Securing Water for All

Asia Water Week 2013

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FUTURE OF URBAN WATER MANAGEMENT

USF UNIVERSITY OF SOUTH FLORIDA

Kala Vairavamoorthy

UNIVERSITY OF SOUTH FLORIDA + GWP

Global Water Partnership

Water Security - Good News & Bad News

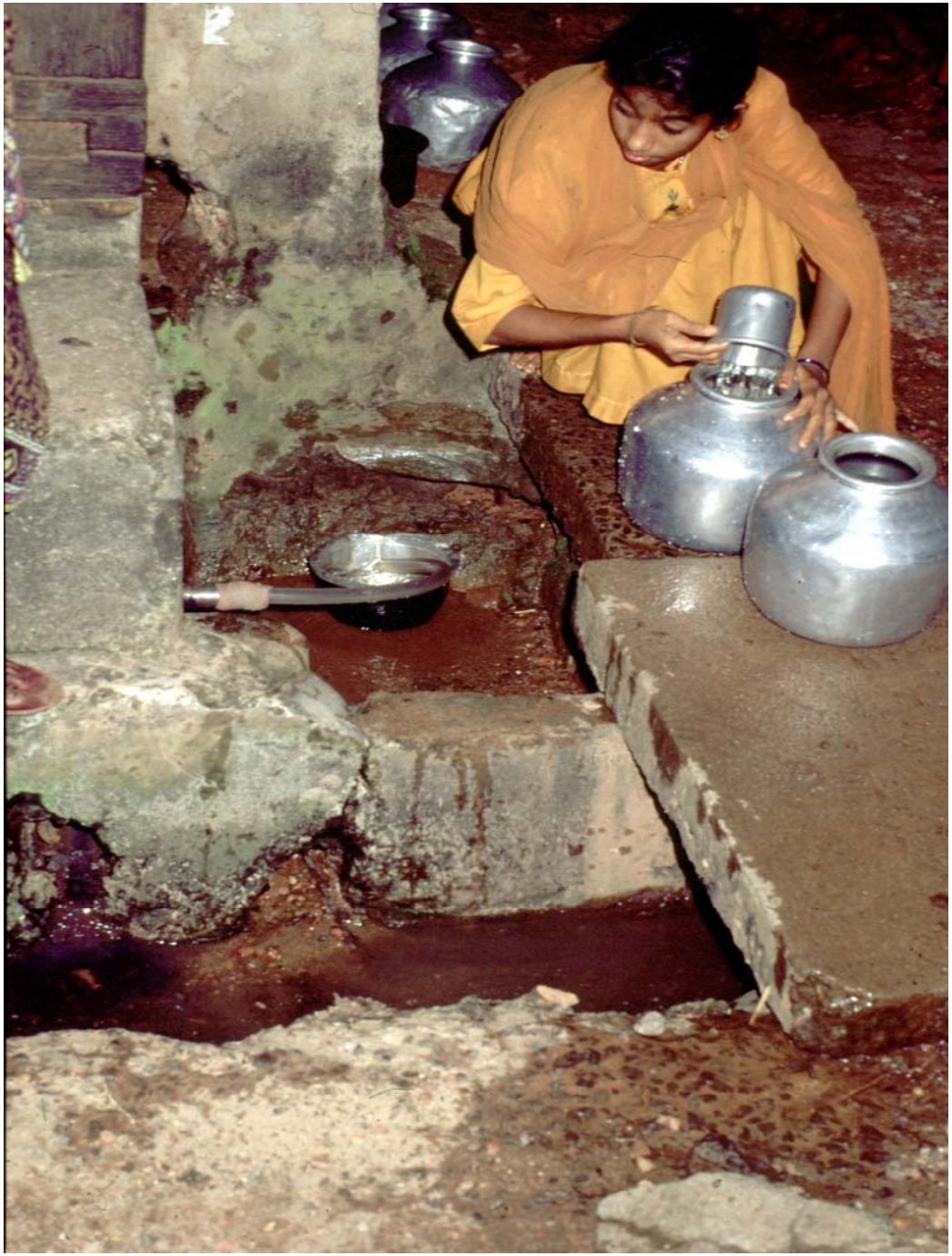
‘Open the loop’ - linear supply and disposal

Good News

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

Bad News

- Systems built for narrow objectives with little resilience – not suited to the challenges ahead
- Extraordinarily resource intensive
- ‘All or nothing’ - Unaffordable to 2/3 of the planet



Bad News – External pressures make the future difficult

- **Entire earth system is changing!**





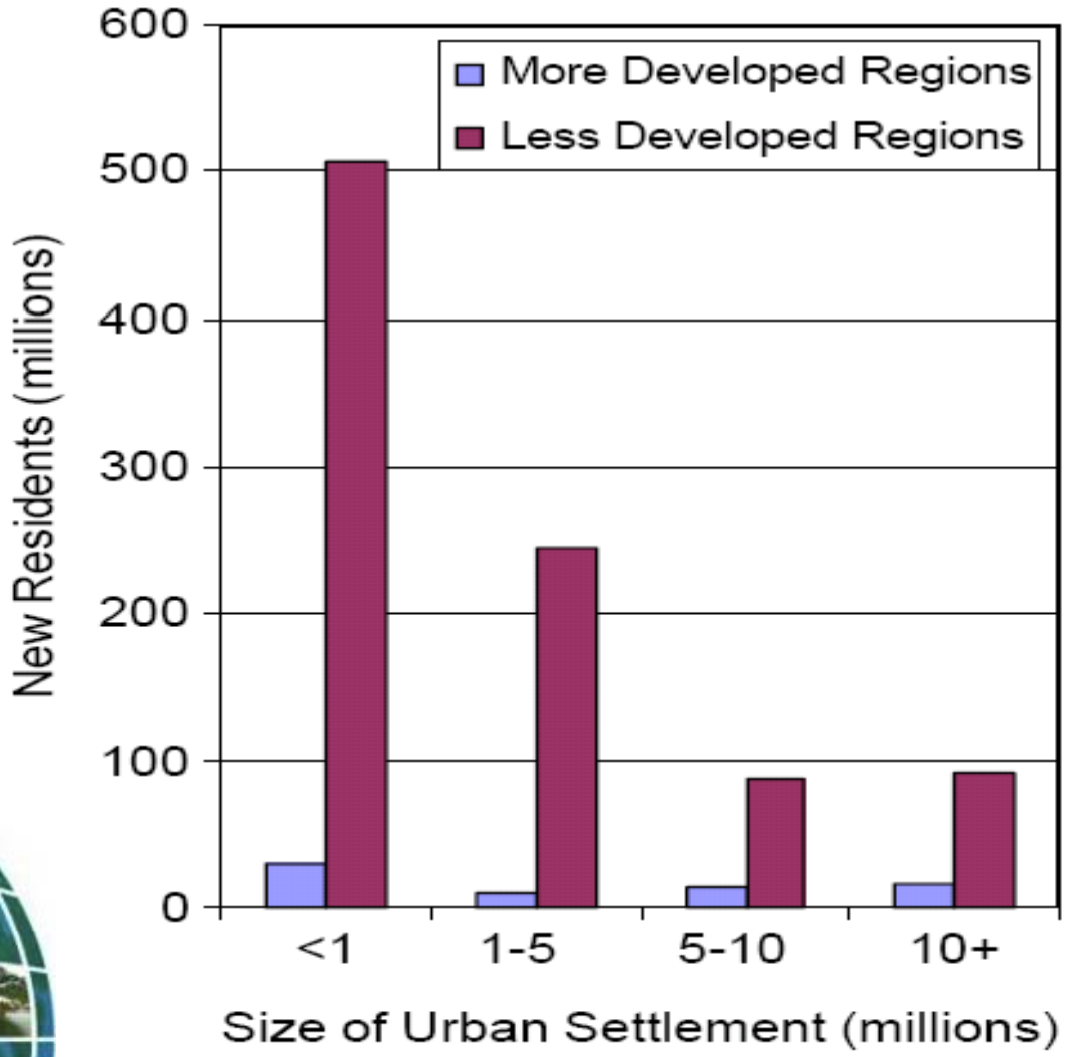


The Urban Arithmetic for 2050

- 155,000 persons per day
- 90% in developing countries
- ~90% in urban areas
- ~850,000 per week in urban settings

Growing but also 'Growing Up'

Opportunity to do Things Differently



Source: UN (2003)

Asia has fastest growing economies

(World Bank, 2012)

World's ten fastest-growing economies			
2001-2010**		2011-2015***	
Angola	11.1	China	9.5
China	10.5	India	8.2
Myanmar	10.3	Ethiopia	8.1
Nigeria	8.9	Mozambique	7.7
Ethiopia	8.4	Tanzania	7.2
Kazakhstan	8.2	Vietnam	7.2
Chad	7.9	Congo	7.0
Mozambique	7.9	Ghana	7.0
Cambodia	7.7	Zambia	6.9
Rwanda	7.6	Nigeria	6.8

Window of Opportunity is Small

Shenzhen

1980

Fishing village of several thousand

Today

City of 7 million – big in electronic manufacturing

Need to think differently

When designing urban water systems keep in mind the following

- **Urban Water Cycle is one system:** understand the relationship between various components
- **Urban water cycle closely linked to watershed:** City depends on and impacts the wider watershed
- **Security through diversity:** explore diverse and flexible options for water sources
- **Water should be fit for purpose** – matching water quality to its intended use.
- **Maximize benefits:** great potential for water, energy and nutrient recovery (beneficiation)

When designing urban water systems keep in mind the following

- **Innovative technologies can play a role:** in helping to serve more people with less
- **Adaptive systems work:** IUWM must take into account that the future is inherently uncertain
- **Water should be managed across institutions:** good governance is a critical to operationalize IUWM
- **Involve all the players:** integration of all stakeholders in decision-making process

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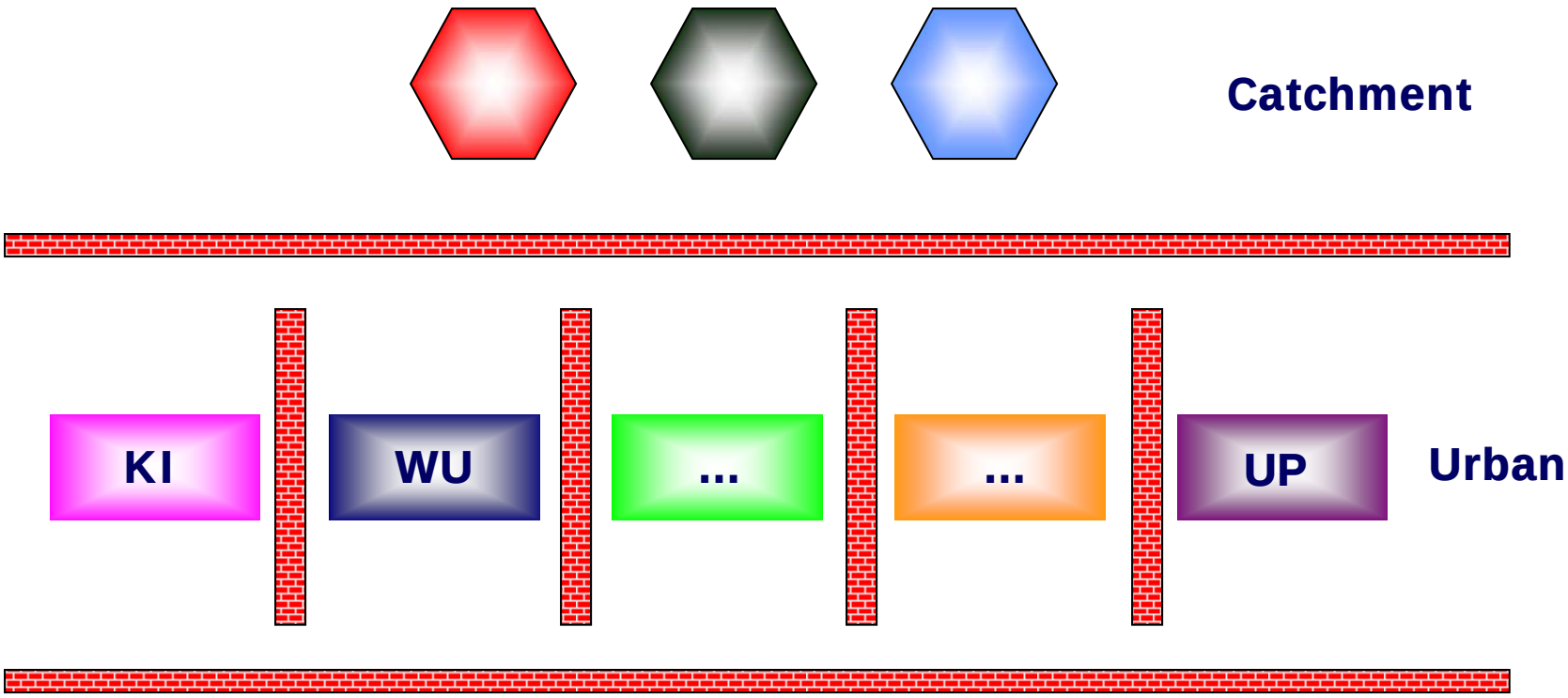
We need to break down barriers



And involve all the players

- **Why?**
  - Poor uptake of available research findings
  - Fragmented institutional arrangements
  - ‘Wicked’ problems - need for ‘integrated’ solutions
- **Who?**
  - Policy makers, planners, regulators, service providers, NGOs, researchers, developers…
- **How?**
  - Inception (training, stakeholder analysis…)
  - Operational (visioning, planning processes..))
  - Backstopping support (monitoring, evaluation…)

Example: Bogota, Colombia

Issue:

- pollution of upper Rio Bogota (tanneries)

Key players:

- Association of tanners, Regulator, Local government, NGO, University,…

Outcomes:

- Almost half of small enterprises have implemented cleaner production principles removing 90% pollution

Example: Lodz, Poland

Issue:

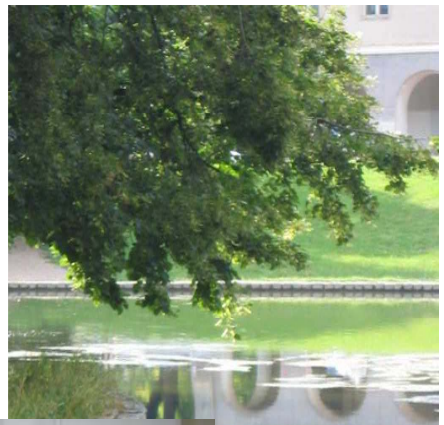
- restoring polluted rivers

Key players:

- city office, University, Ecohydrology institute, service providers, developers

Outcomes:

- Demonstration technologies being scaled up as part of city redevelopment
- development of a city-wide strategic plan for water

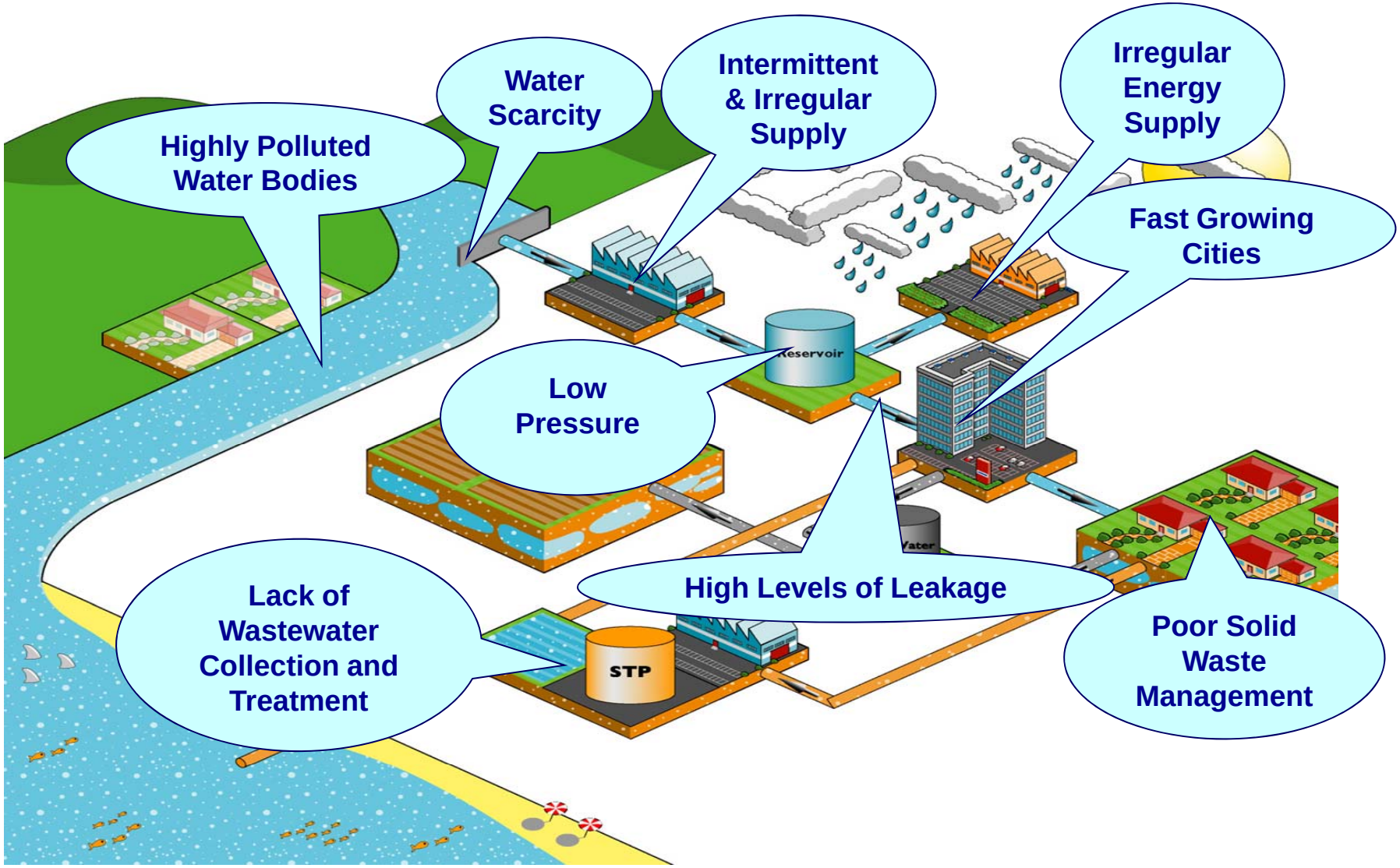


We need to put water in the minds of people?

Doing more with less
‘Integration the key’

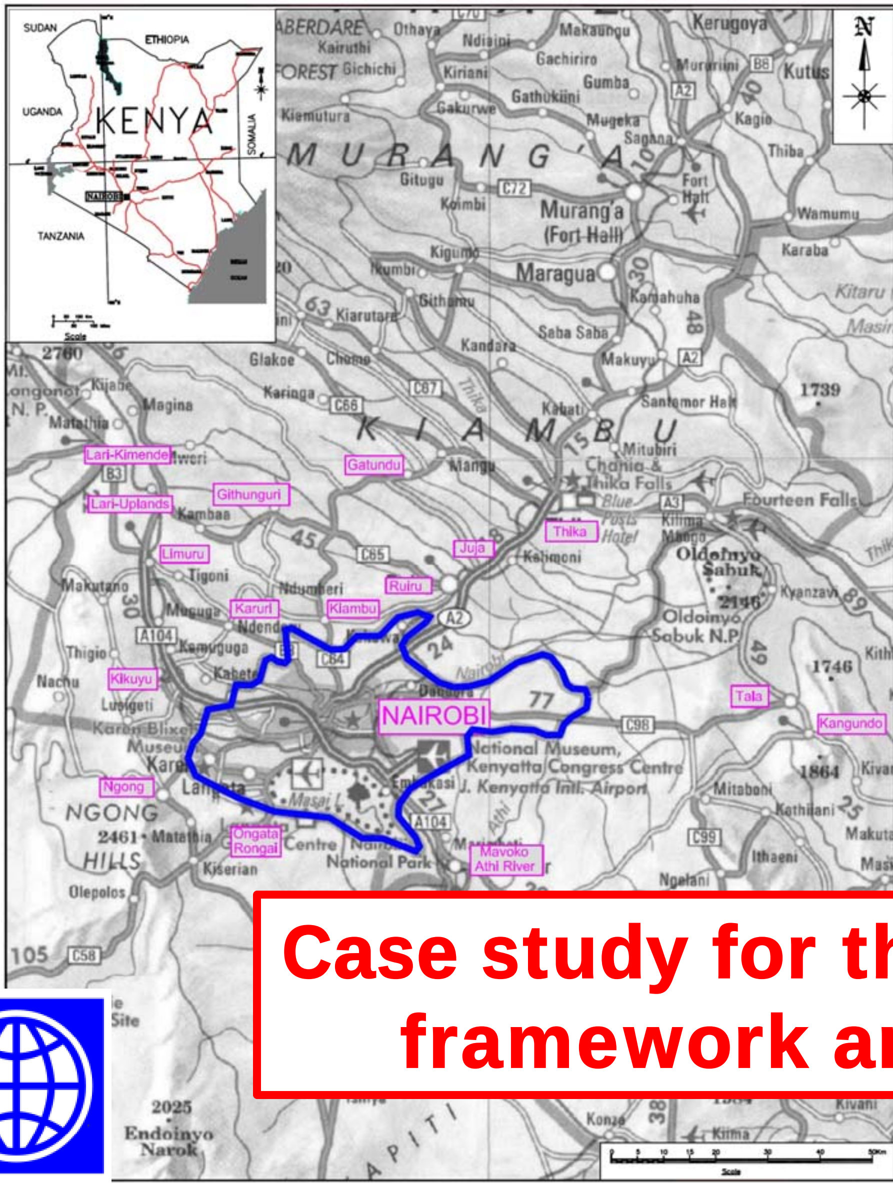
Holistic systems approach
to the urban watershed

Tailored IUWM Framework for Developing Countries Required



Source: CSIRO

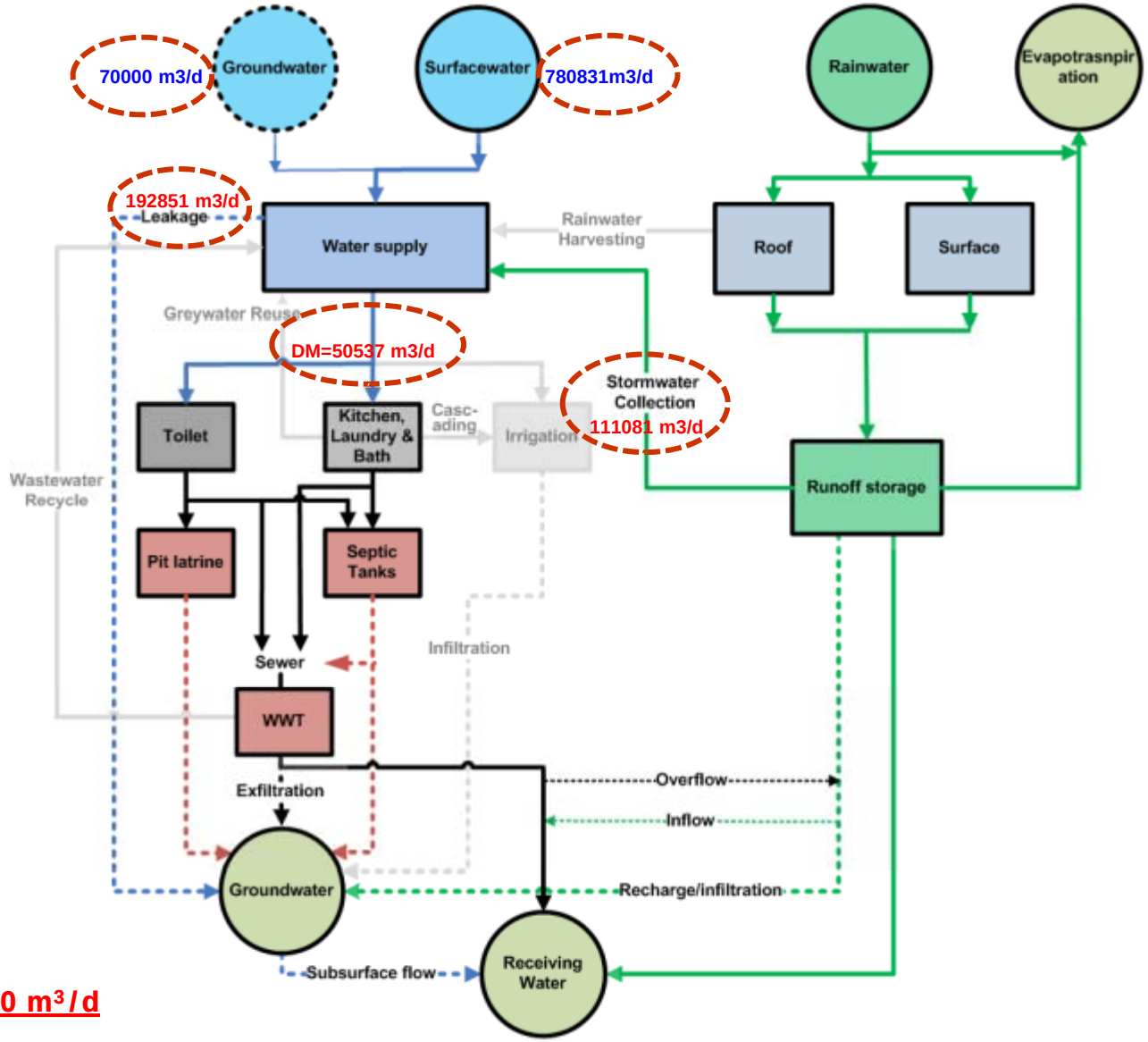
Case Study: Water Resources for Nairobi and Satellite Towns



- Today 3.14 M Inhabitants
- Prediction year 2035 between 6.4 and 11.2 M Inhabitants
- Huge supply/demand gap

Case study for the application of the framework and the principles.

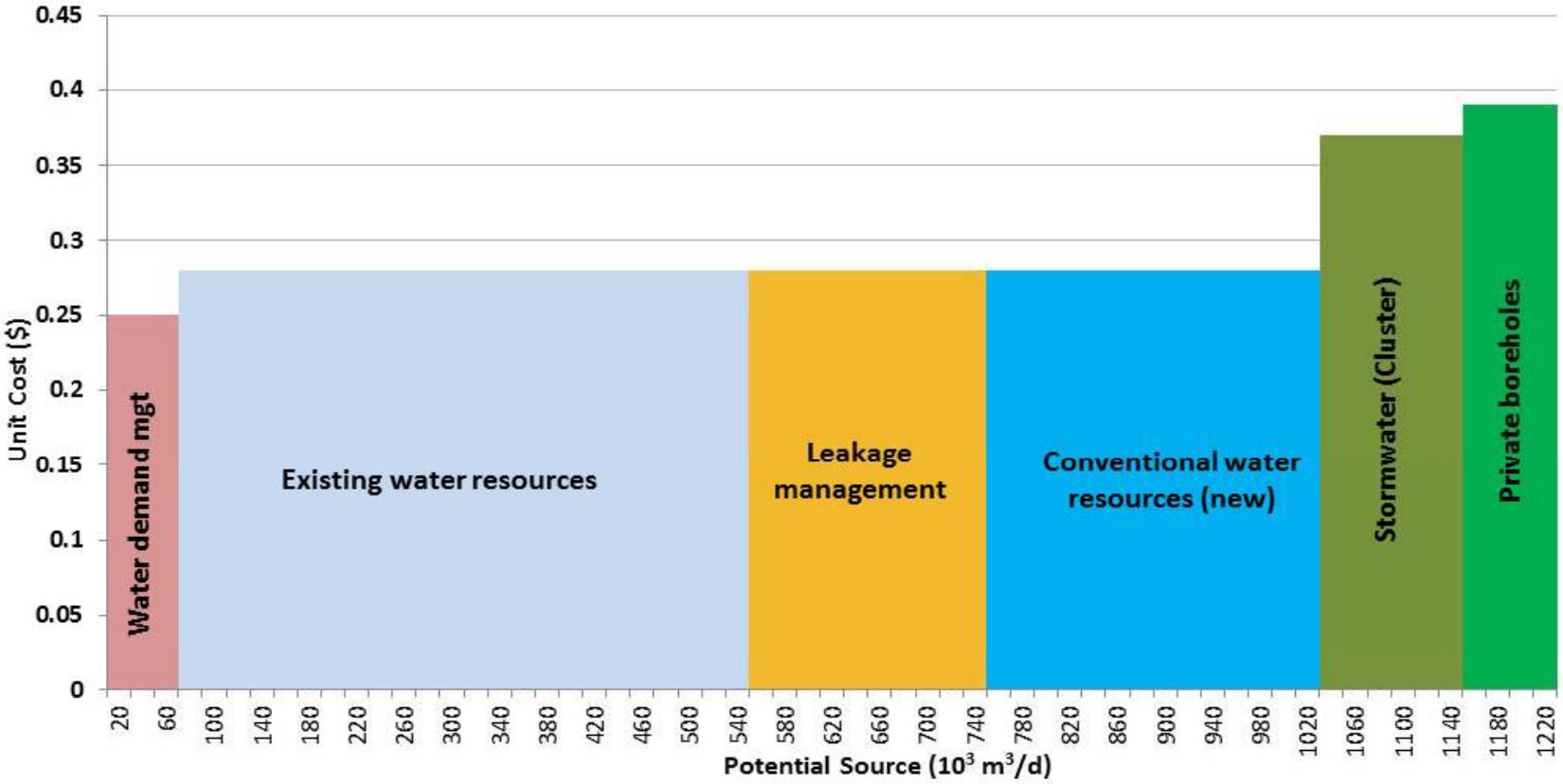
IUWM Application 1 (stormwater, leakage, demand management)



Demand = 1205300 m³/d

IUWM Application 1 (stormwater, leakage, demand management)

- Unit costs of **US$ 0.29/m3** (cf. to 0.36)



Nairobi - It's about having a Portfolio of viable options

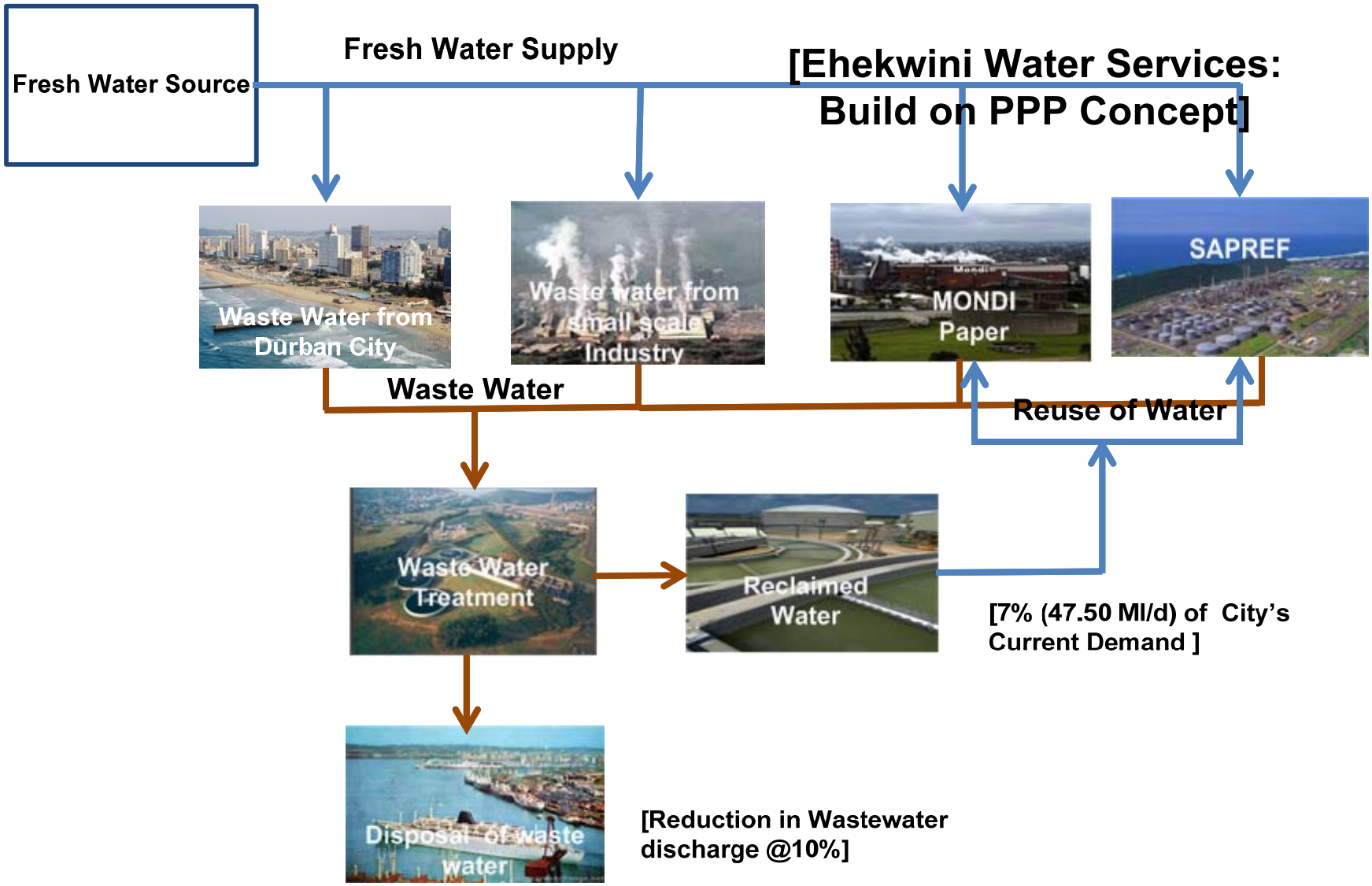
Phnom Penh's Water Success Story

- **NRW reduced from 72% to 6.19% (1993-2008)**

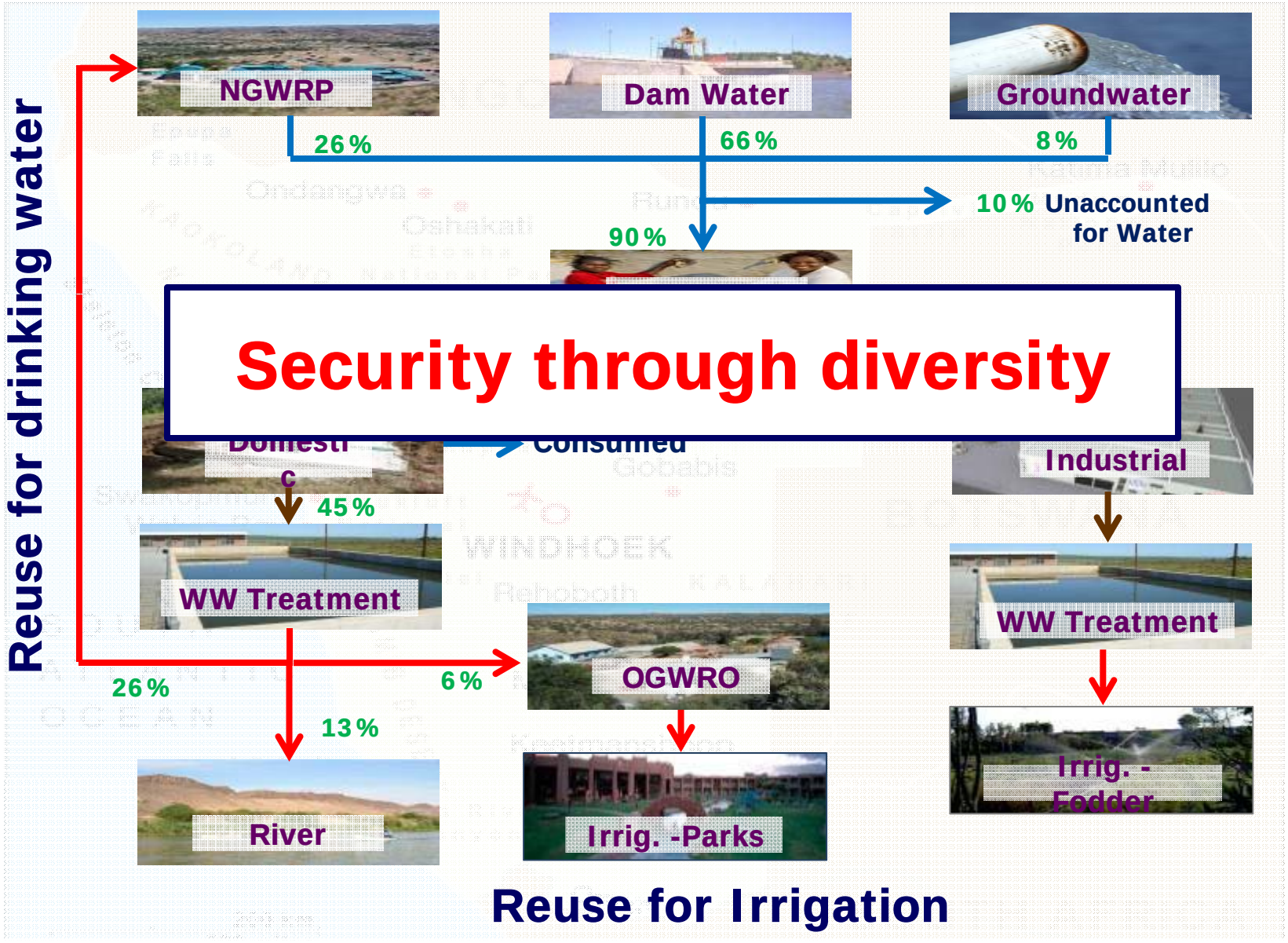
- **Water saving about 25,000m3/d (serving about one million more people)**
- **Increasing revenues by over US$ 20 million per annum**

Biswas and Tortajada 2009

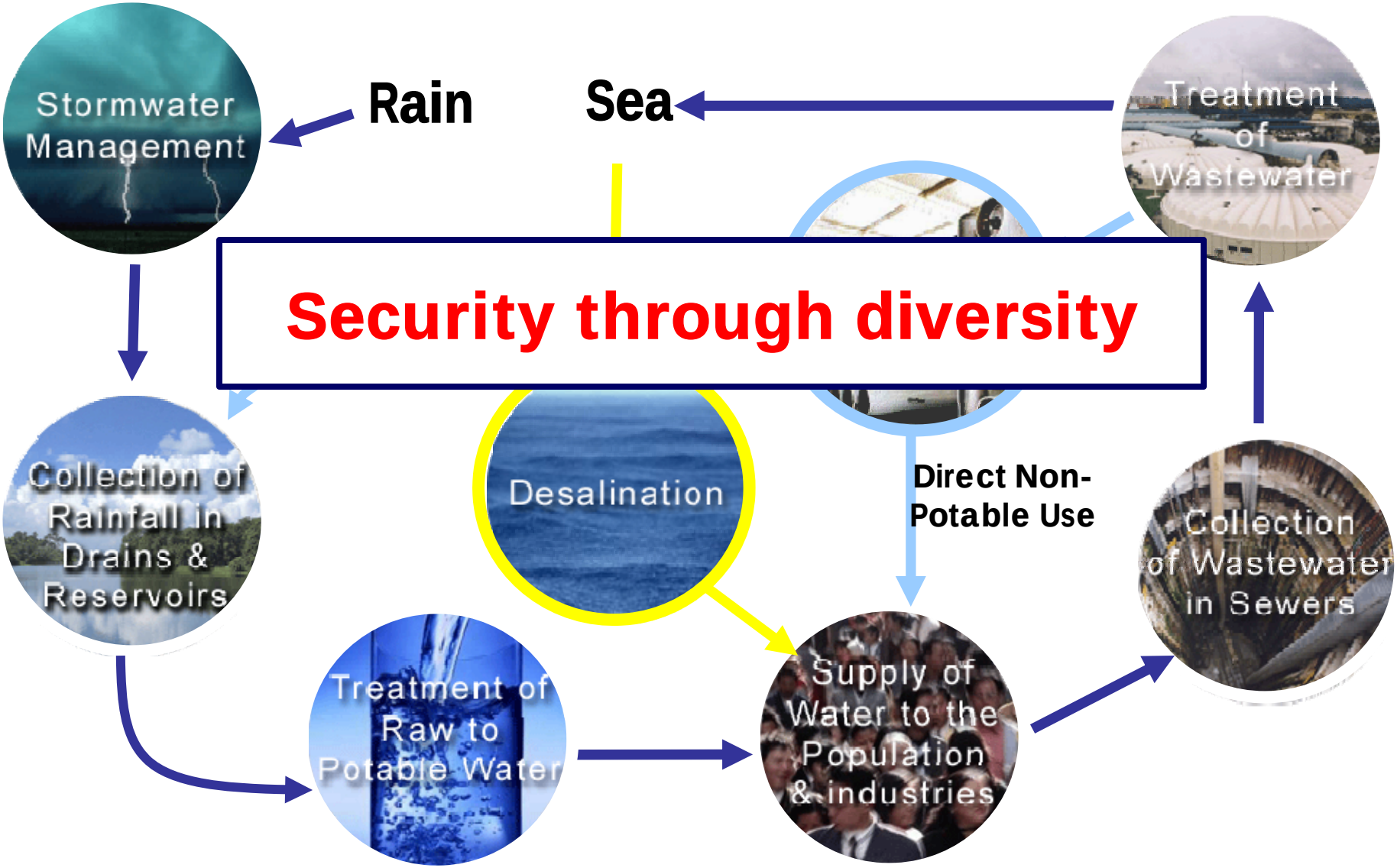
It's already happening: Ethekwini



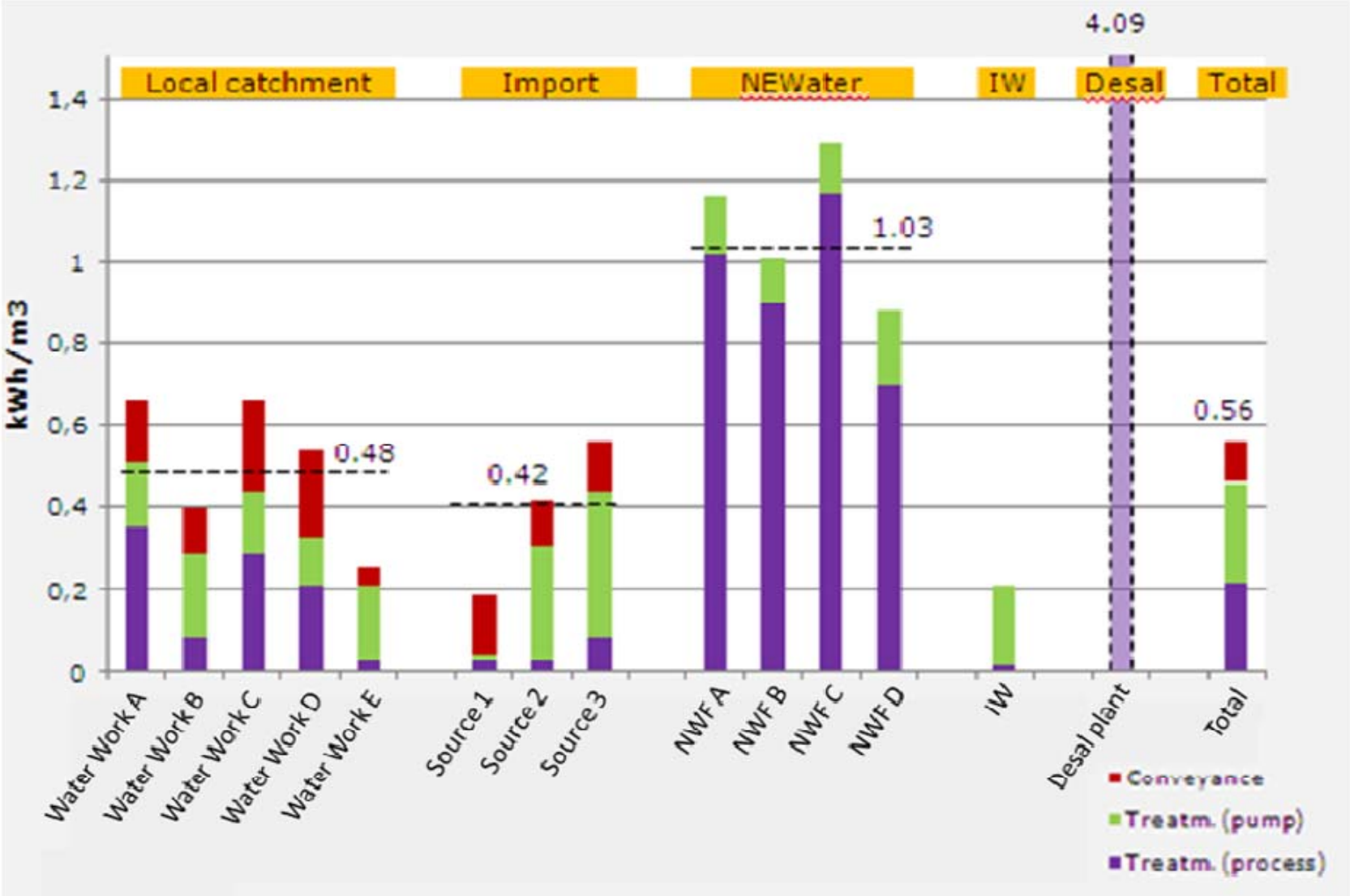
It's already happening: Windhoek



It's already happening: Singapore



Unconventional water sources: more energy intensive



NEWRI 2010

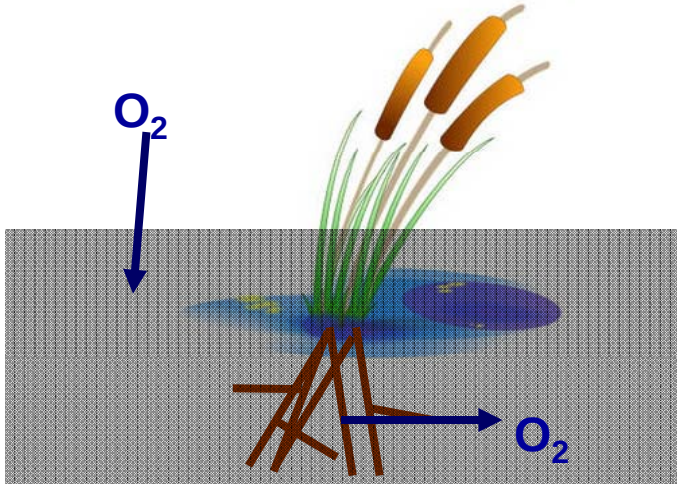
Natural systems can help close the water cycle

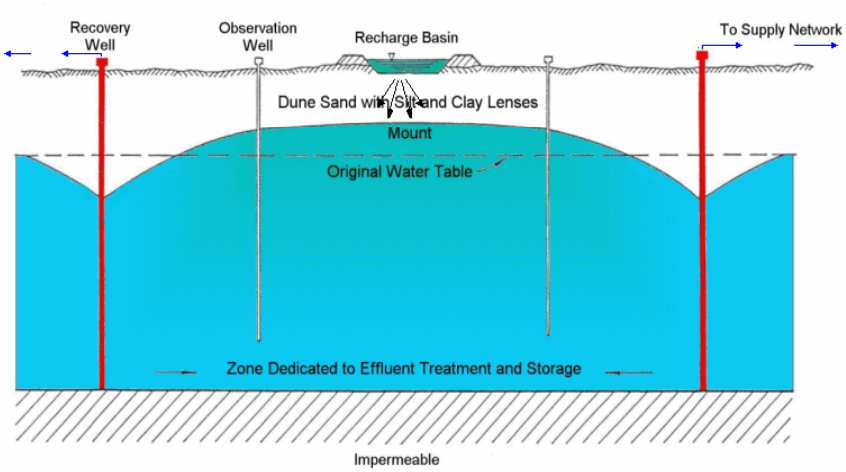
bank filtration,

soil-aquifer treatment,

constructed wetlands,

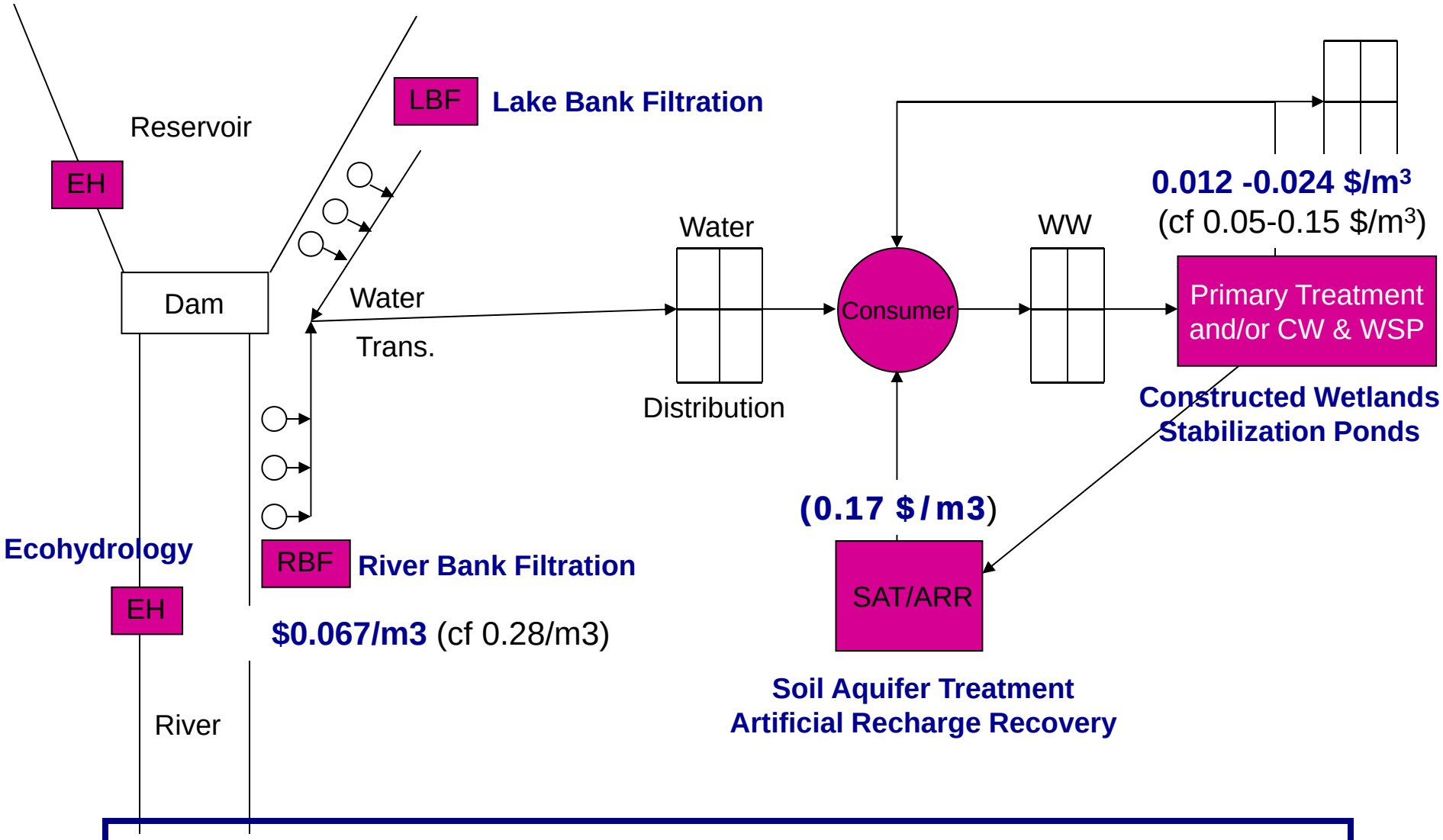
hybrid systems





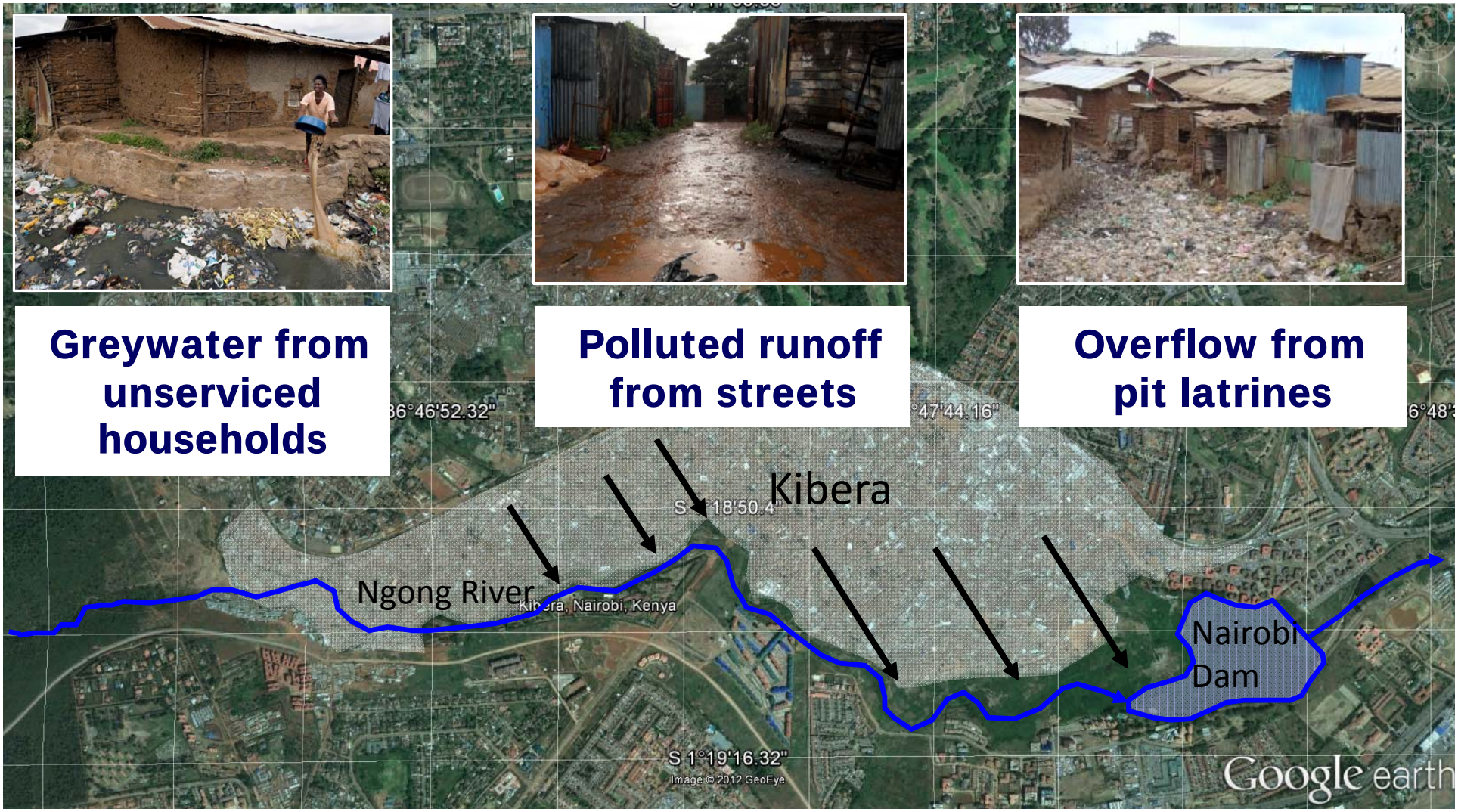
Recharge - Recovery Scheme

Natural systems can help close the water cycle

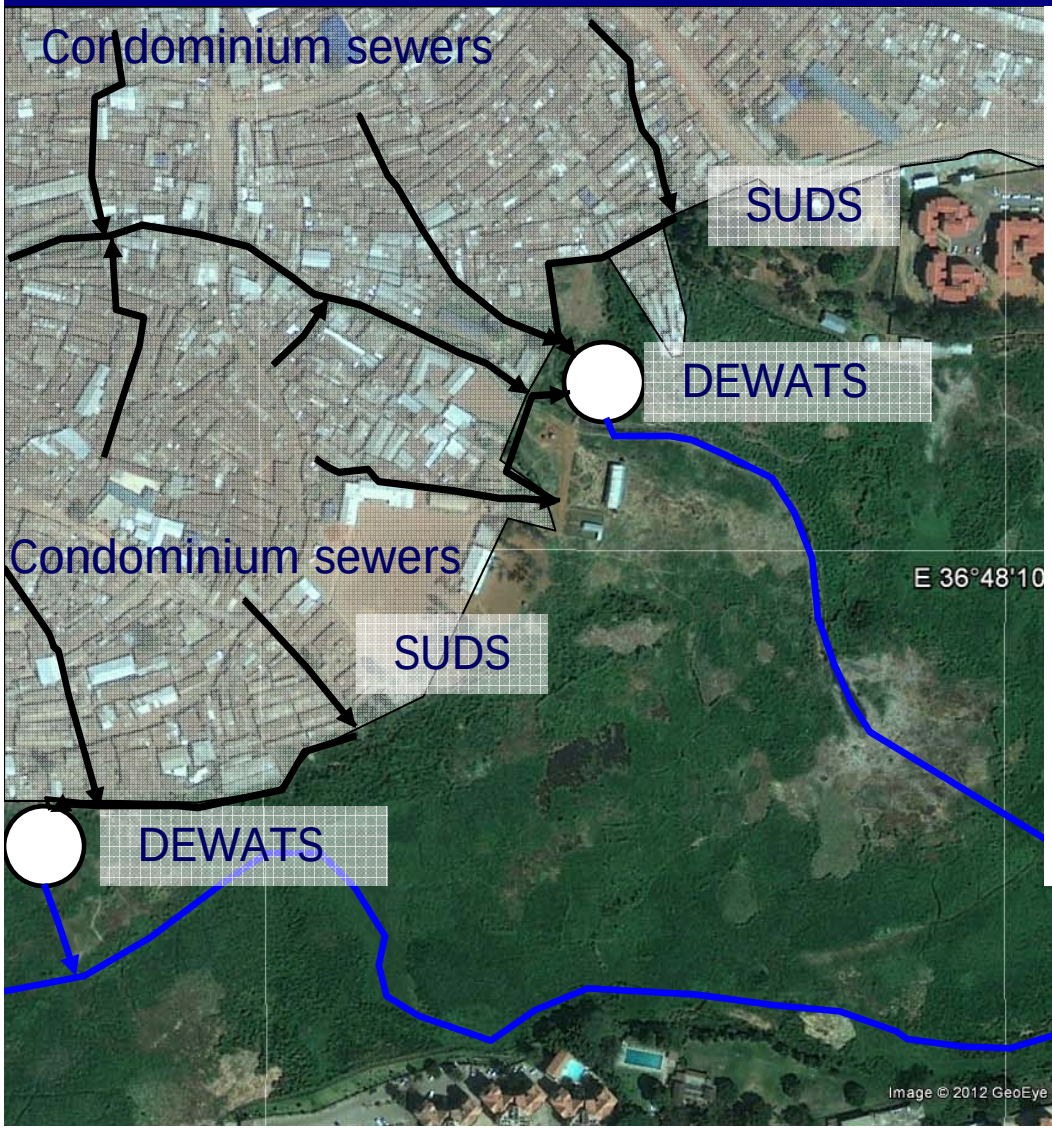


Low Energy – Water Efficient' Closed Loop

Flows from Kibera pollute Nairobi Dam
No longer used as a water source



Urban water infrastructure provision to Kibera benefit all of Nairobi



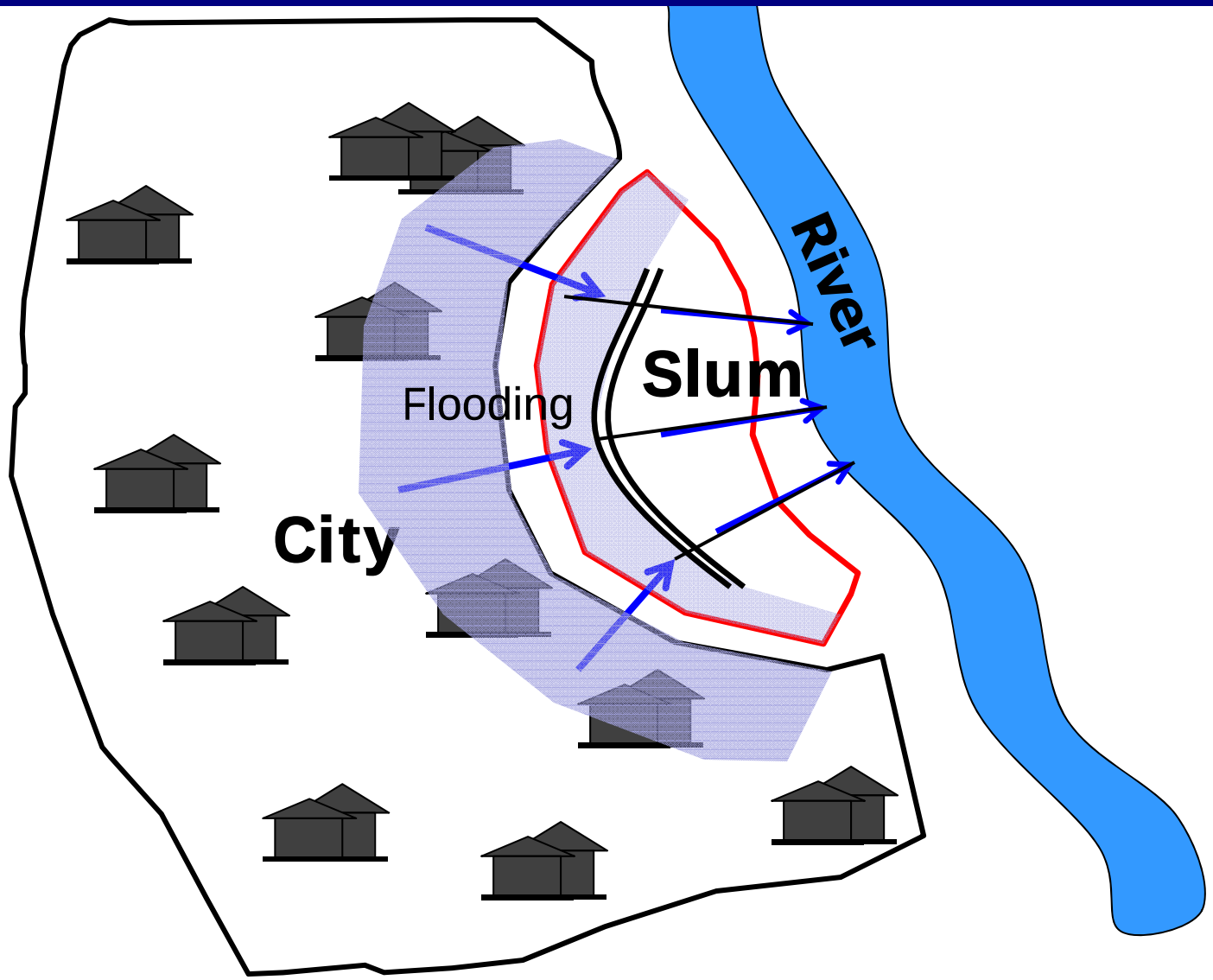
Cost for provision of drainage and sanitation for Kibera

- EAC US$ 1.0M

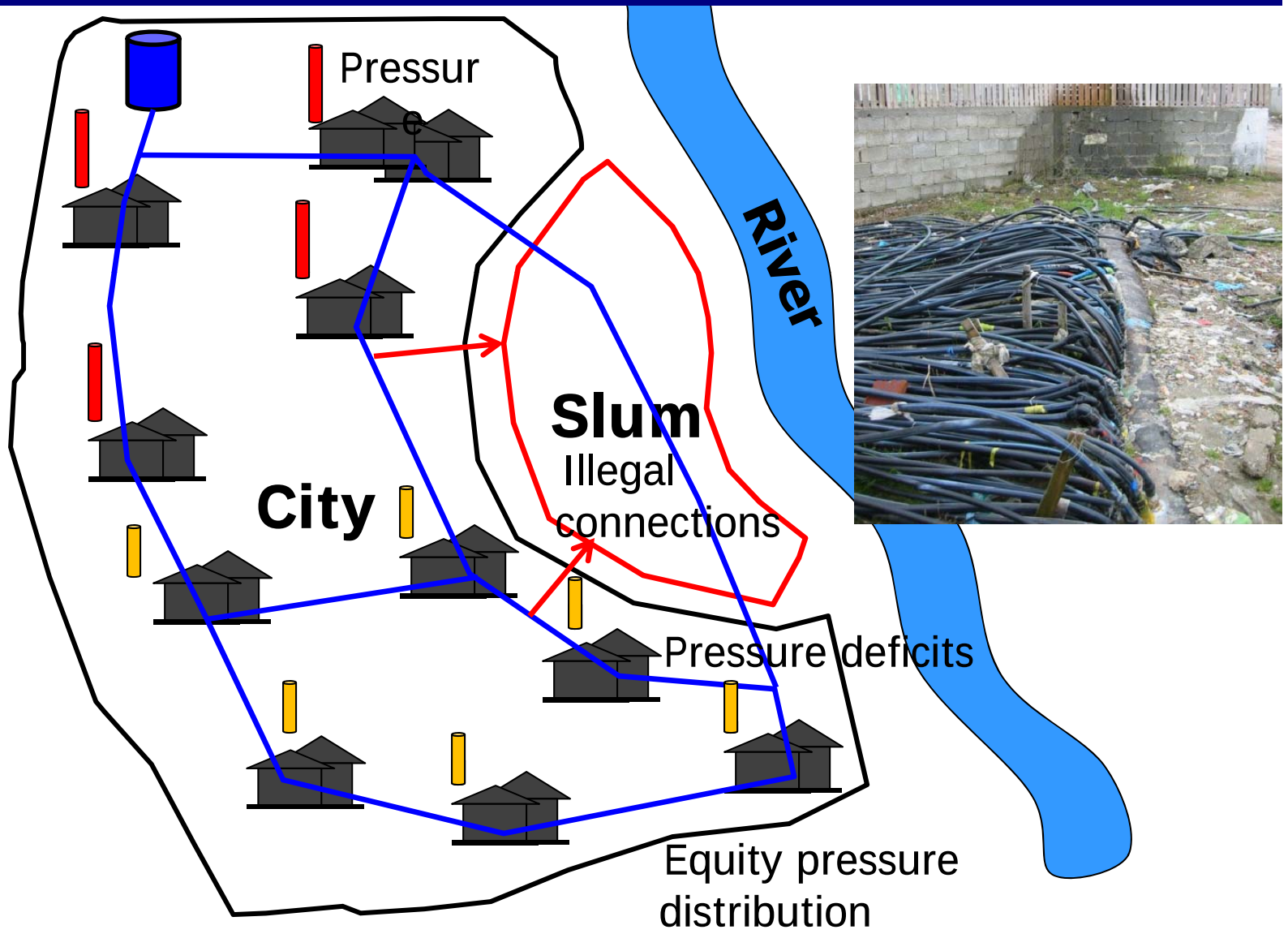
Potential water resources after slum improvement

- Yield 17,300m3/d
- Cost of water (0.16 $/m3)
- More than US$ 800,000 revenue per year

Slum networking can provide improved flood protection to city



Slum networking can provide improved water services to all

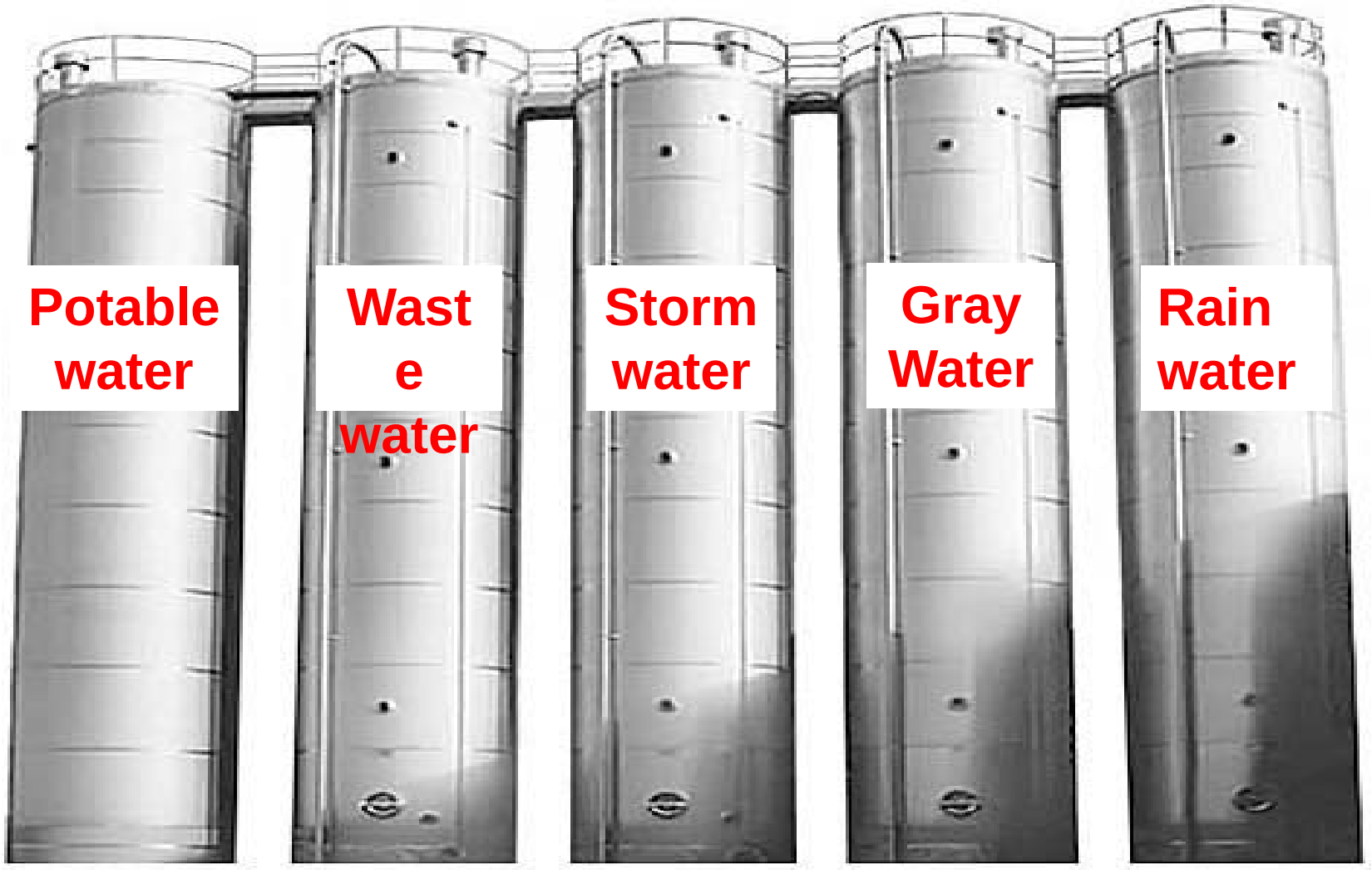


Take home message

Manage water supply, wastewater & stormwater together (one urban water cycle)……. and think creatively about what could be your water sources (and don't focus on the obvious ones).

(educate future urban leaders on the integrated perspective of the urban water cycle and contextualize each component of the water system within this perspective)

We need to build connections between silos



G, I

The water sector can't do it alone

Land planners
Architects
Developers

Gov't officials
Financiers
Energy experts

Think about Harvesting

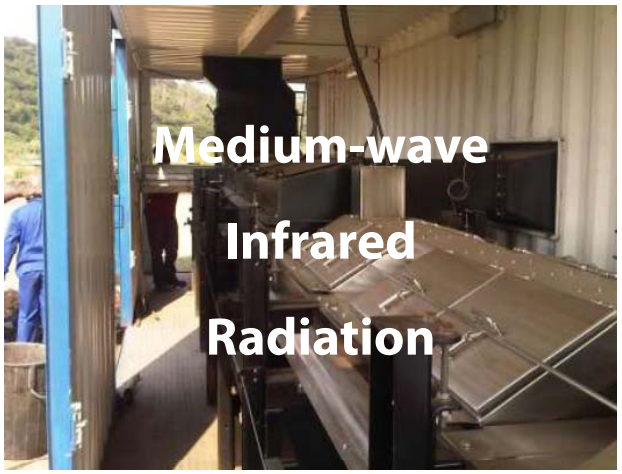
Integrated Treatment

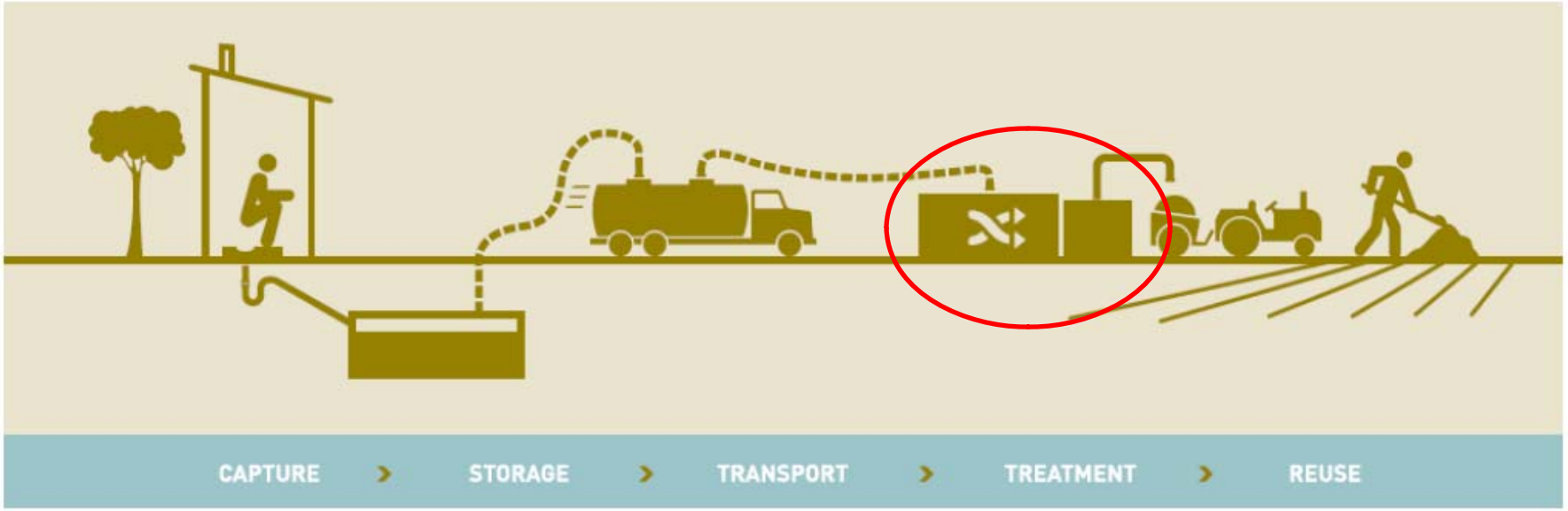
Entrepreneurs see the harvesting potential, India

Collection, transport, treatment and reuse-system (GTZ,2009)

Entrepreneurs see the harvesting potential, Durban

Fecal sludge into safe fertilizer: LaDePa machine





We’re harvesting for Agriculture: China

Under the 11th five-year plan, 400 million m^3 treated wastewater available for agriculture in Beijing in 2010

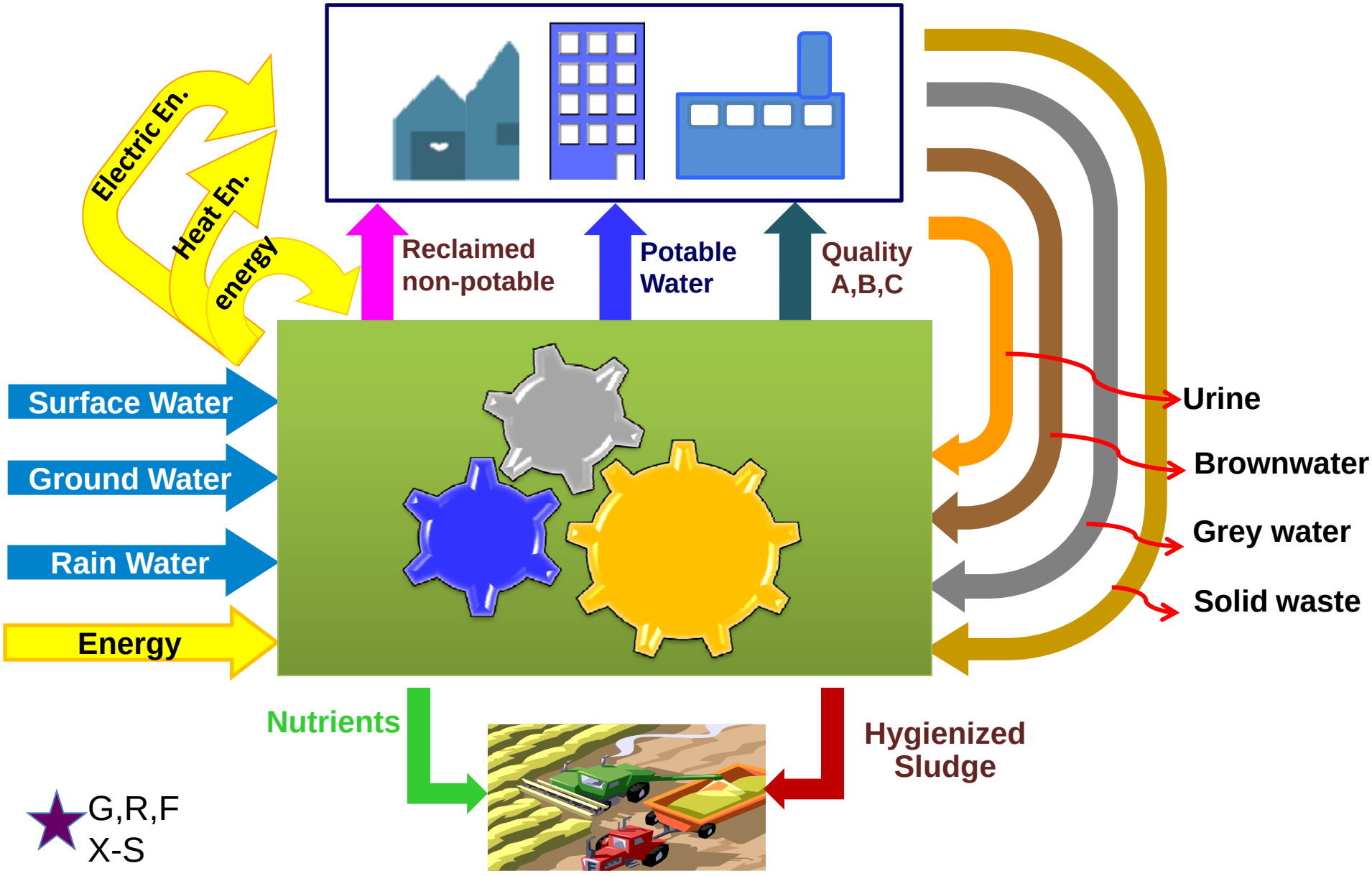
Harvesting heat from sewers

Heat exchanger in sewers

Heat is reclaimed from treated sewage water of the adjacent sewage treatment plant

Dalian-Xinghai (China) : Environment-friendly heating and cooling

Think about a Water Machine



Water Machine – 'designer waters'

Tertiary: **Irrigation**

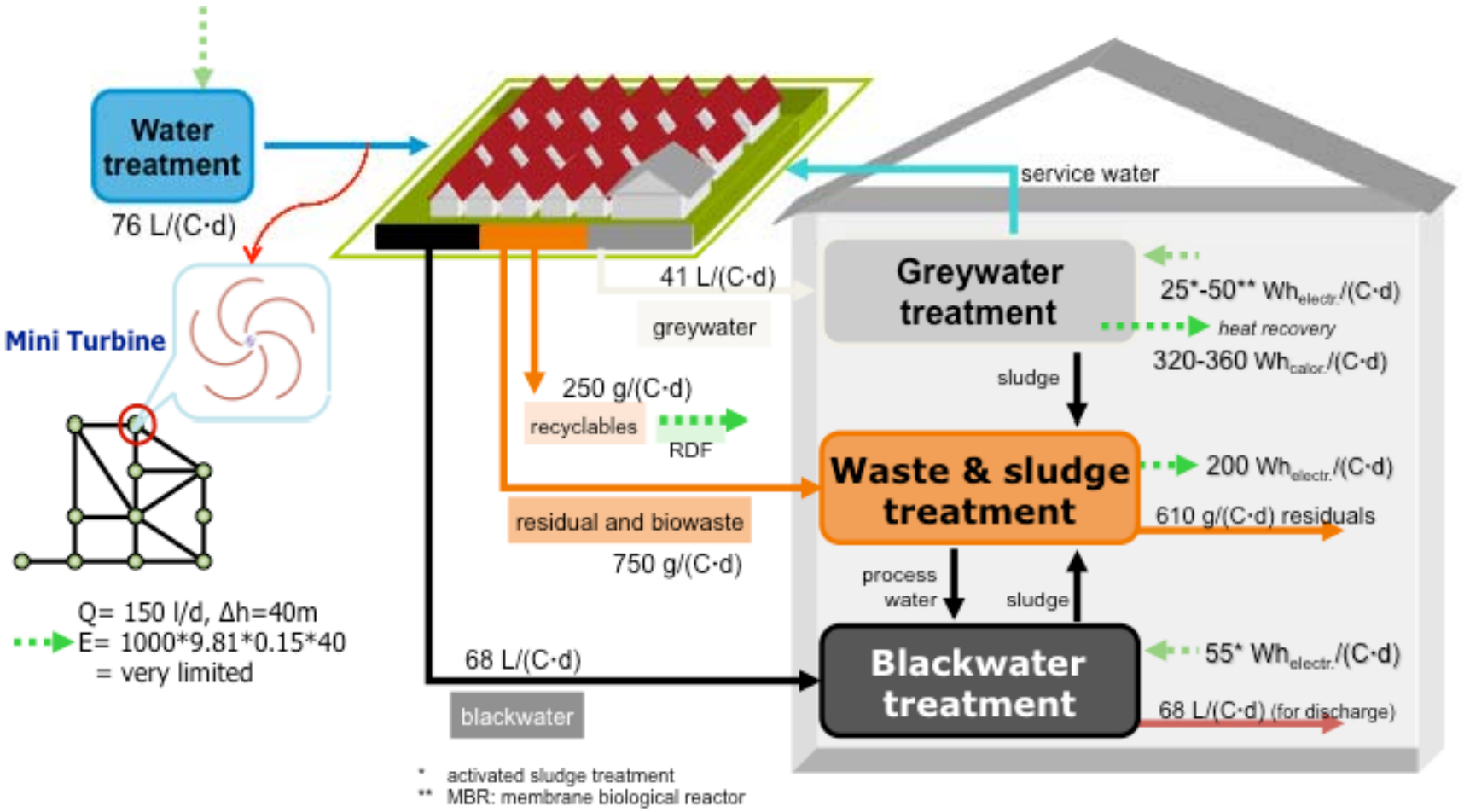
Nitrified: **Cooling**

RO (Single): **Refinery**

2nd+RO+MF: **AAR**

RO(Double): **Refinery**

Water Machine: Semi - Centralized



International Water Association

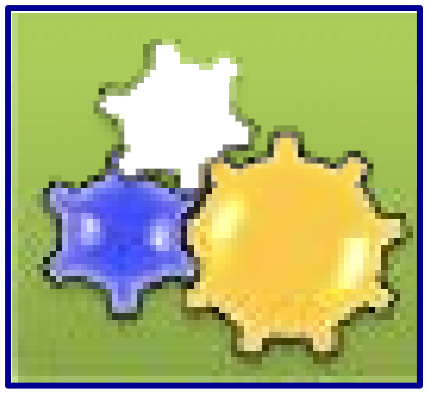
TU Darmstadt | Institute IWAR | Cornel et al.

Xing Dao – water machine proposal

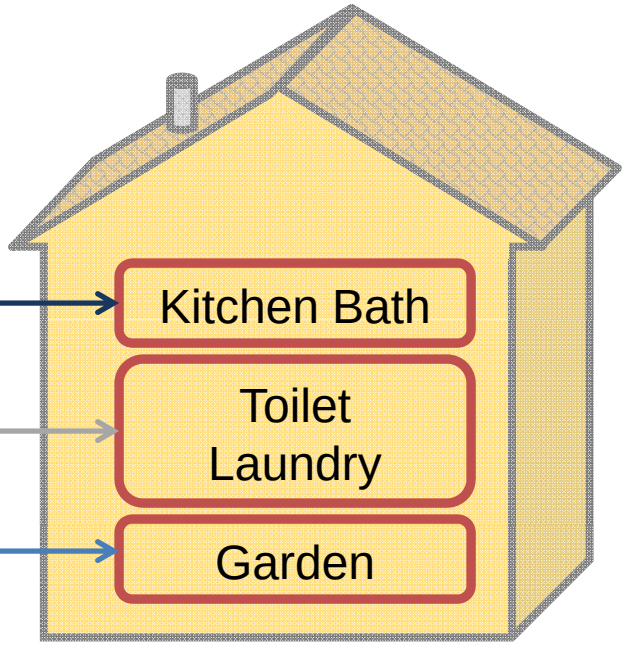
TU Darmstadt | Institute IWAR | Cornel et al.

But how will water machines be plumbed?

Challenge: Deliver Water Quality Fit for Purpose

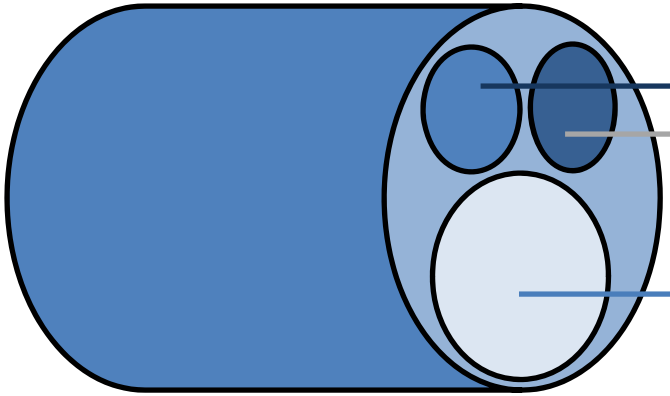


Water Machine



Water Users

Pipe Bundles for Different Water Qualities



Service water for toilet & laundry

Service water for garden

Potable water

Take home message

Driver for water management should be beneficiation –maximize value added
(institutions & regulations to support and not hinder)

‘All water is good water: fit for purpose’

(educate future urban leaders on all benefits of water – public health, aesthetics, economic development, drive green economy)

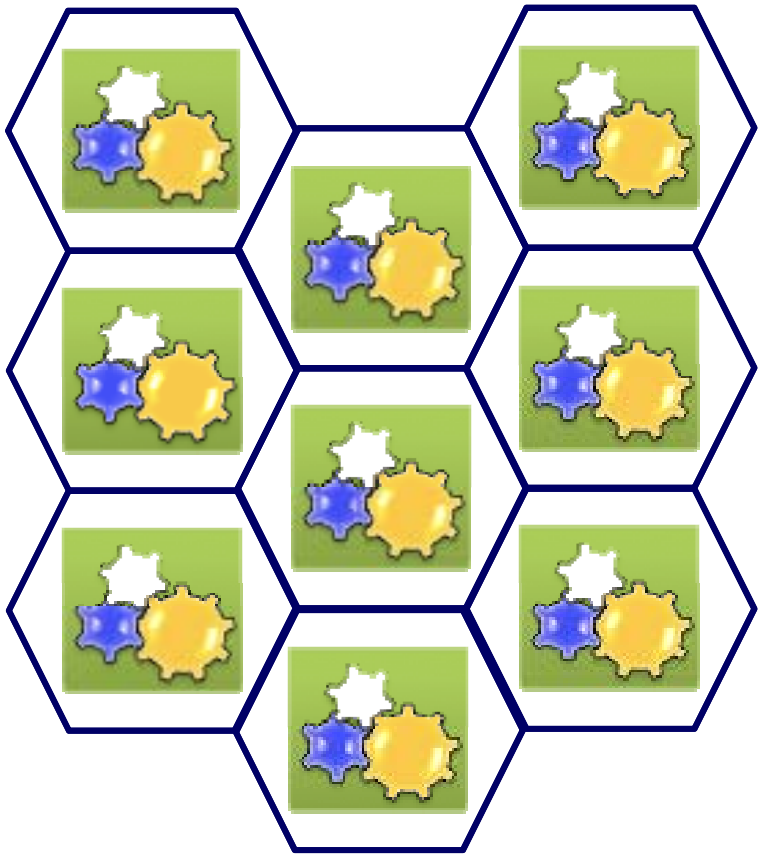
Clustered Approach to UWM

In order to implement the principles a clustered approach to water management is helpful.

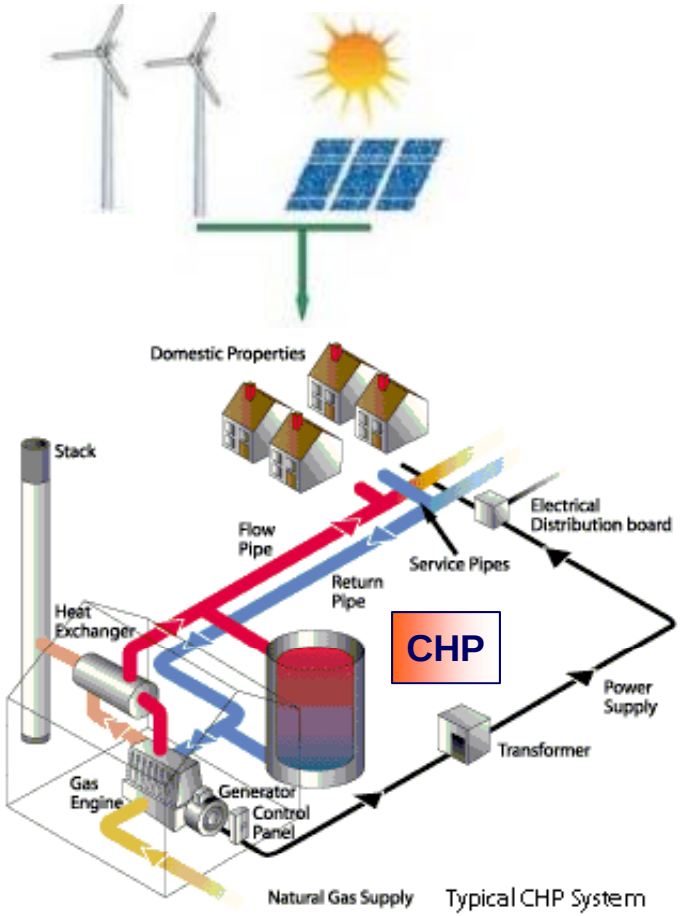
Clusters allow maximum efficiency while giving adaptive capacity

A supply and treatment unit (water machine) for each district

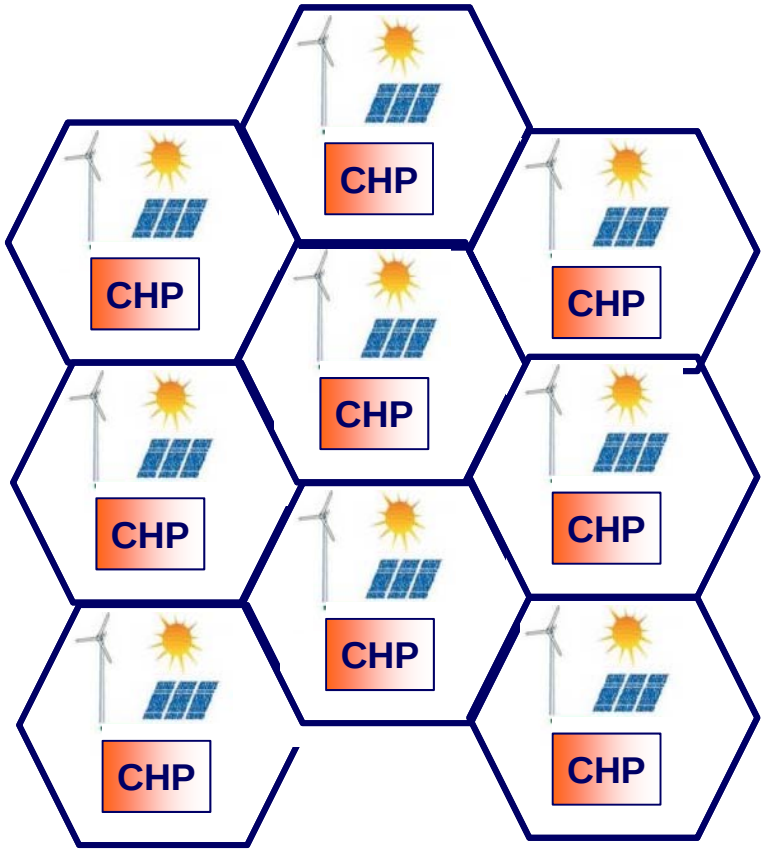
- Semi central supply and treatment unit as part of clustered city structure
- Use scalability of treatment technology (membranes)
- Customized supply and treatment for each cluster
- Utilizing synergy effects and re-use potentials



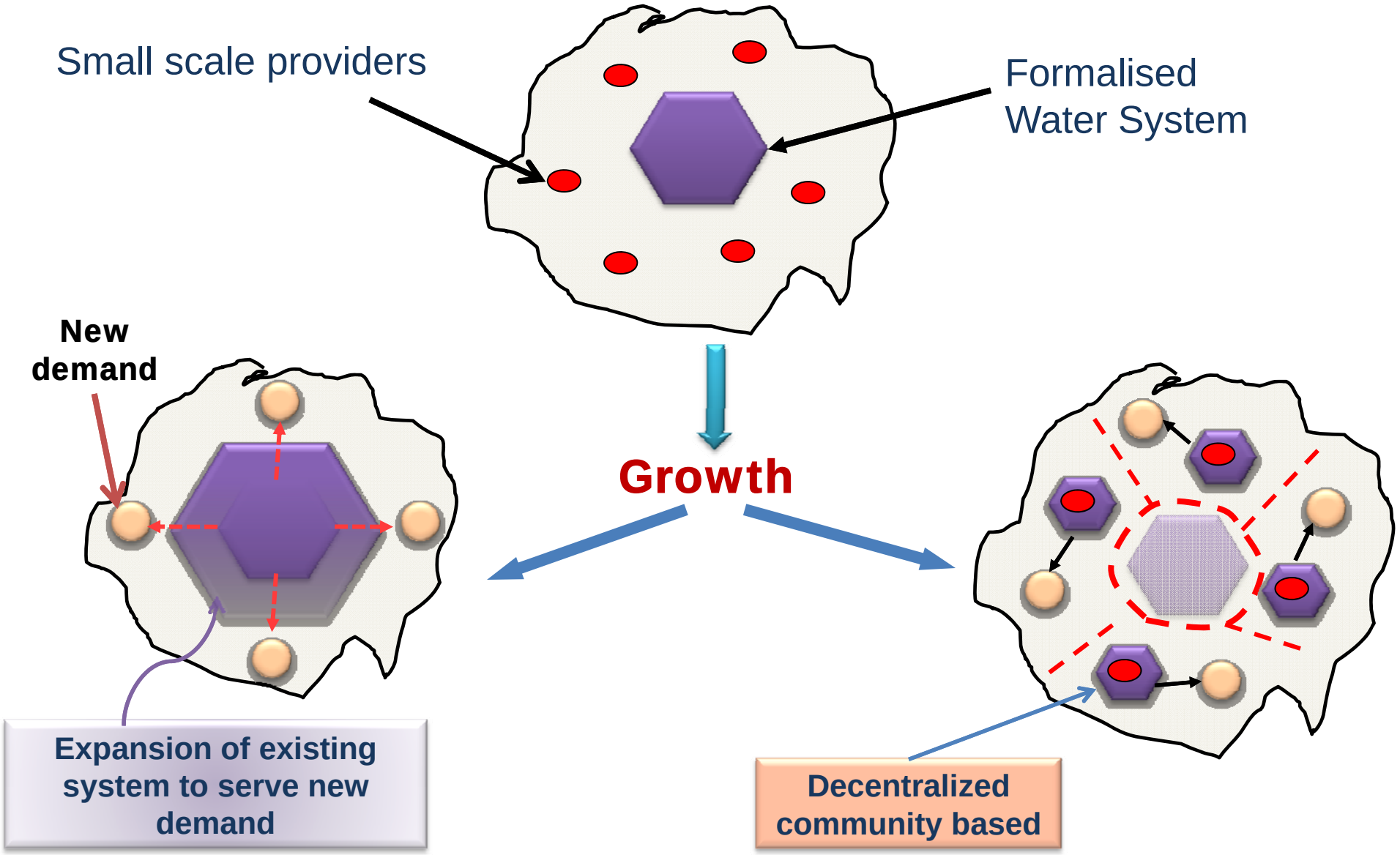
Energy sector is already thinking in these lines



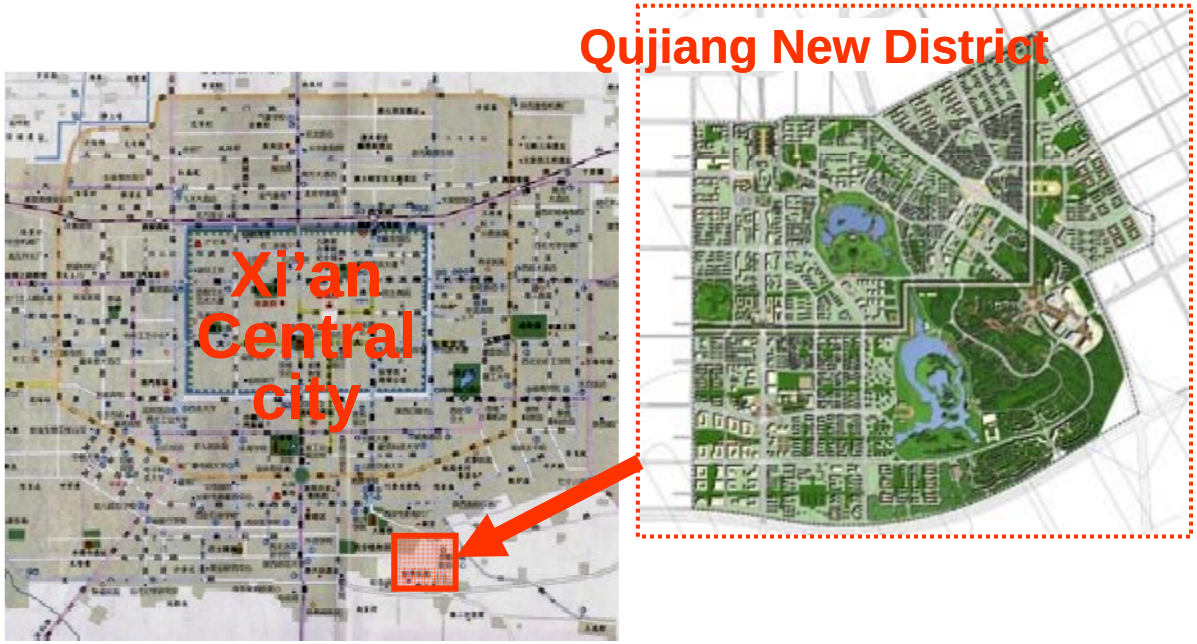
Typical CHP System

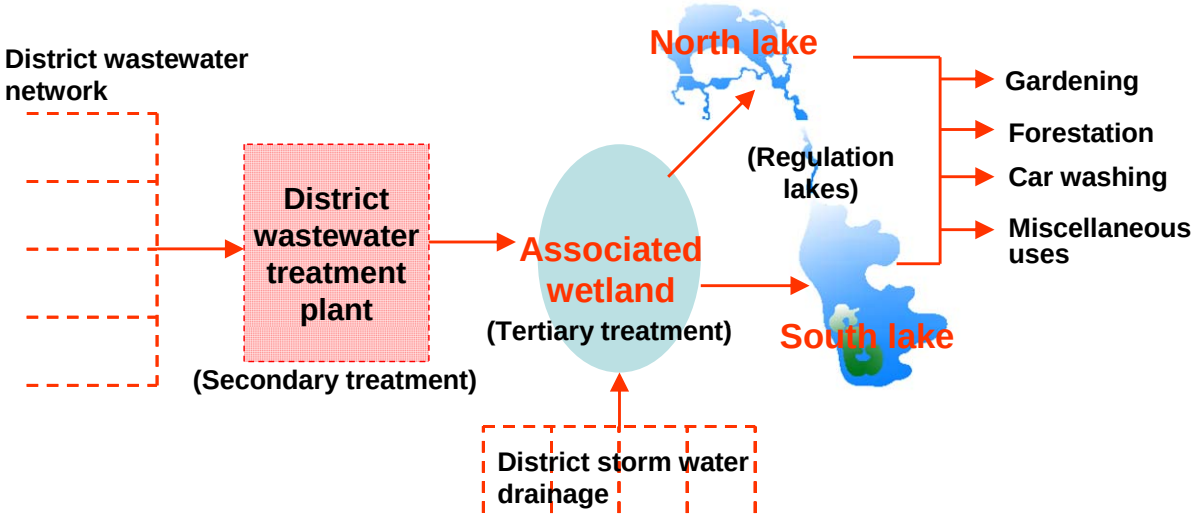


Look for opportunities to create new paradigms (not extended old ones)



Xi'an – newly developed district as independent water system





International Water Association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BUKEDEA
KAPCHORWA
BUKWA
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SSEMBABULE
BUNDA
KIRUHURA
LYANTONDE
MASAKA
MUKONO
BUGIRI
BUSHENYI
MBARARA
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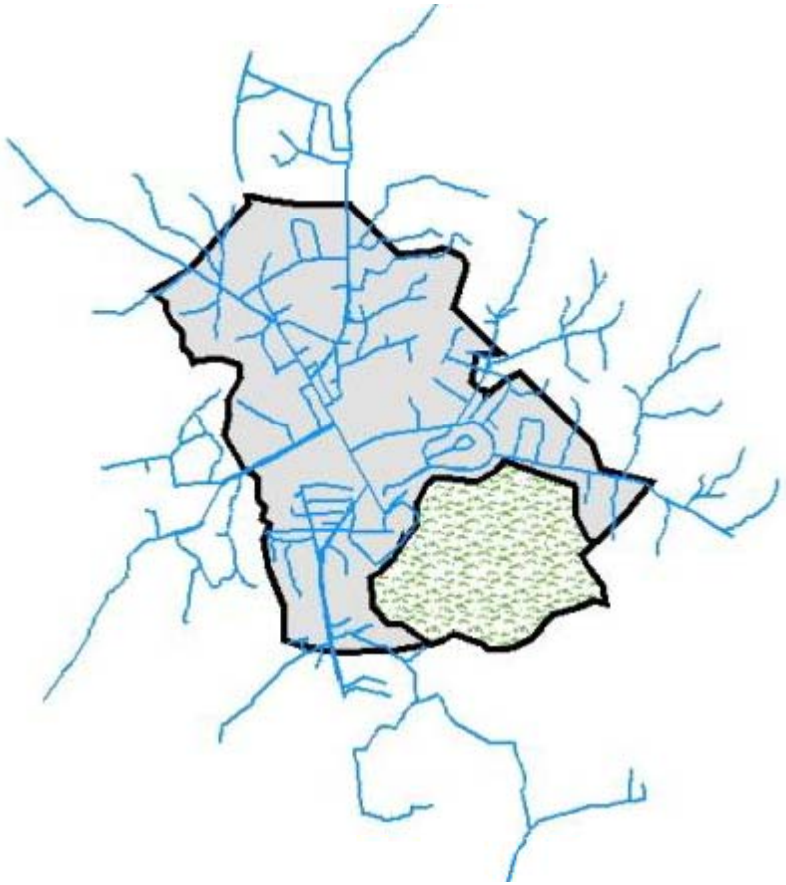
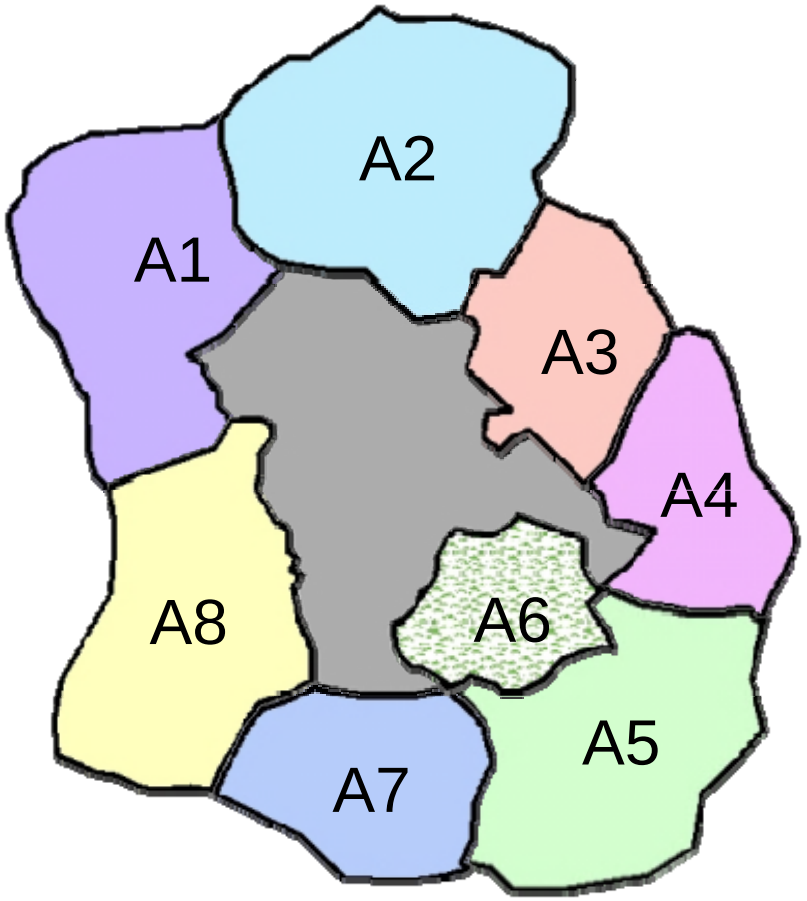
RAKAI
ISINGIRO
NTUNGAMO
KISORO
KABALE

Central infrastructure core expanding



Let’s ring fence the old paradigm



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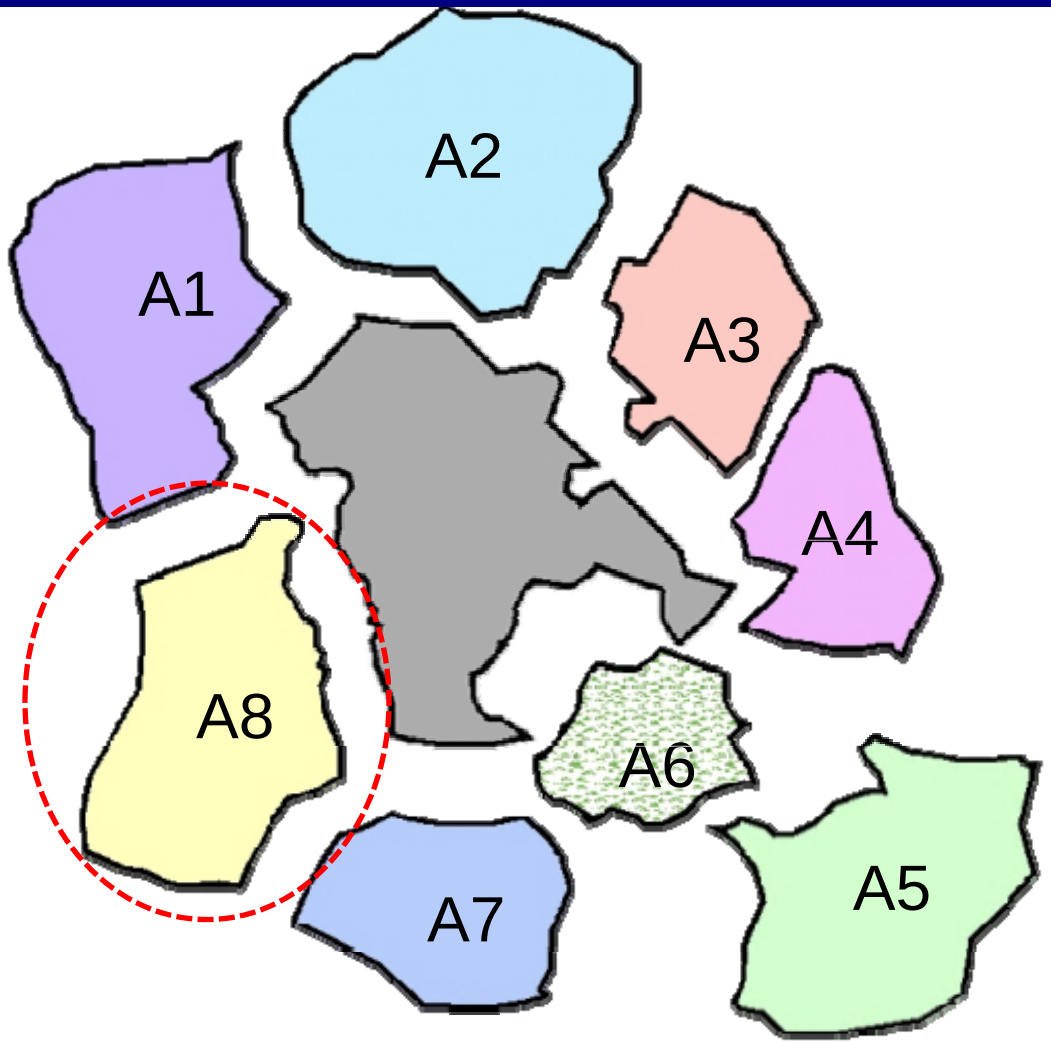
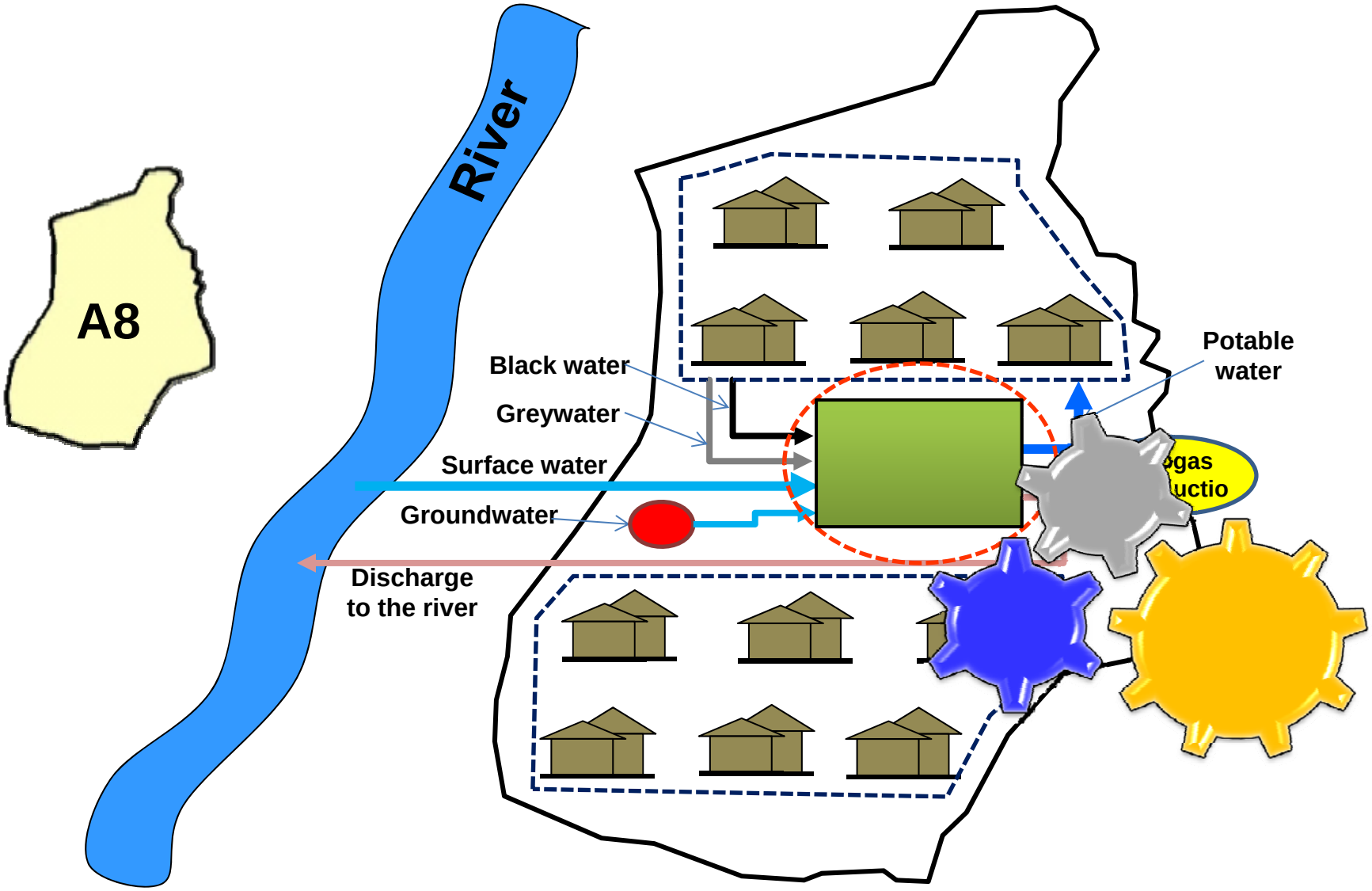
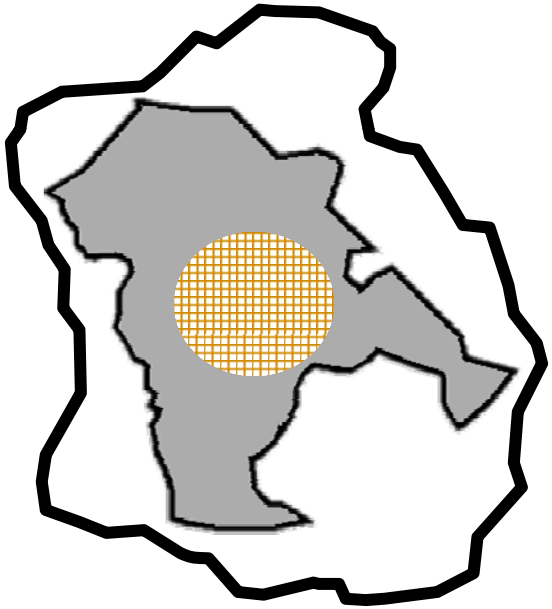


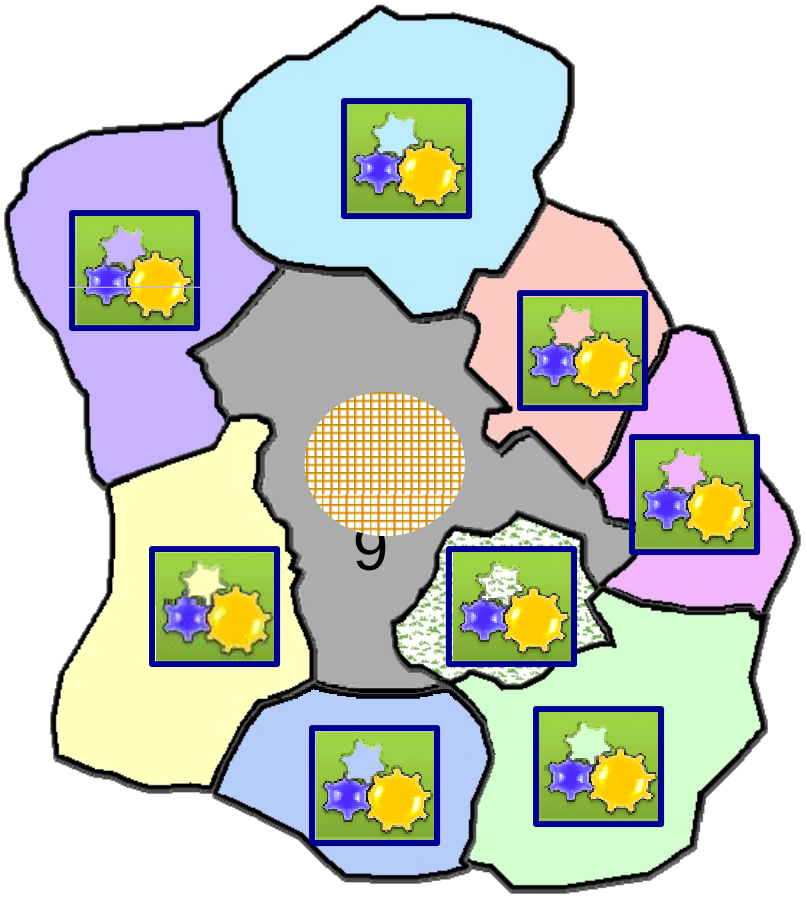
Tailor made solutions for cluster



Semi-Centralized is cheaper?



Average Annual Costs
5,148,000 US$



Average Annual Costs
3,787,000 US$

Take home message

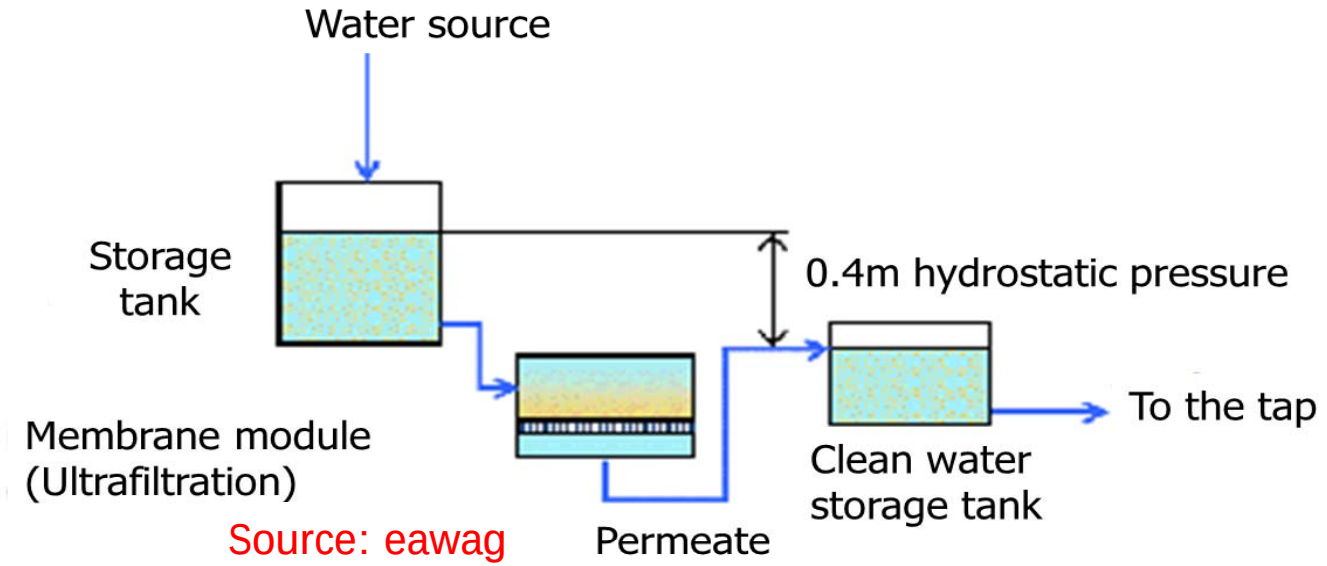
Manage water supply, wastewater & stormwater together (one urban water cycle)……. and think creatively about what could be your water sources (and don't focus on the obvious ones).

(educate future urban leaders on the integrated perspective of the urban water cycle and contextualize each component of the water system within this perspective)

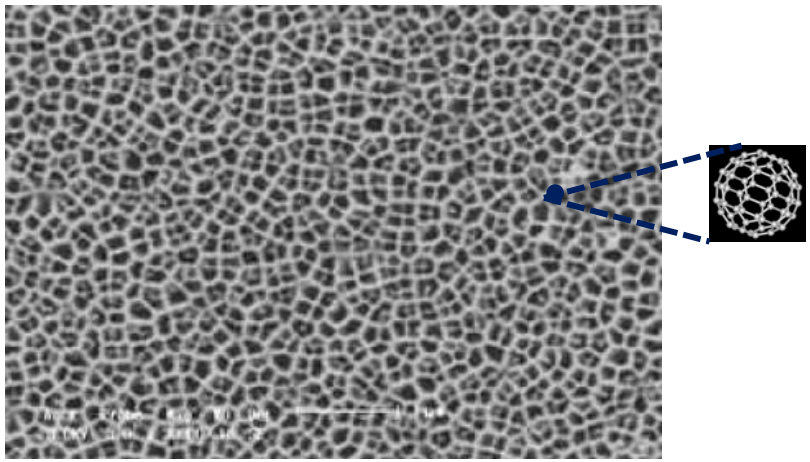
Smart Thinking

Smart Water, Smart Networks, Smart by Design

New low pressure / super strong membranes make them attractive to developing countries

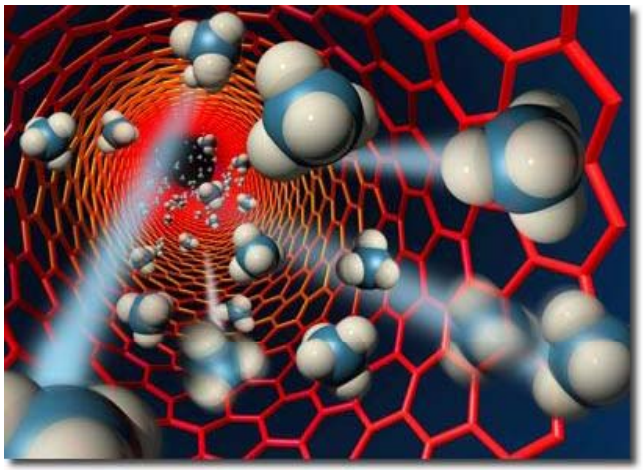


Source: eawag



Buckyball treated membranes

Richard Merritt (2009)



Super smooth carbon nano-tubes

Scalability of membranes makes them very attractive across a continuum of options

Point-of-Use

Networks of the future will have lives of their own

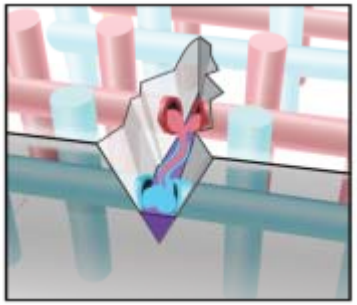
Smart Pipes

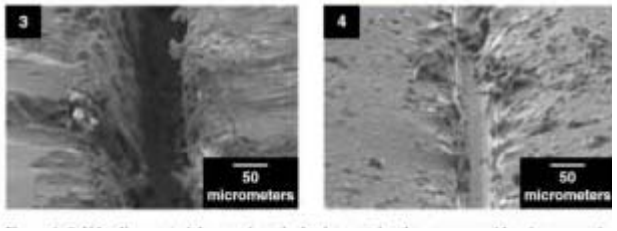
- Nano scale sensors embedded into pipes during manufacturing.
- Sensors monitor data on hydraulic, material, and environmental
- Sensors provide geo-referenced data points

Metje et al. 2011

Self Healing

- Various strategies: ***capsule, vascular, intrinsic***
- Pipes store healing agents and polymerizers that solidify when mixed
- Healing efficiencies 100%
- Recovery strength >100%





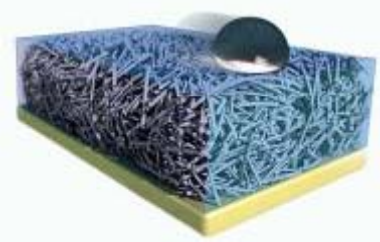
Corrosion formation

Corrosion Repair

White et al. 2011

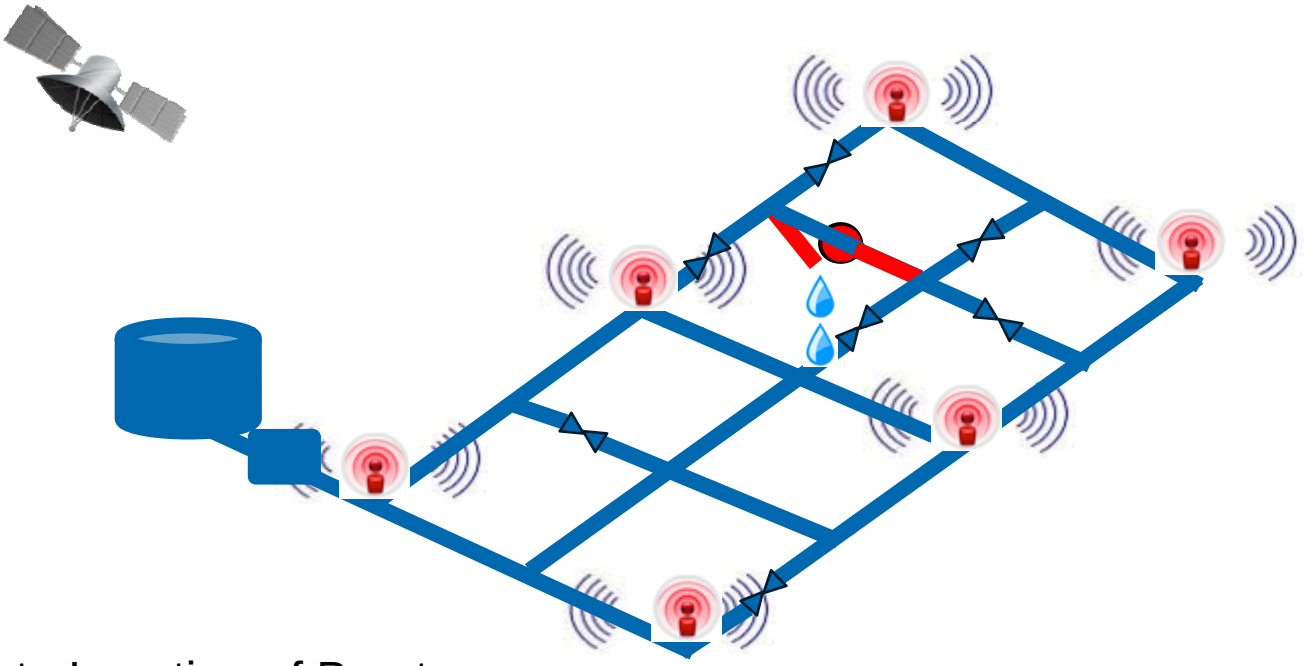
Frictionless

- Slippery Liquid-Infused Porous Surfaces (SLIPS)
- Super-thin Nano-substrates infused with a liquid lubricant creates a smooth surface
- Reduced biofilm formation by 96-99%

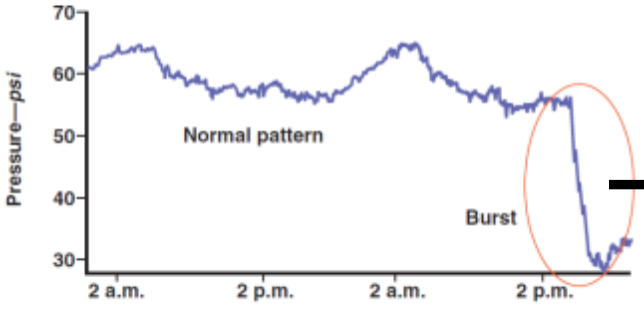


Epstein et al. 2012

‘Smart’ helps manage pipe-bursts more effectively



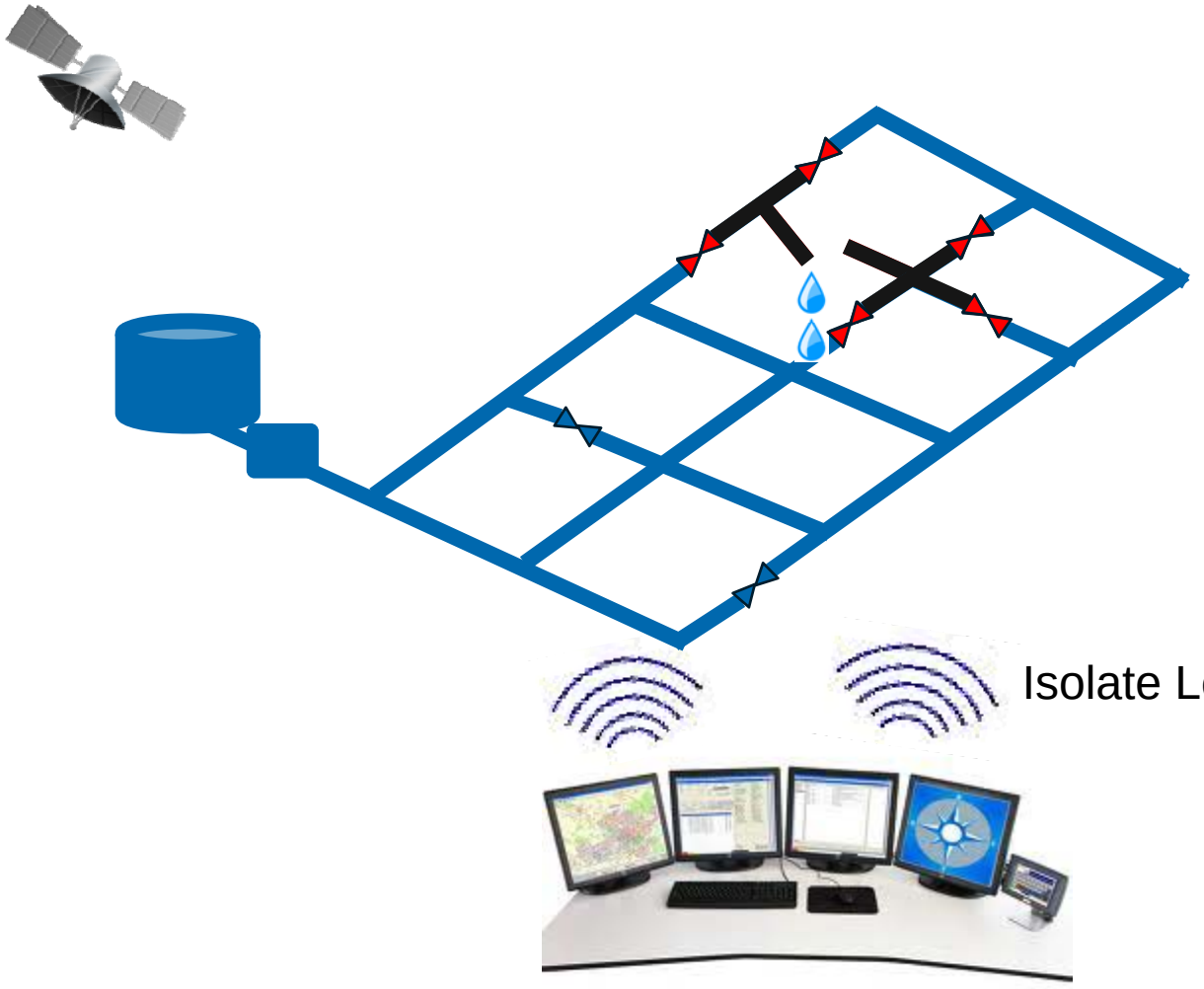
Calculate Location of Burst



Optimal Valve Isolation

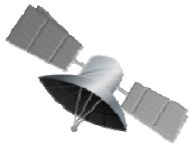
Allen et al. 2011

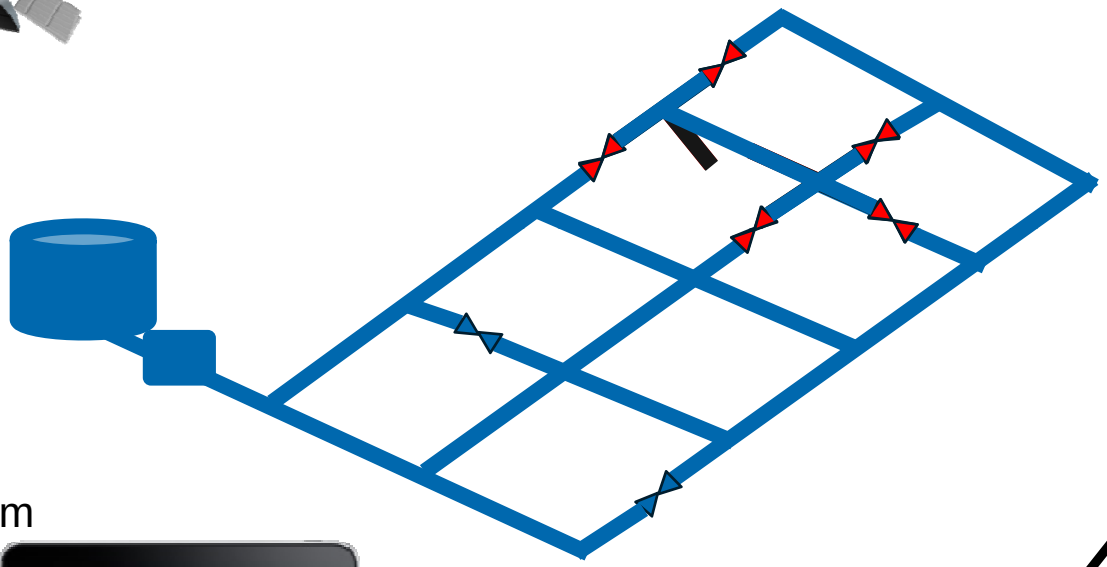
‘Smart’ helps manage pipe-bursts more effectively



Allen et al. 2011

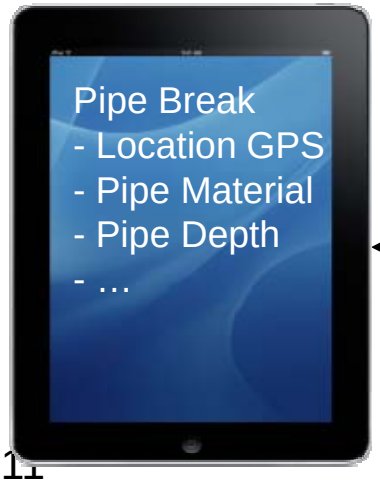
‘Smart’ helps manage pipe-bursts more effectively





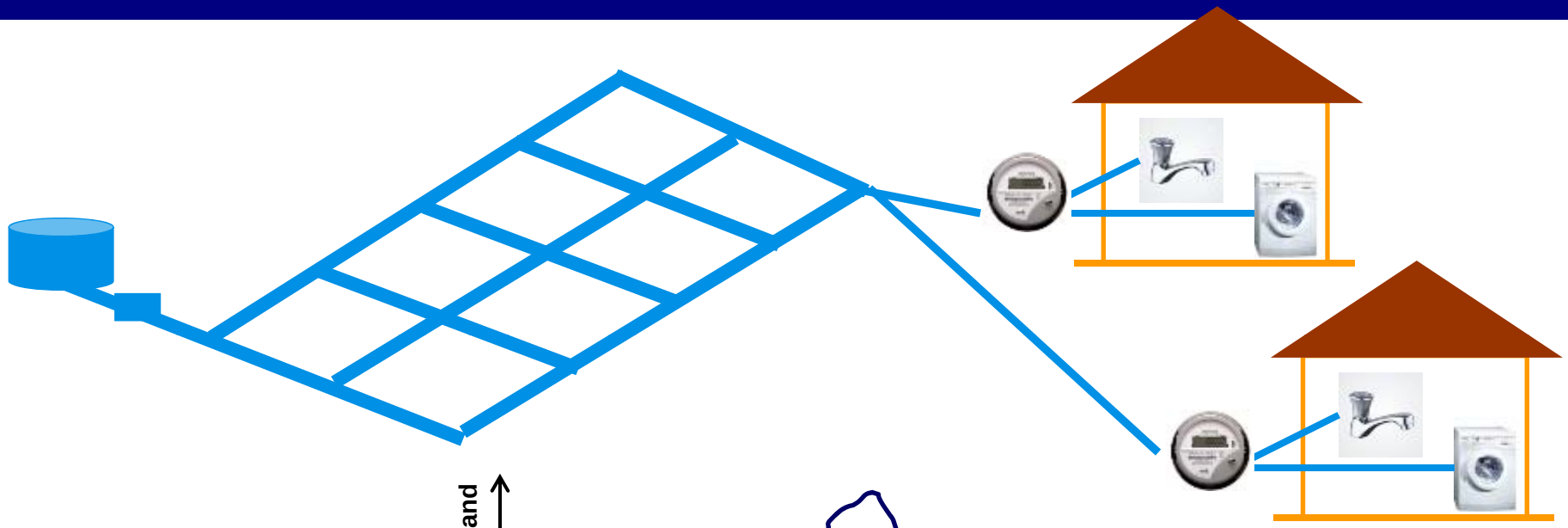
Alert Customer

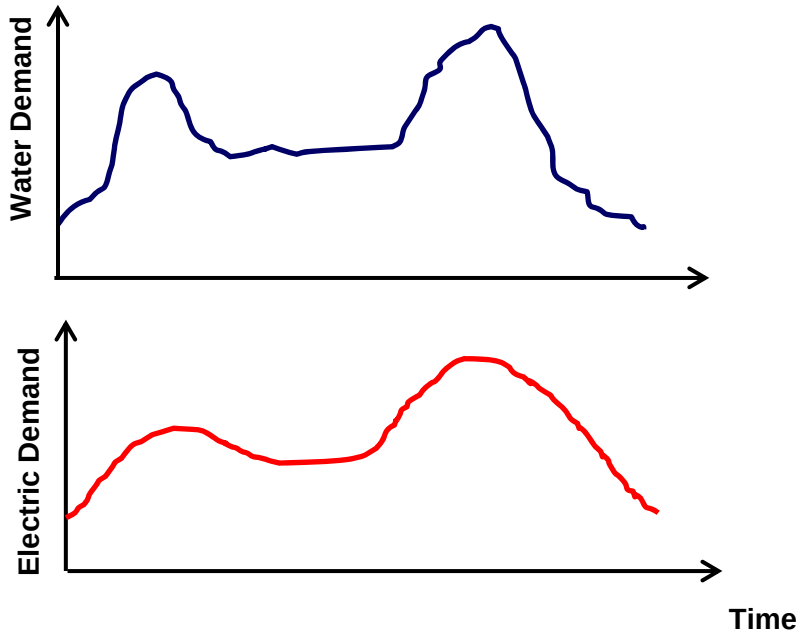
Repair Team



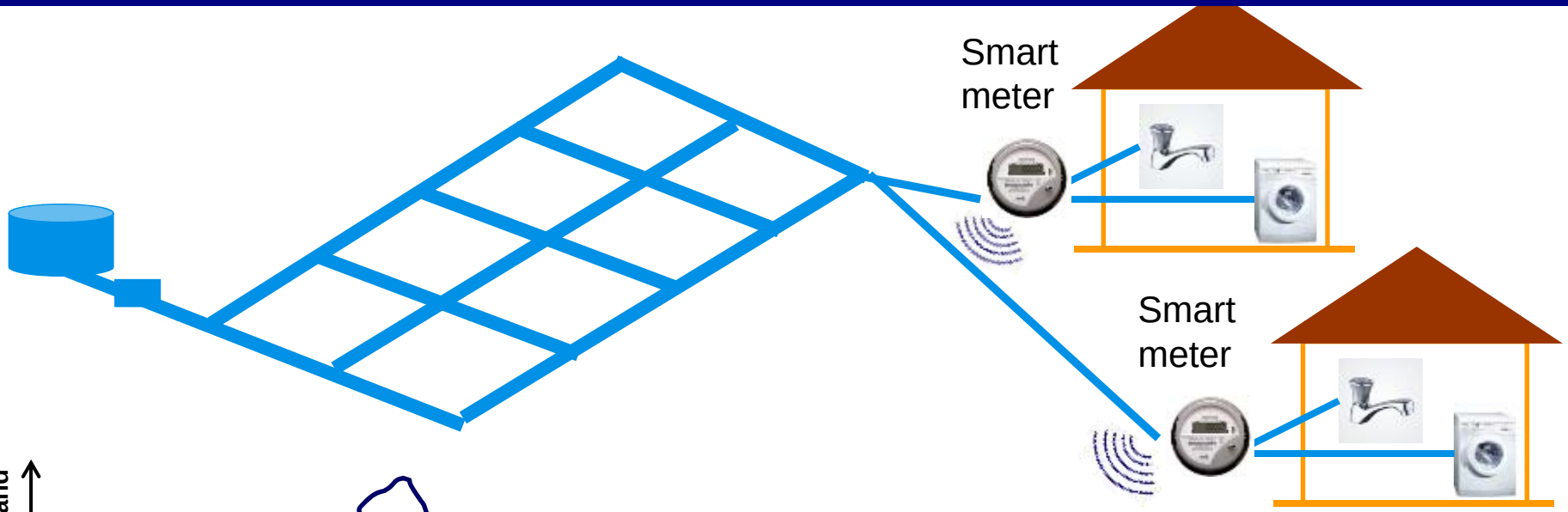
Allen et al. 2011

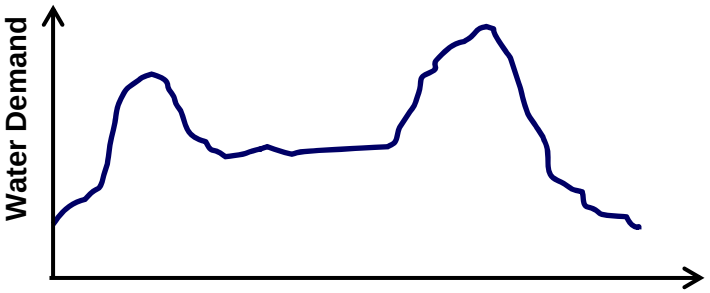
‘Smart’ allows appliances to negotiate with the water market

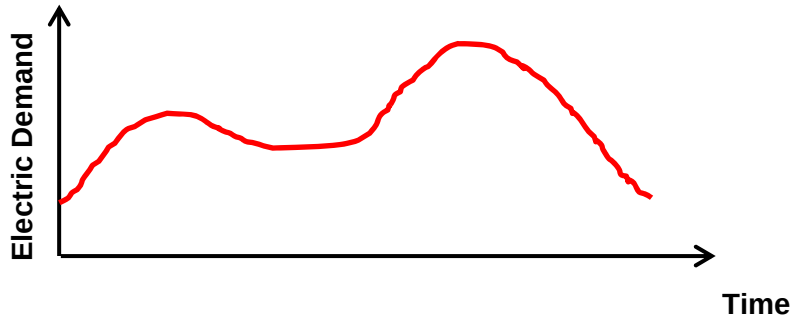




‘Smart’ allows appliances to negotiate with the water market

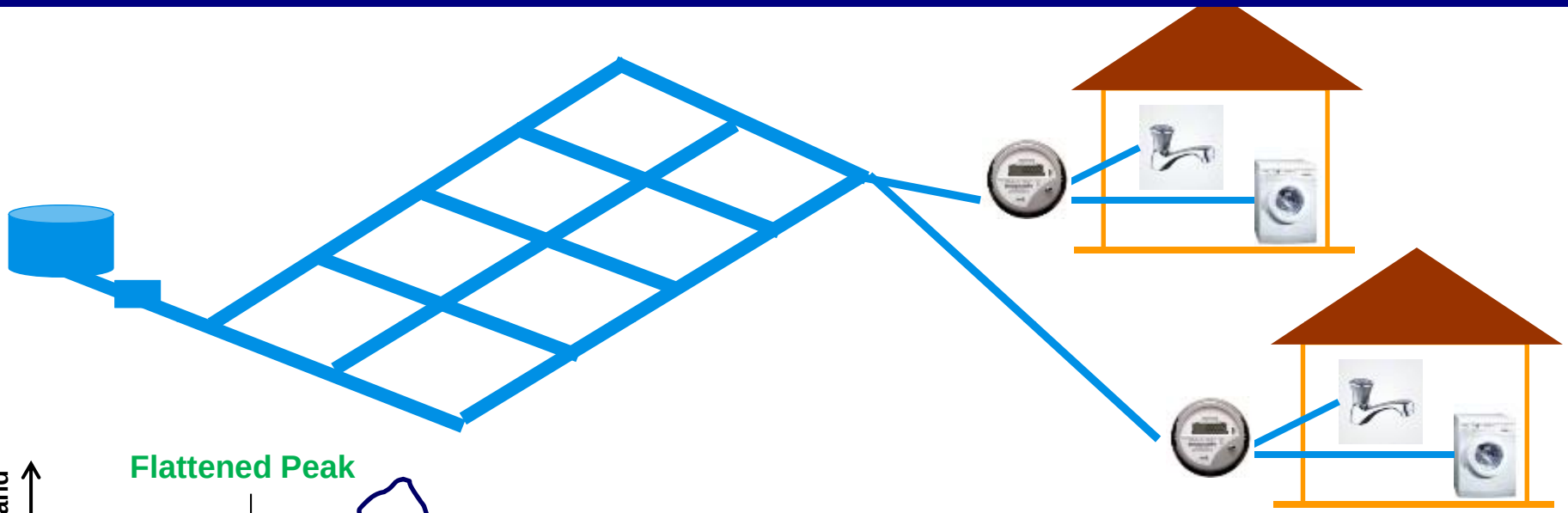


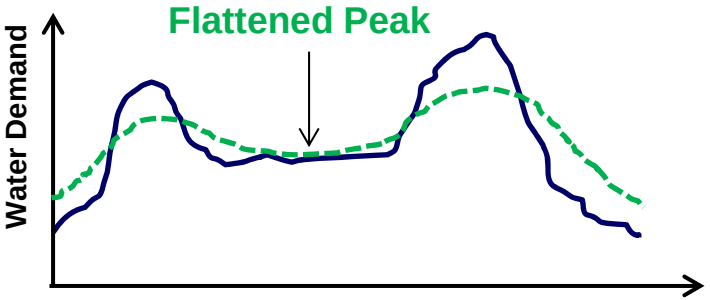


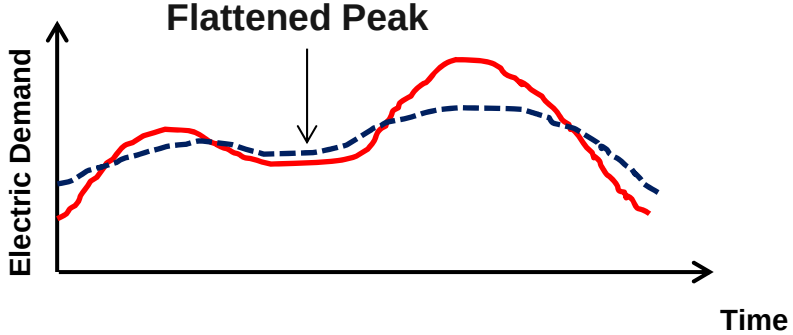


Central Control
Unit

‘Smart’ allows appliances to negotiate with the water market



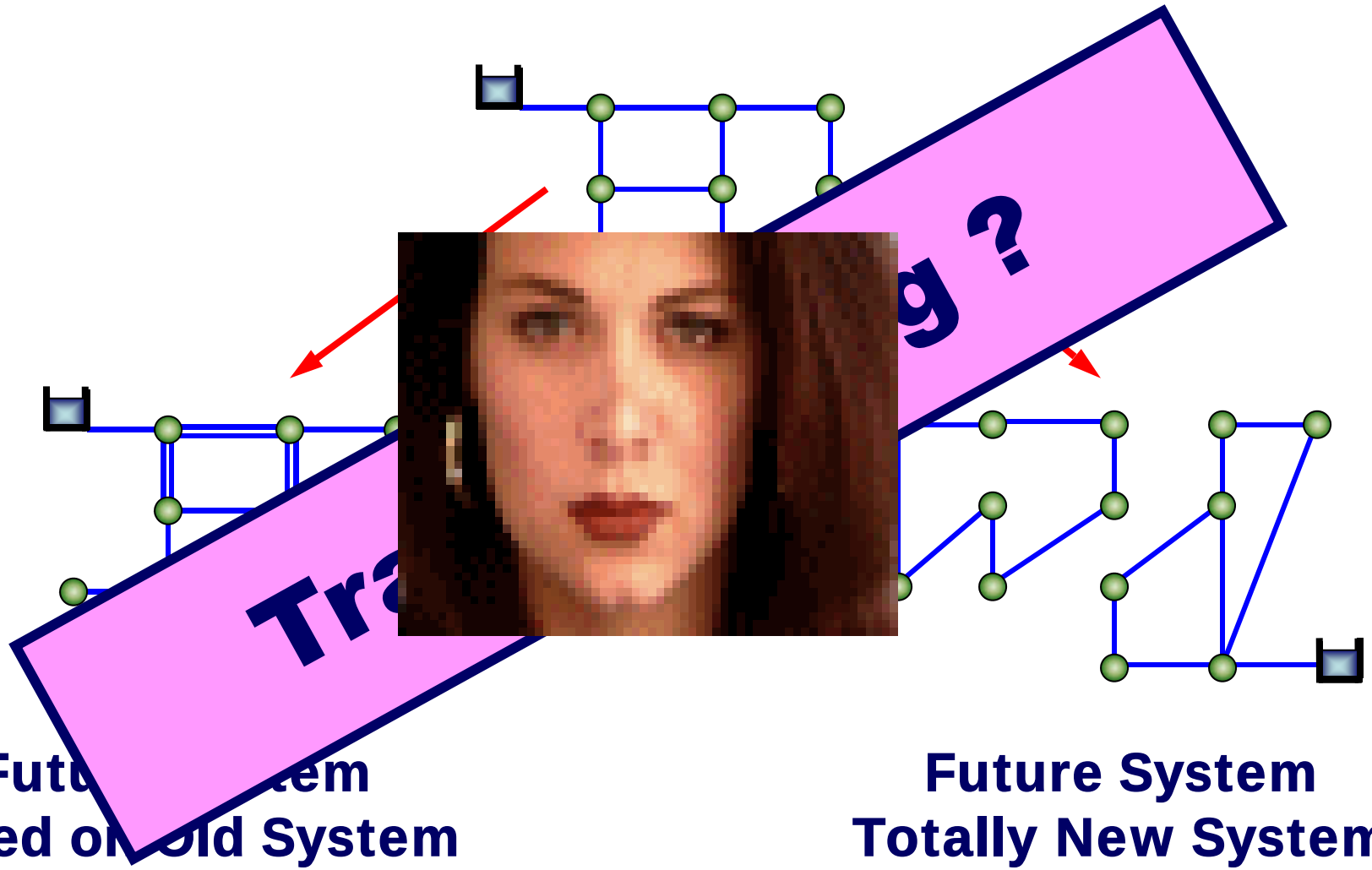




Central Control Unit

Transitioning

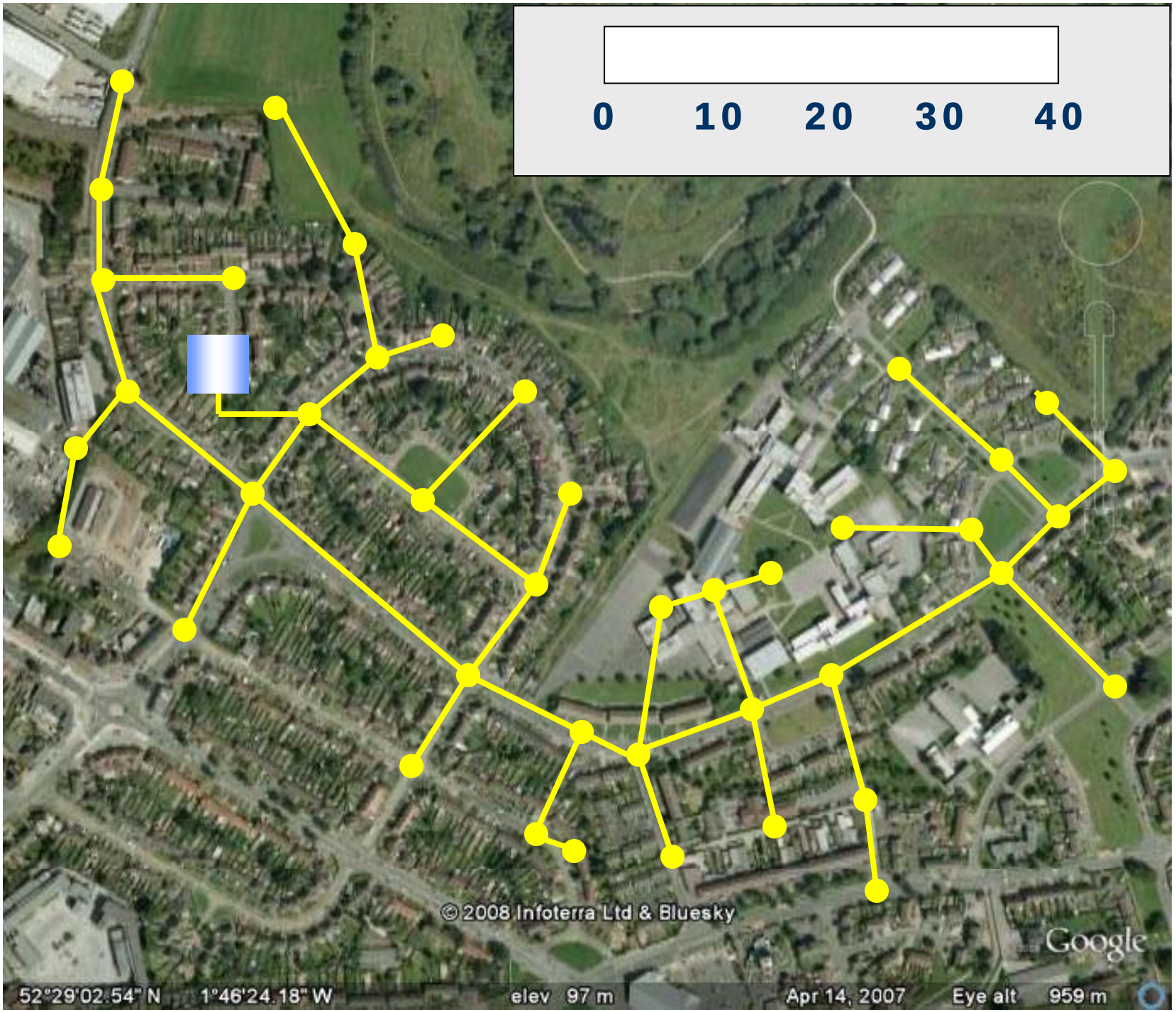
Transitioning



Future System
Based on Old System

Future System
Totally New System

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


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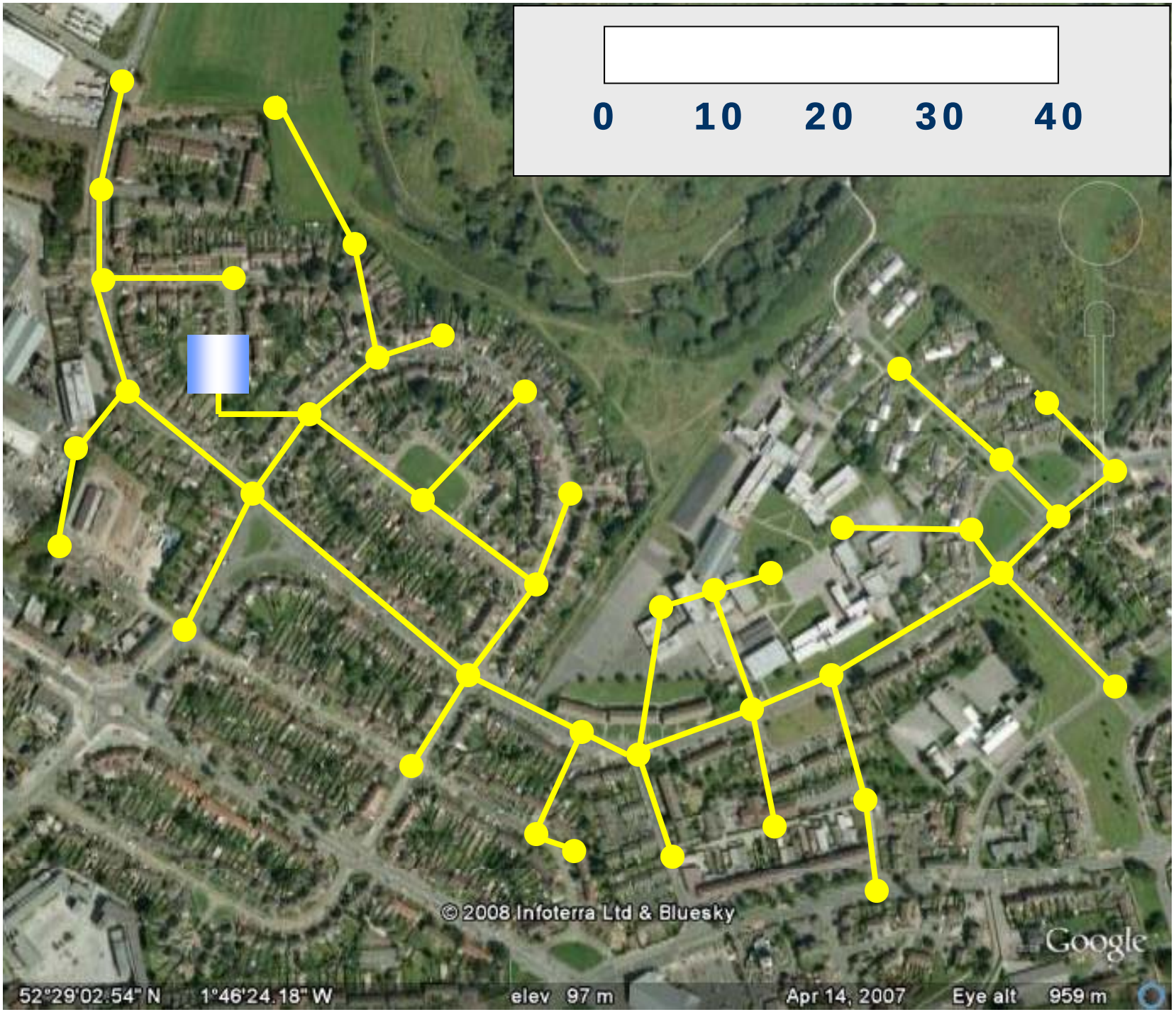
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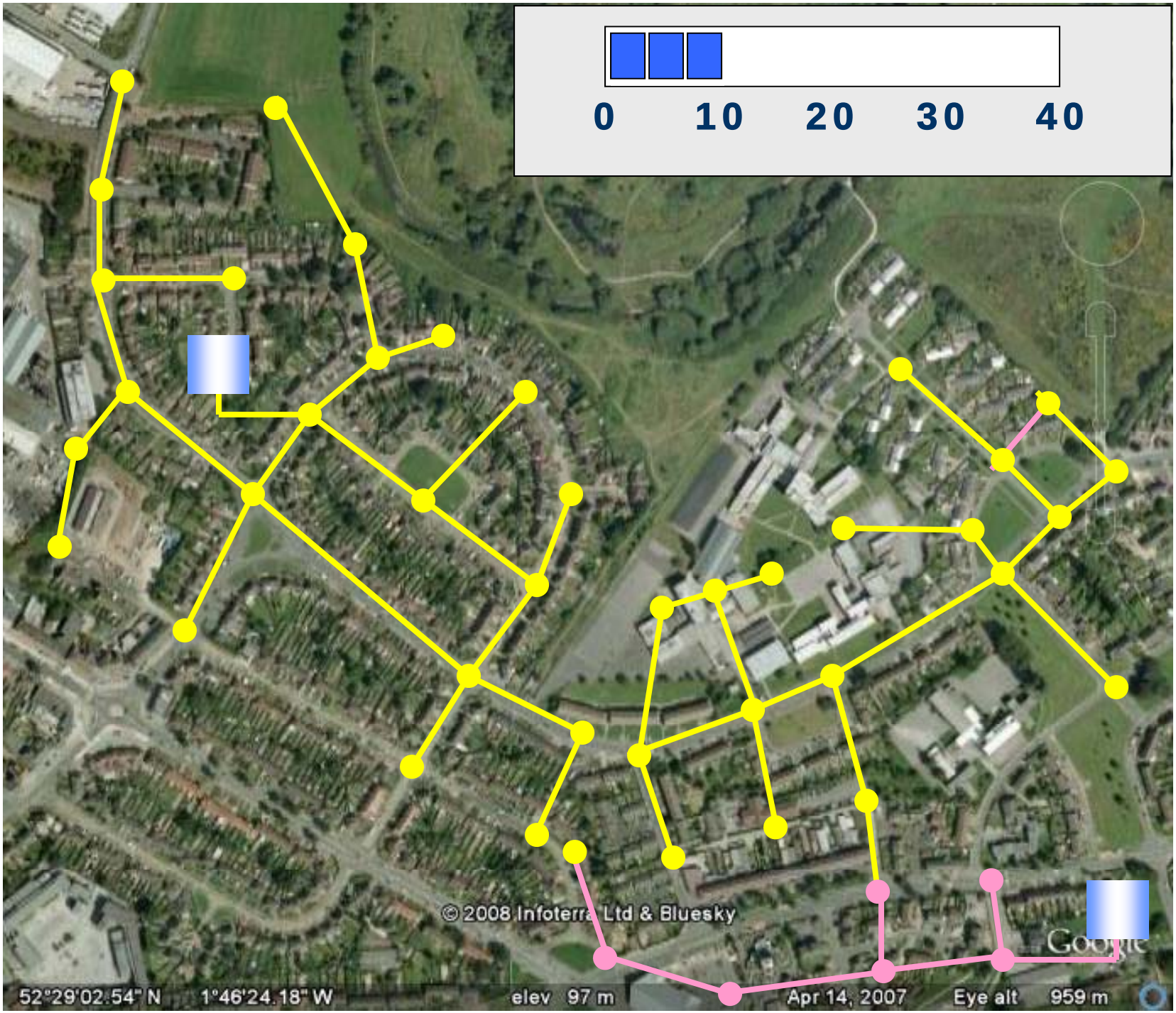
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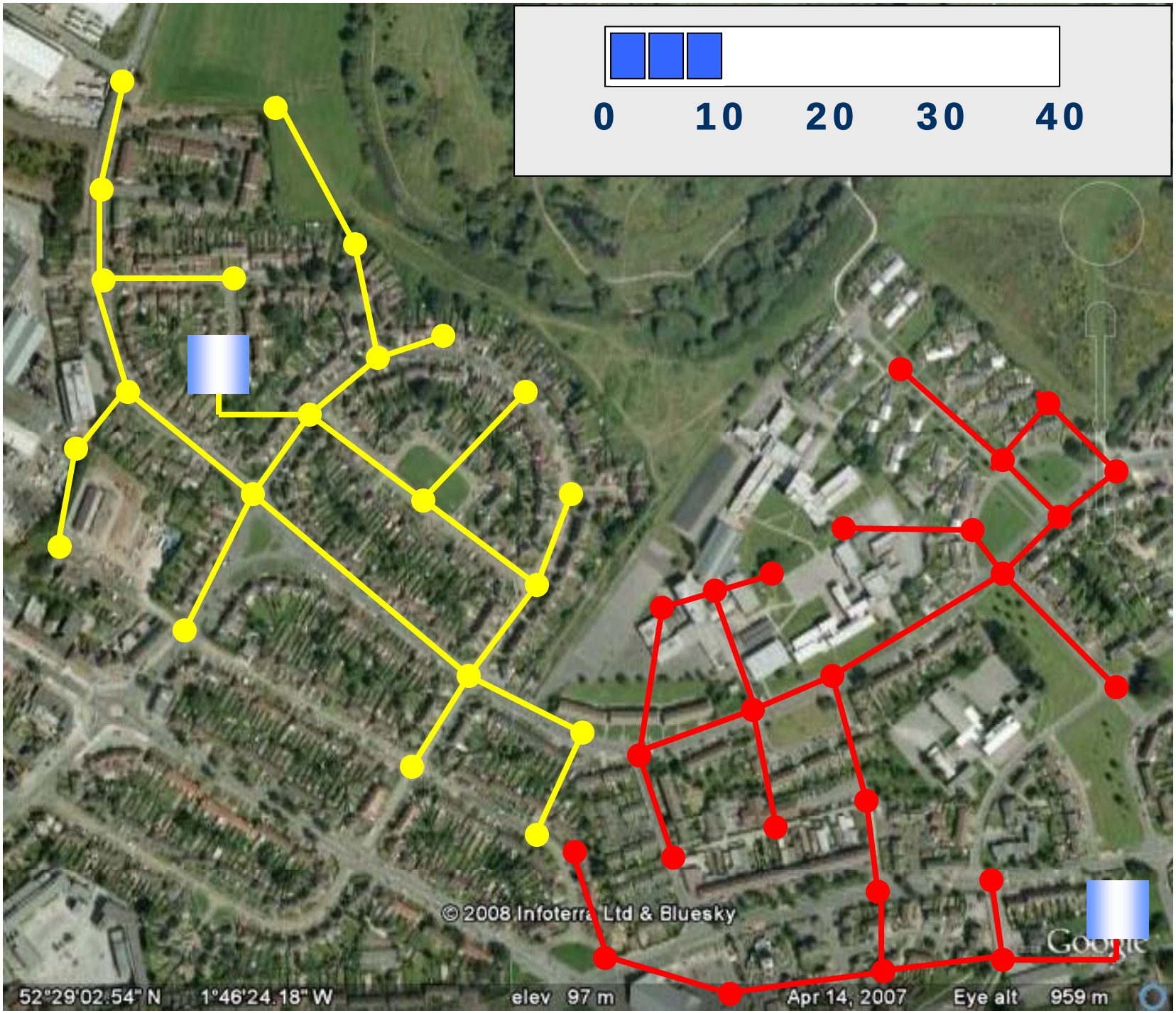
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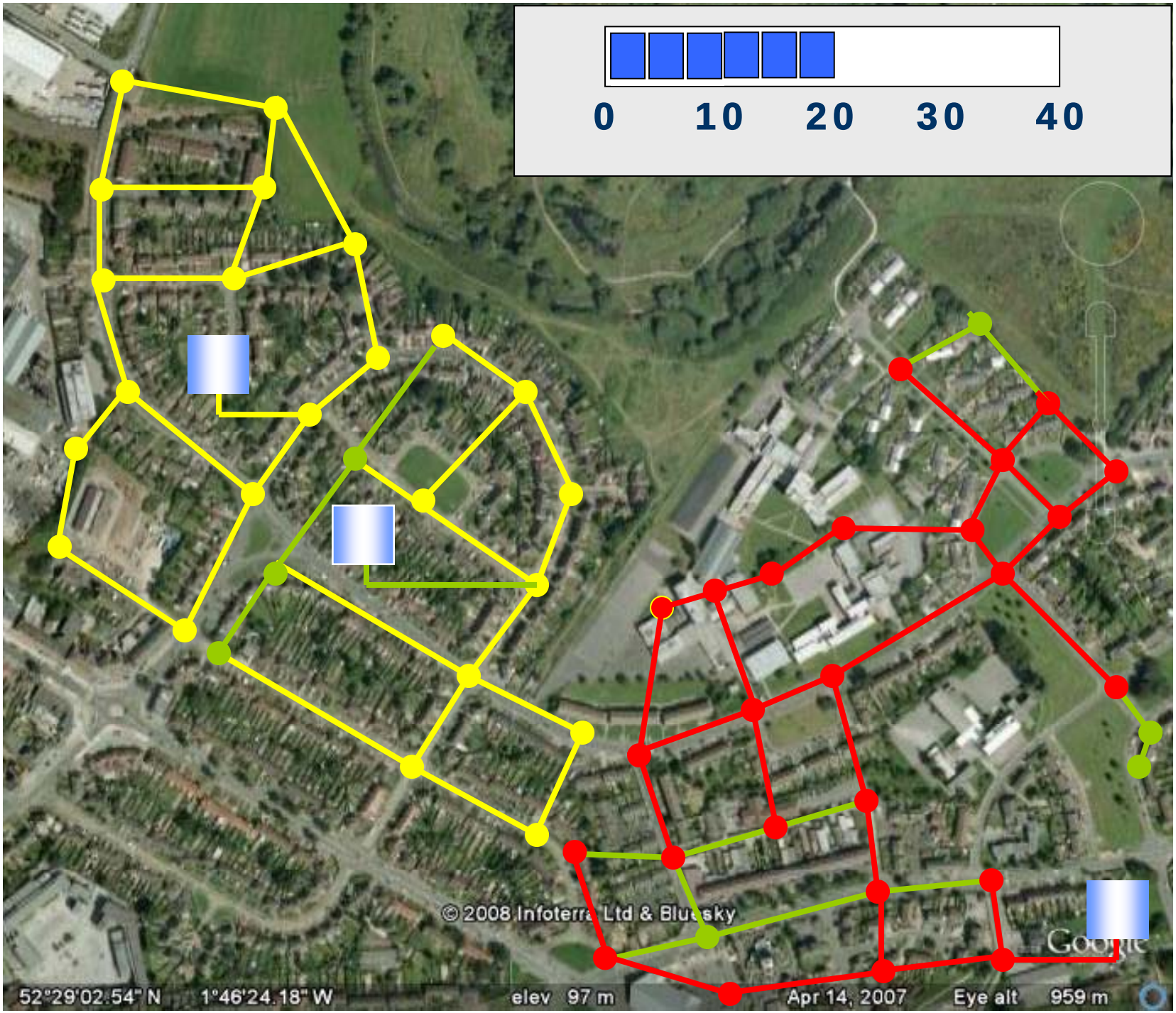
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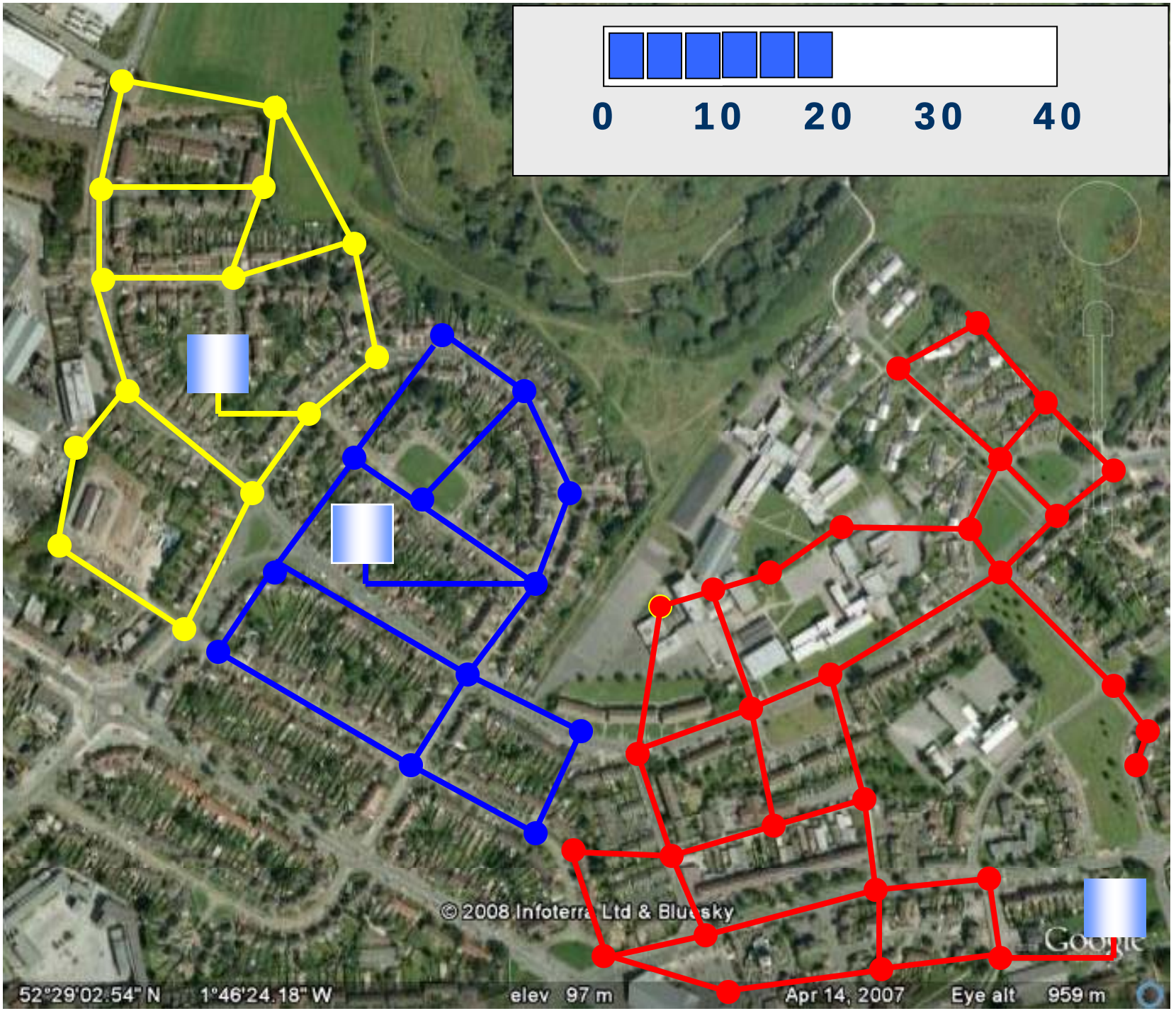
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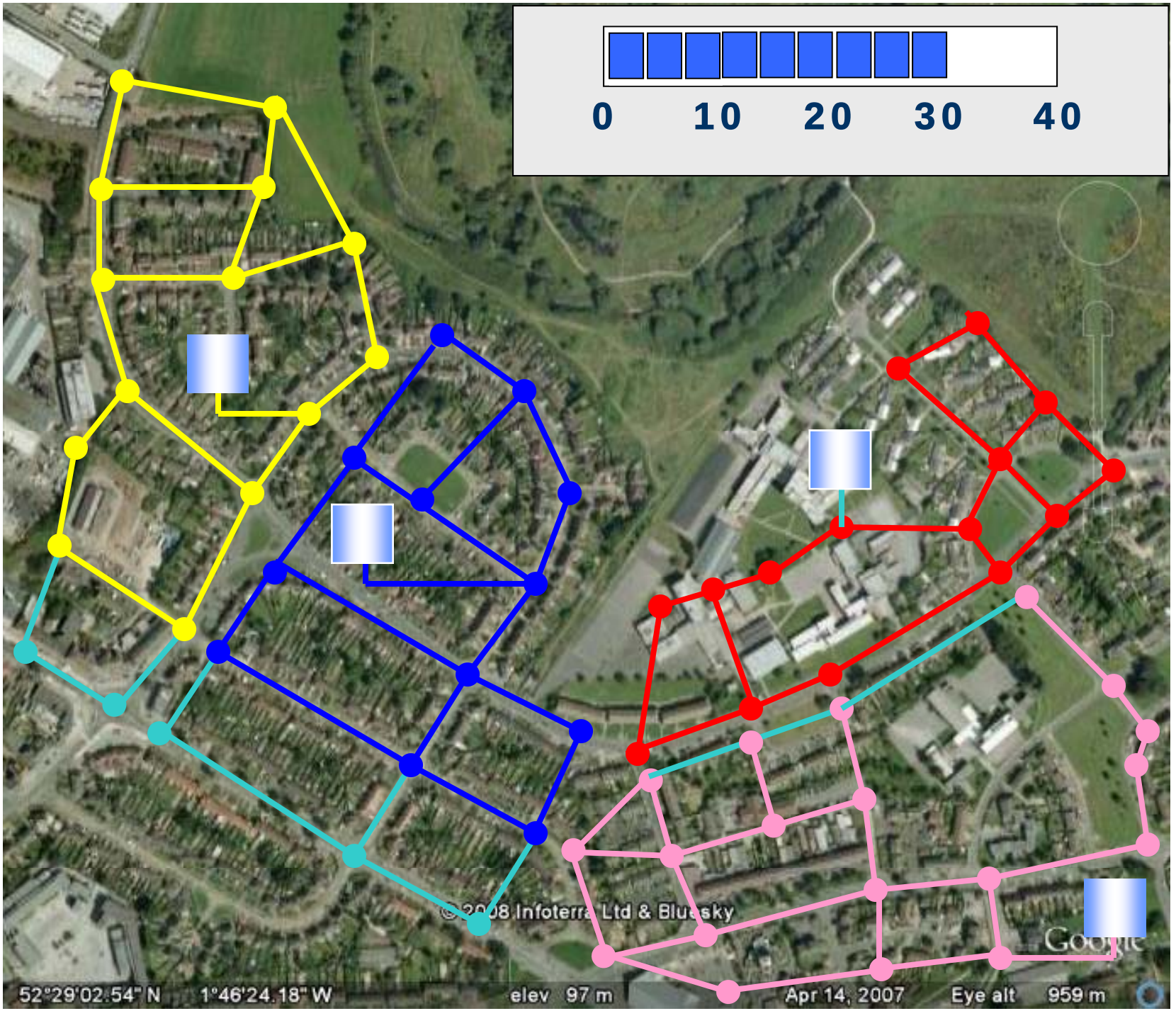
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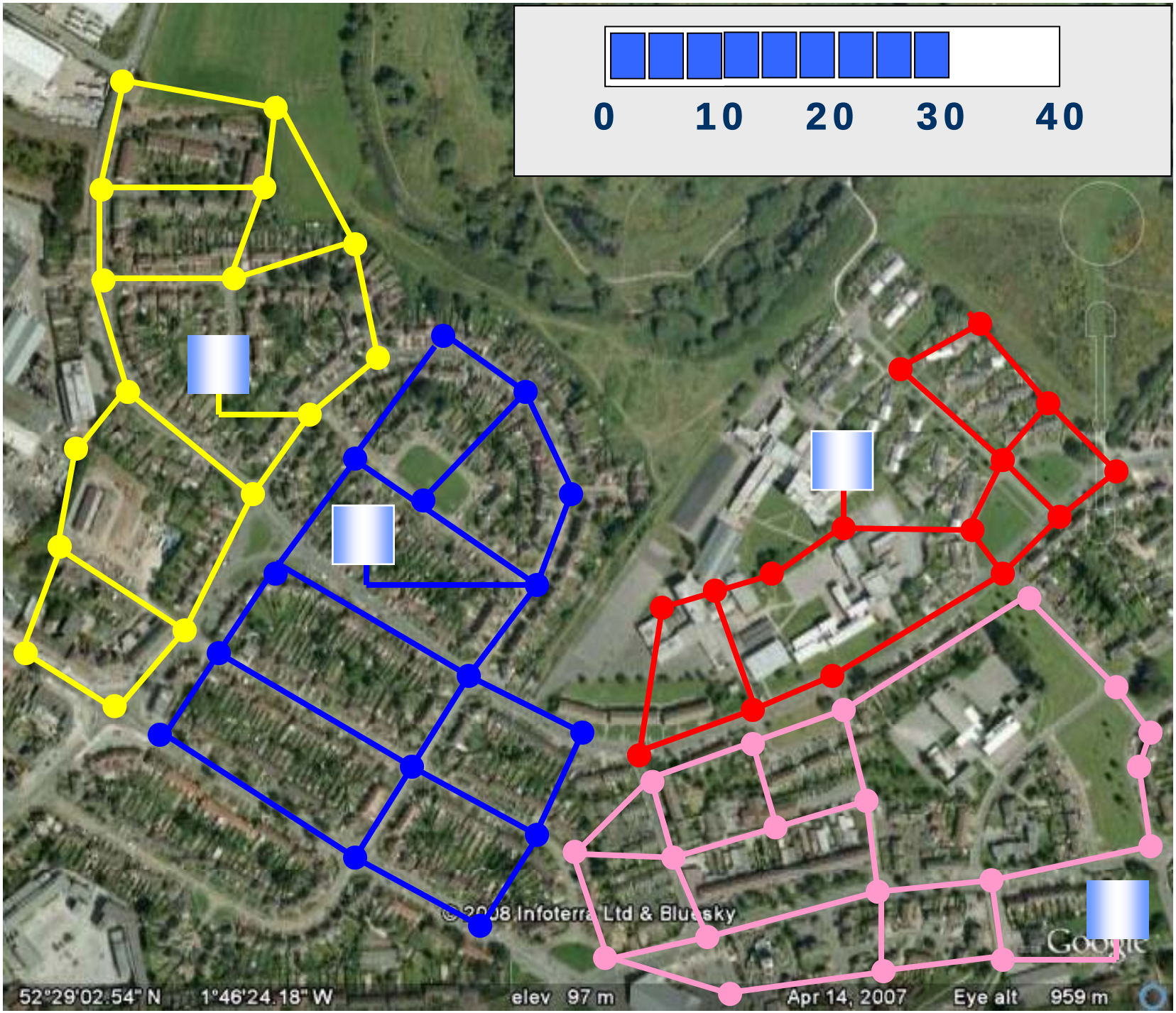
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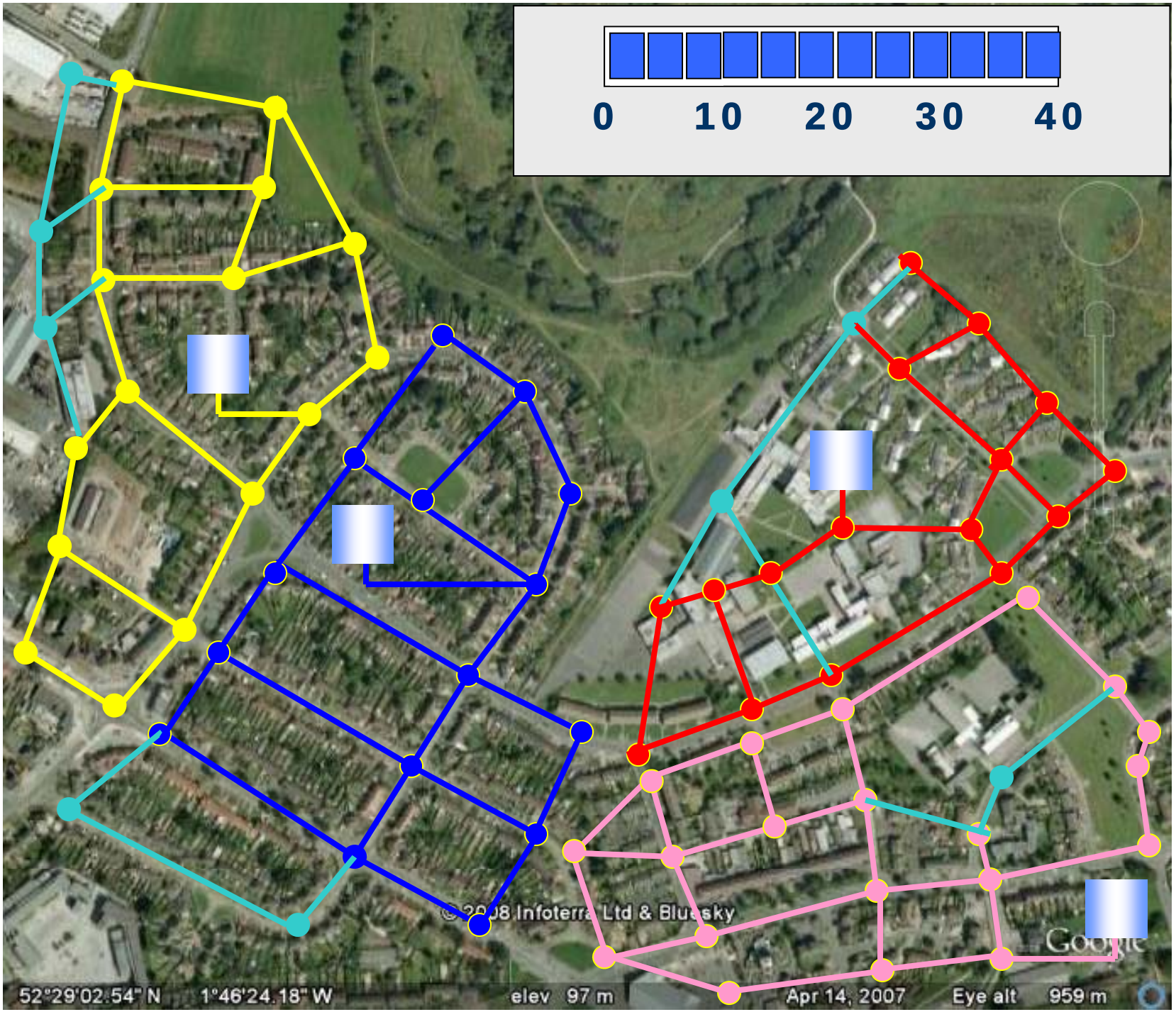
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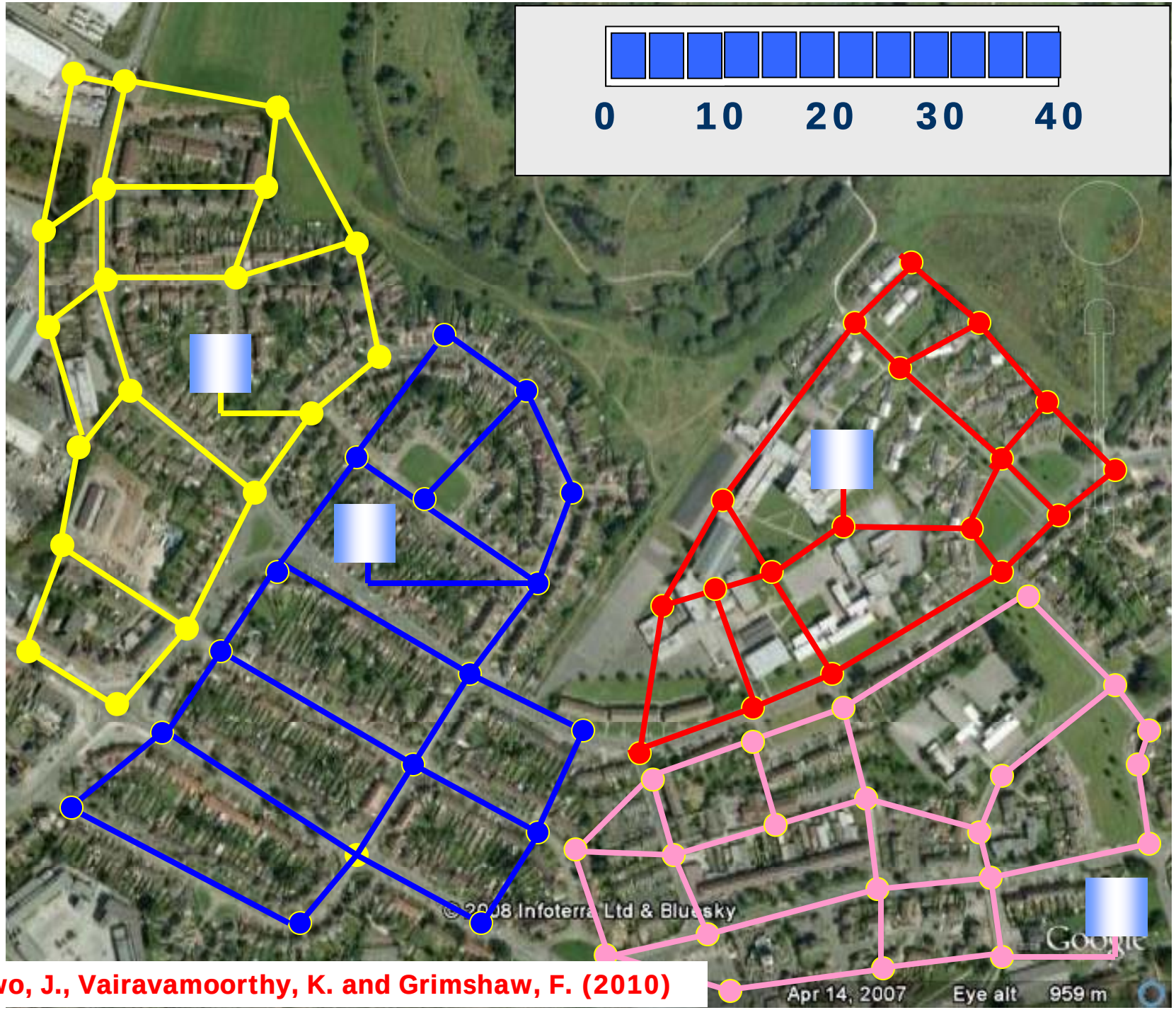

Sempewo, J., Vairavamoorthy, K. and Grimshaw, F. (2010)

Take home message

- **ove away from tinkering and think about how you might have designed from scratch - then look at transitional pathways & don't**

Institutions are the origin of change and the medium for legitimizing change

MMM

Choices Before Us

Patel School of Global Sustainability


Thank You

Kalanithy Vairavamoorthy

vairavk@usf.edu