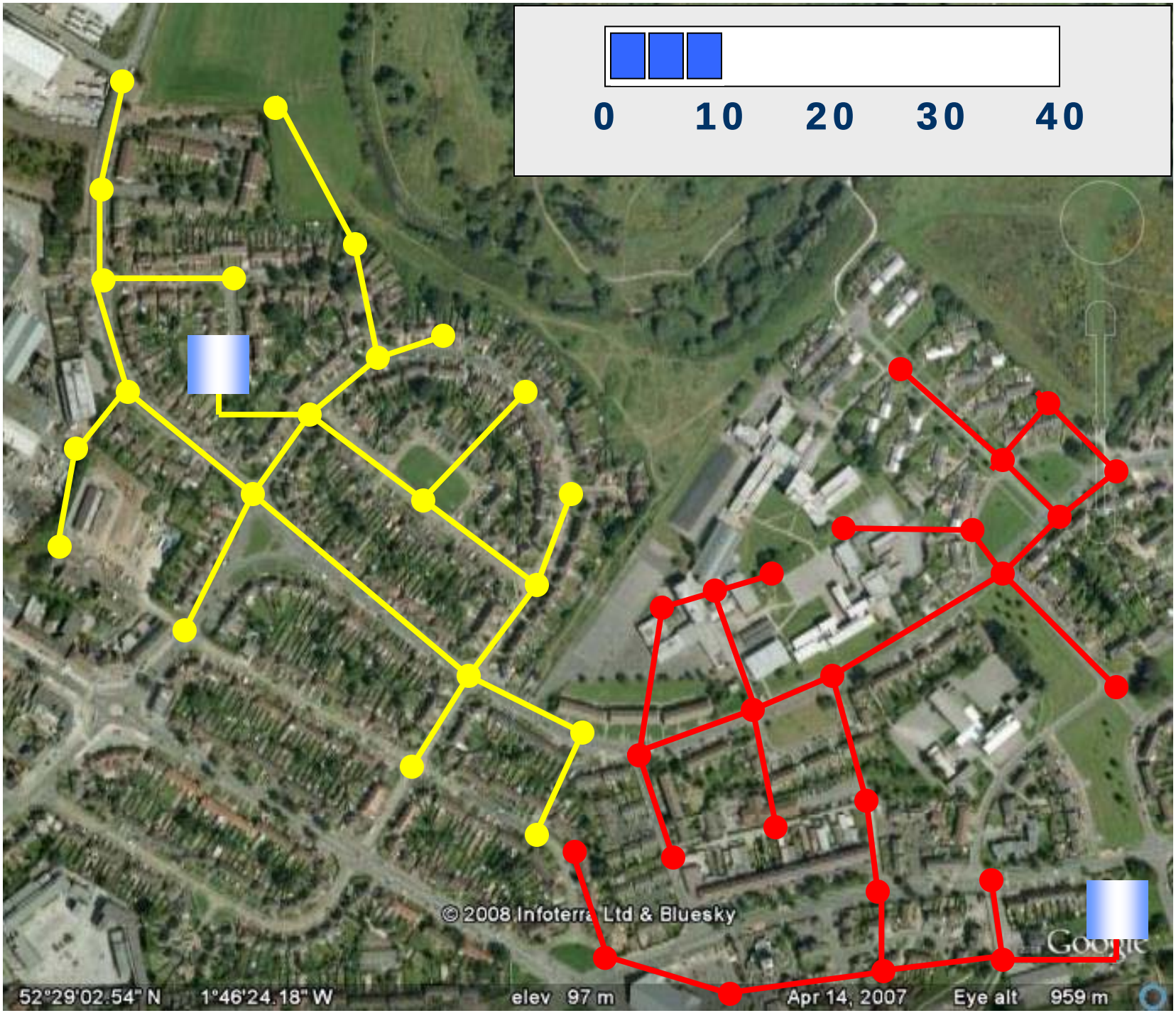
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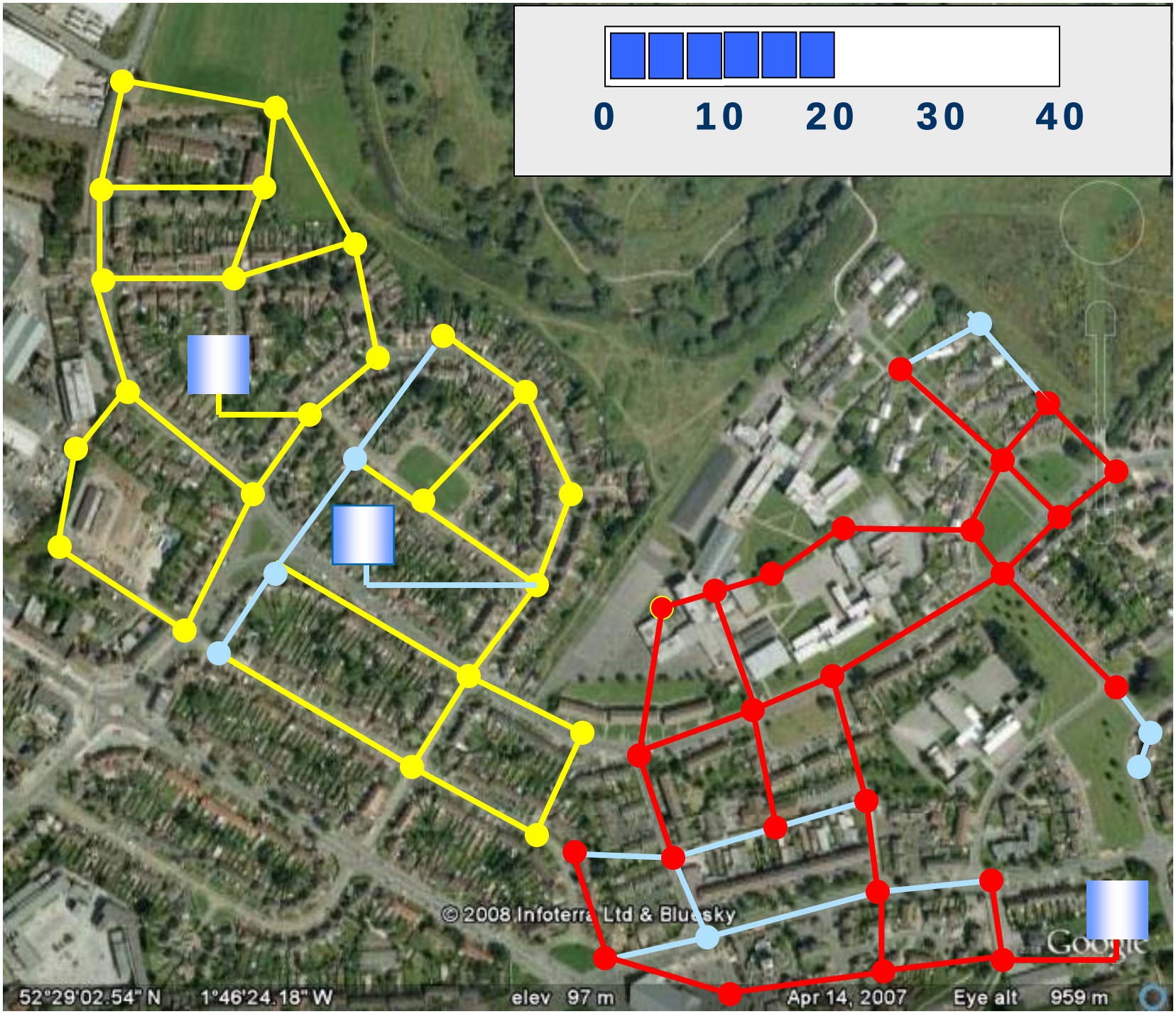
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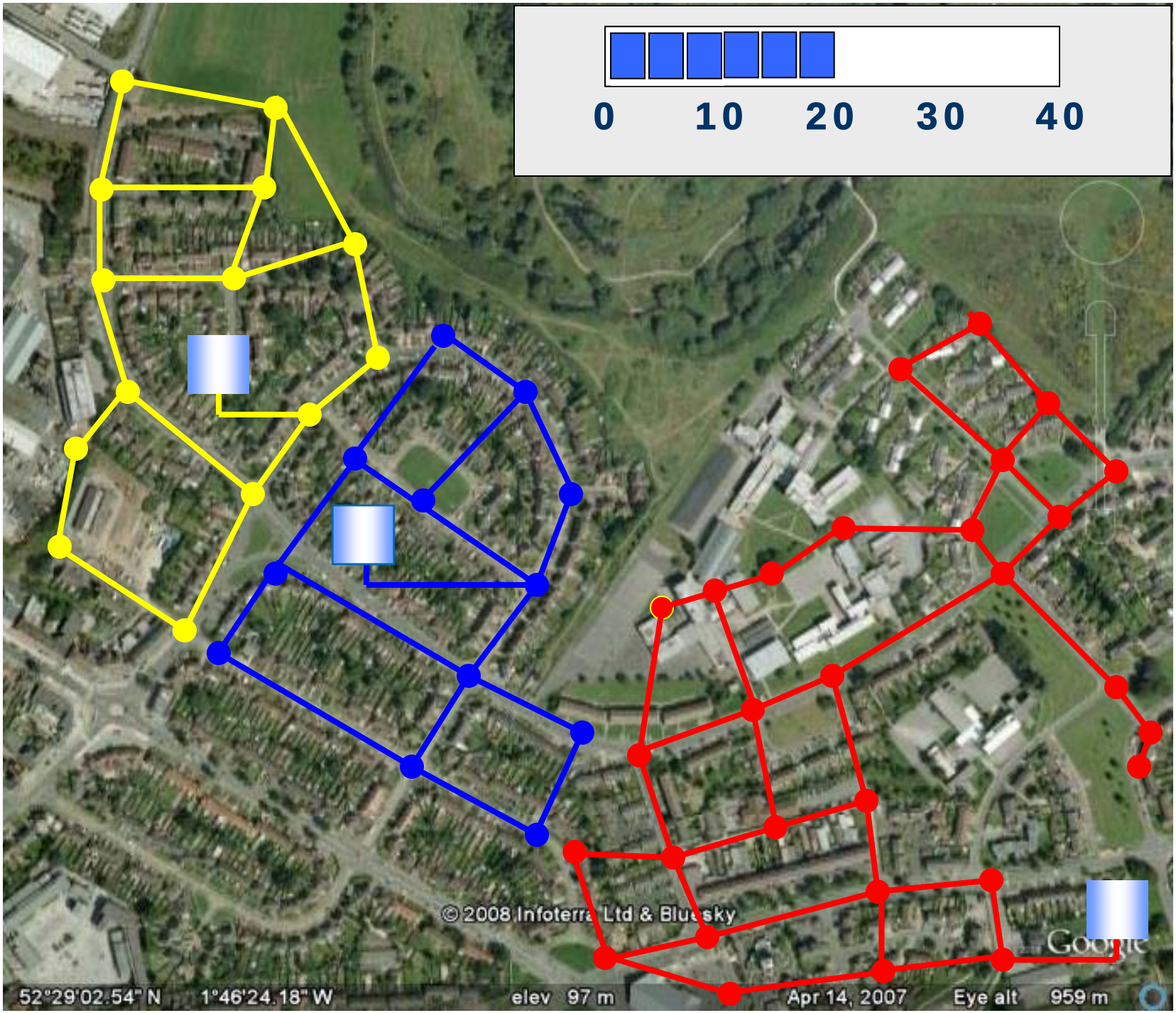
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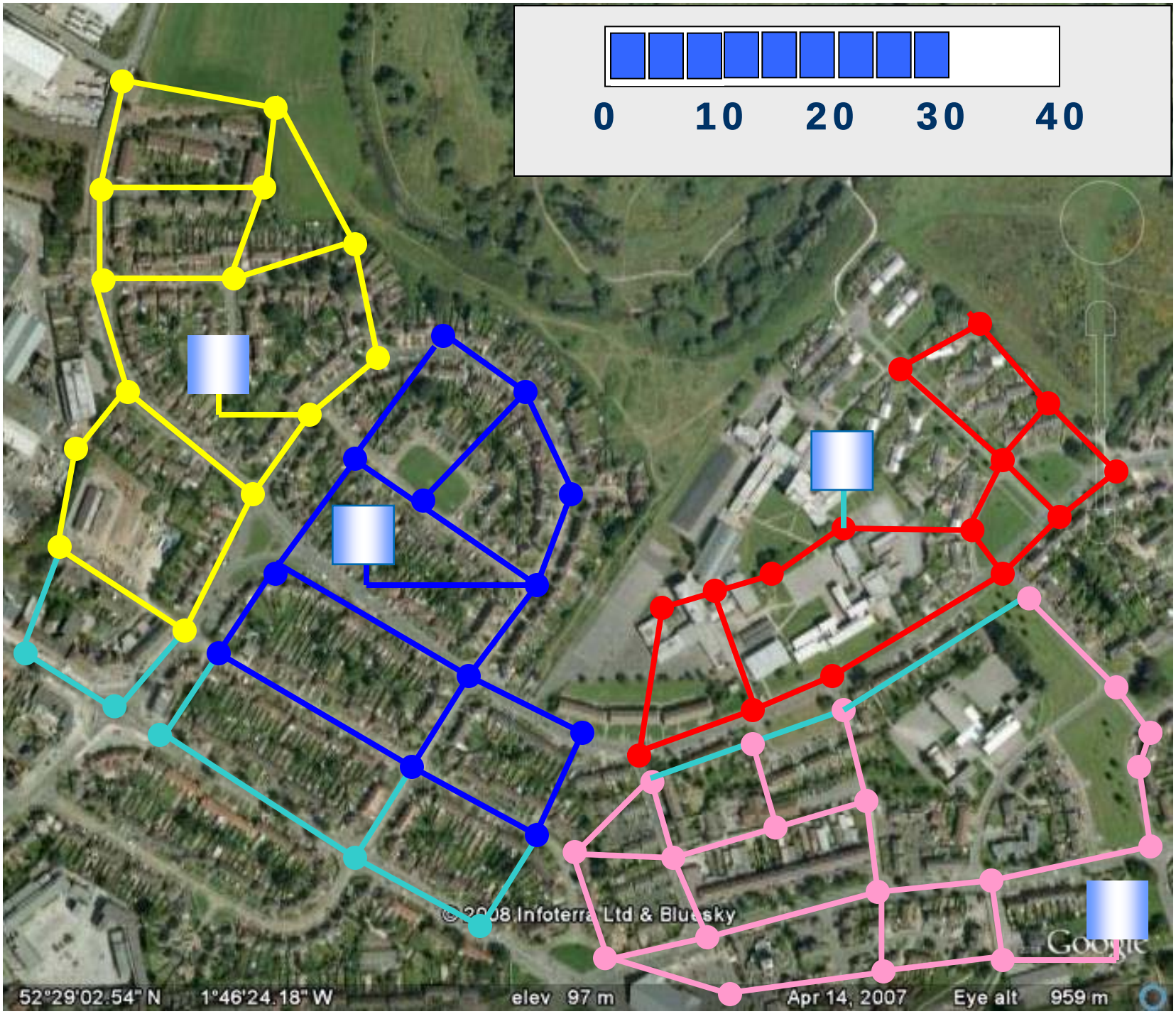
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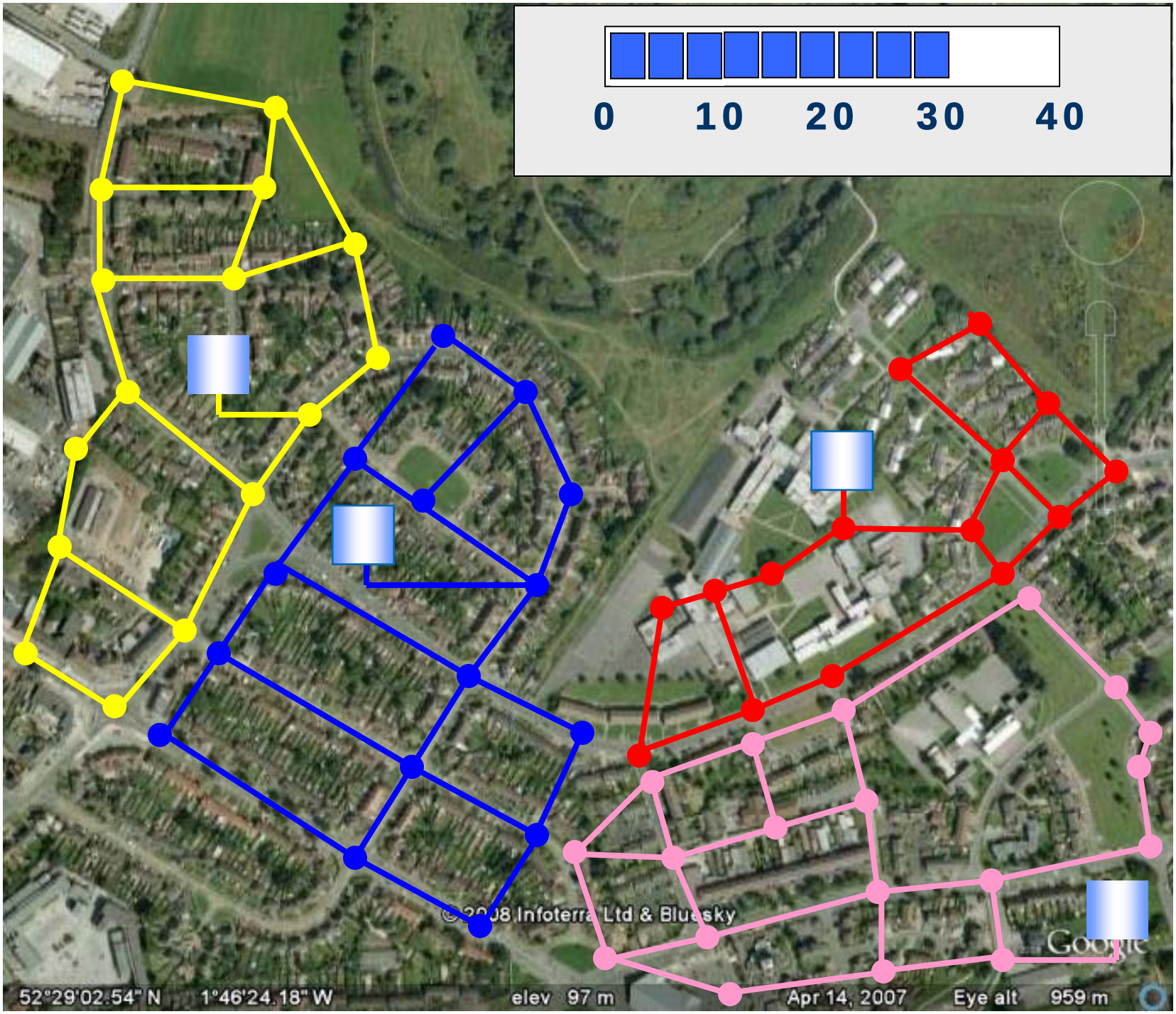
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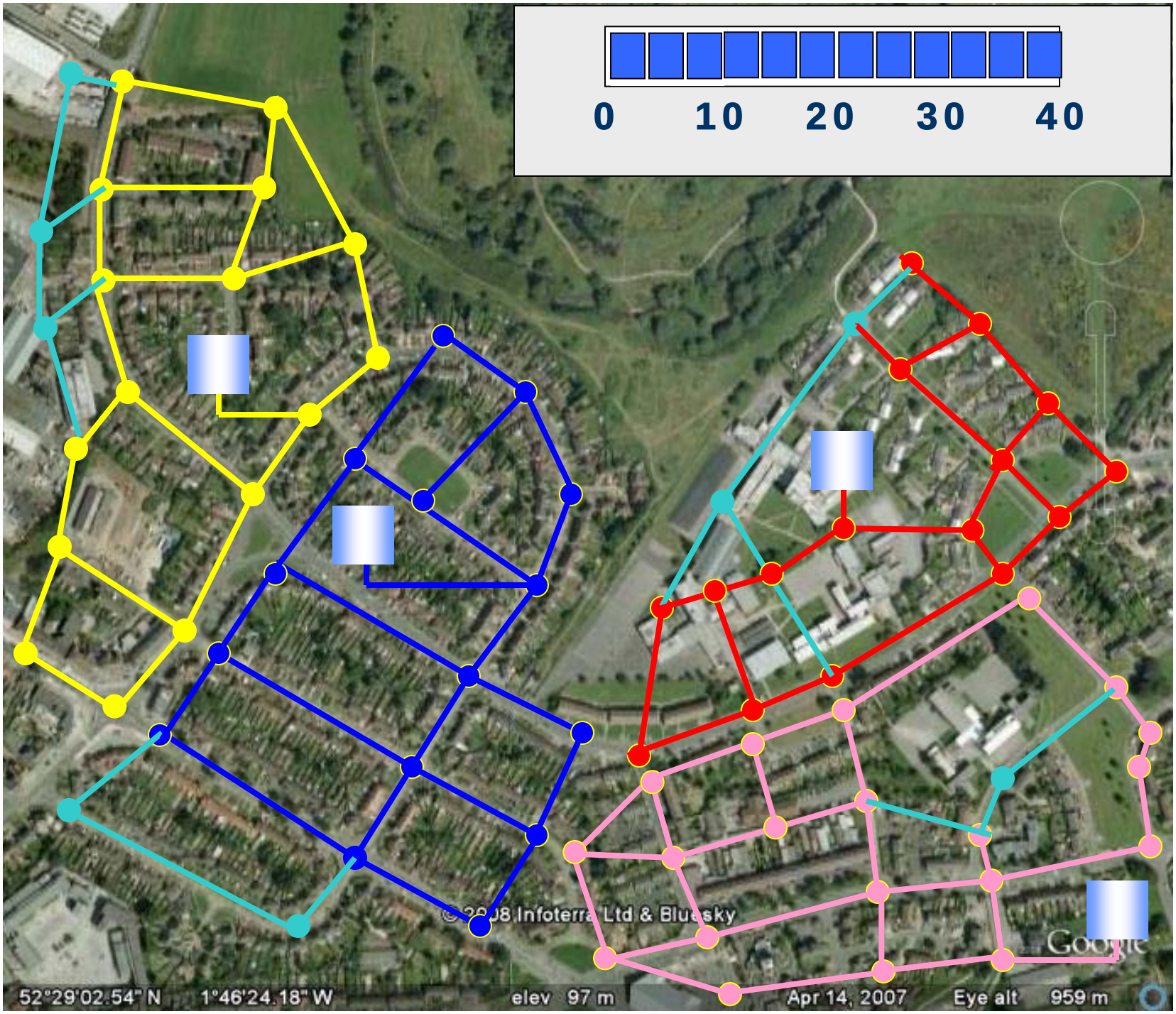
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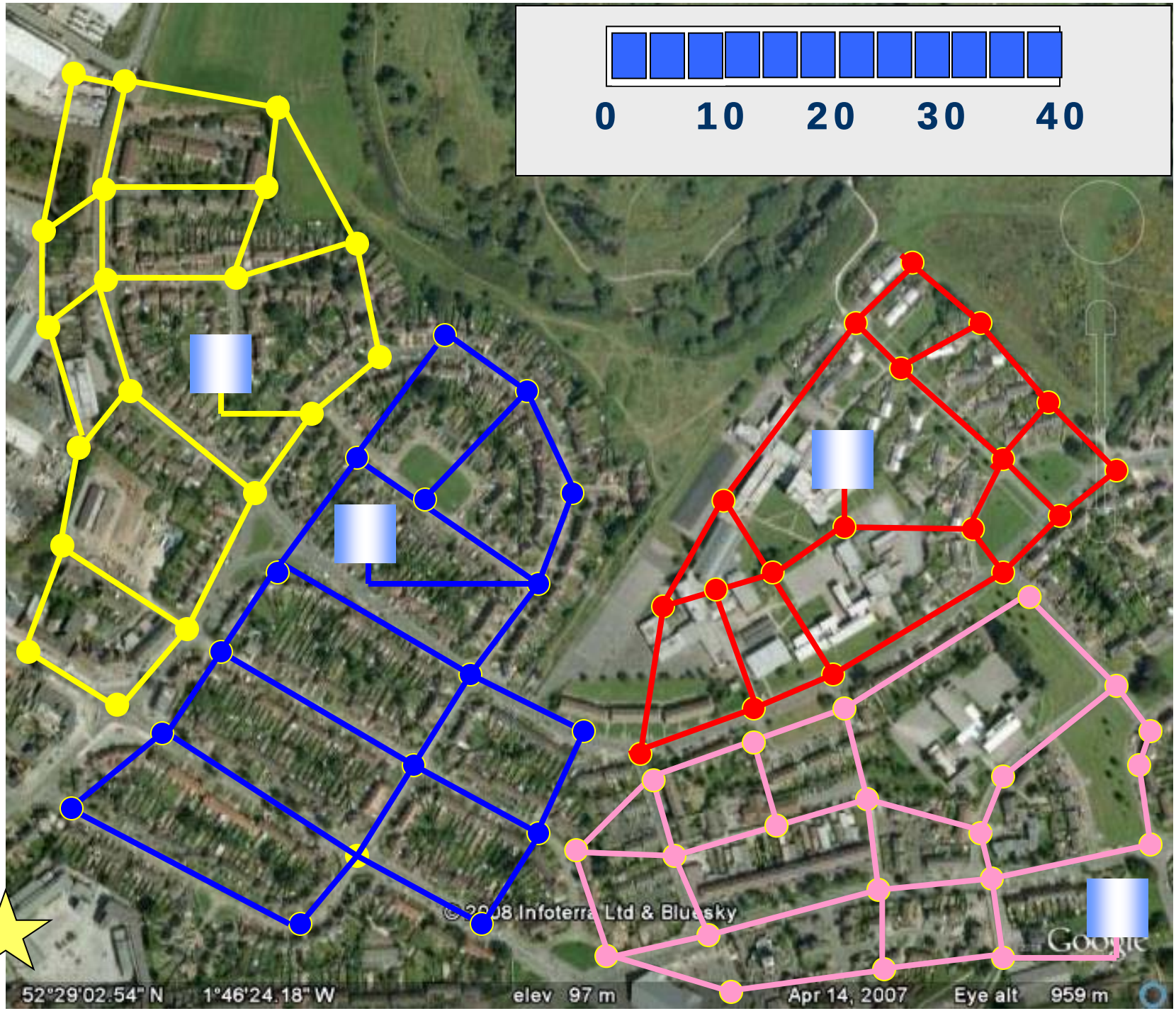
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Summary

Summary

- We need to face the new challenges arising from the unprecedented changes taking place.
- Harmonization of approaches will require a different approach to planning and development (integrated, flexible, demand driven….)
- Sustainable and equitable solutions require locally-driven, incremental changes within a radical, wider shared vision
- Technology can make old solutions more efficient and durable – technologies combined we can achieve new system solutions

Choices Before Us

SWITCH Paris Conference

24- 26 January

Themes

- Decisions Support Systems
- Natural System and Treatment
- Sustainable Urban Drainage Systems
- Water Resource Recovery and Reuse

Thank You

Kalanithy Vairavamoorthy
Scientific Director of SWITCH-IP (EU-FP6)
vairavk@grad.usf.edu