

# The Metabolic City and the Alternative Water-Services design methods

*Water Efficiency Conference 2015*

**Fernanda Garcia-Alba Garciadiego**

*Civil, Environmental and Geomatic Engineering  
University College London*

# Introduction

- Urbanisation
- Integrated Urban Water Management (IUWM)
- Surface Water Management
- Case Study: Mexico City
- Methodology
- Discussion

# Urbanisation



[http://gallery.mediumgeek.com/v/mytravels/mexico06/Mexico\\_slum.jpg.html](http://gallery.mediumgeek.com/v/mytravels/mexico06/Mexico_slum.jpg.html)

## starting stage

- primitive houses
- low income households



<http://adilsud.blogspot.co.uk/2010/07/justice-of-slums.html>

## boom stage

- raise vertical density
- middle income households
- developers build formal like apartments

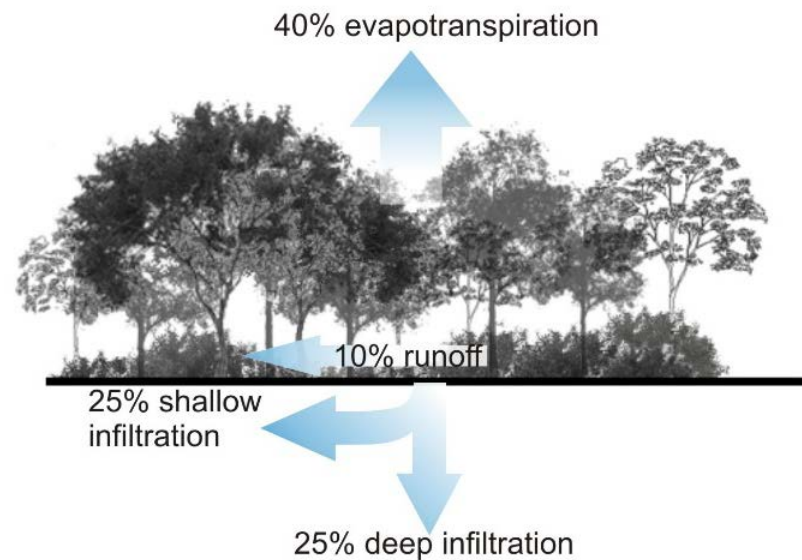
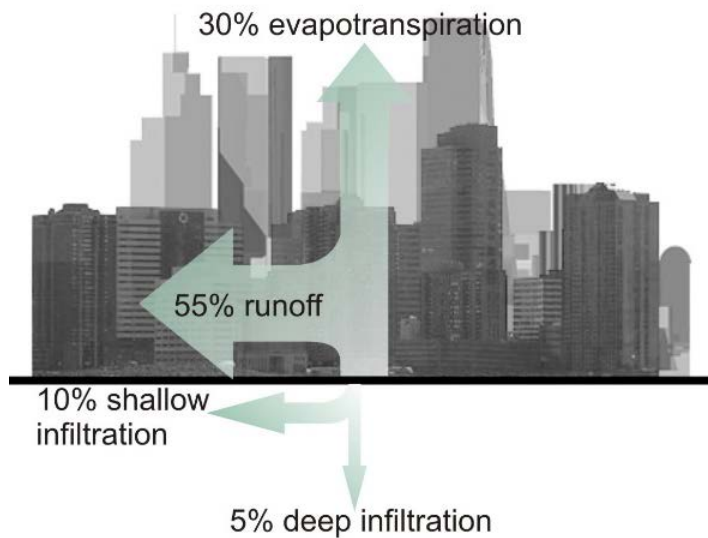


[http://commons.wikimedia.org/wiki/File:Rio\\_de\\_Janeiro\\_Brazil\\_slum\\_Pav%C3%A3ozinho\\_favela\\_December\\_2008.jpg](http://commons.wikimedia.org/wiki/File:Rio_de_Janeiro_Brazil_slum_Pav%C3%A3ozinho_favela_December_2008.jpg)

## saturation stage

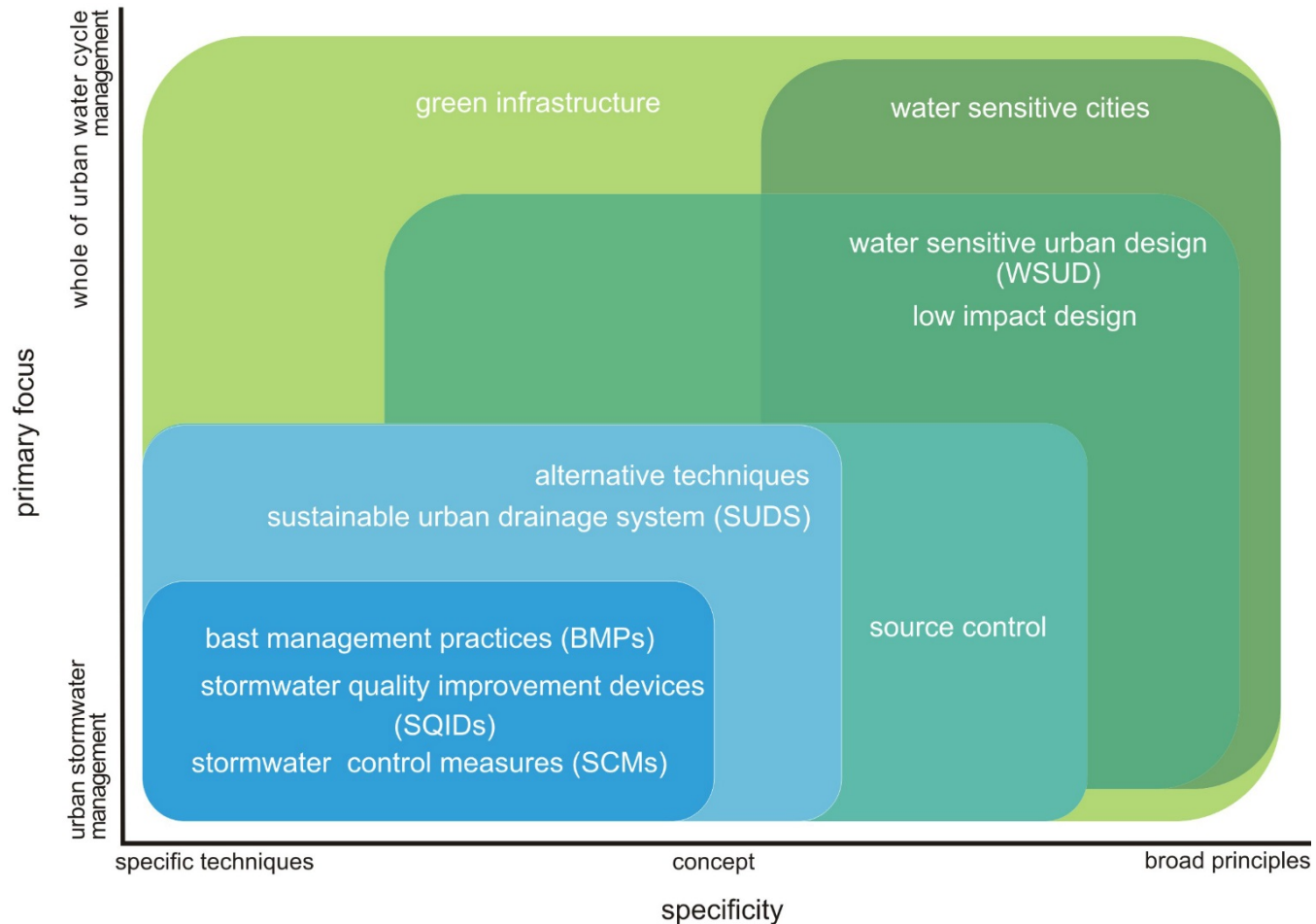
- vertical densification

# Urban and natural water runoff



Based on Pazwash (2011)

# Integrated Urban Water Management (IUWM)



Urban drainage terminology classification, according to their specificity and their primary focus (Fletcher et al. 2014)



# Surface water management

## Sustainable Urban Drain System (SUDS)



- technologies and techniques that reduce and retain water runoff
- enhance water quantity and quality
- runoff is managed at source
- enhance water infiltration
- reduce water pollutants through physical and biological processes

## Water Sensitive Urban Design (WSUD)



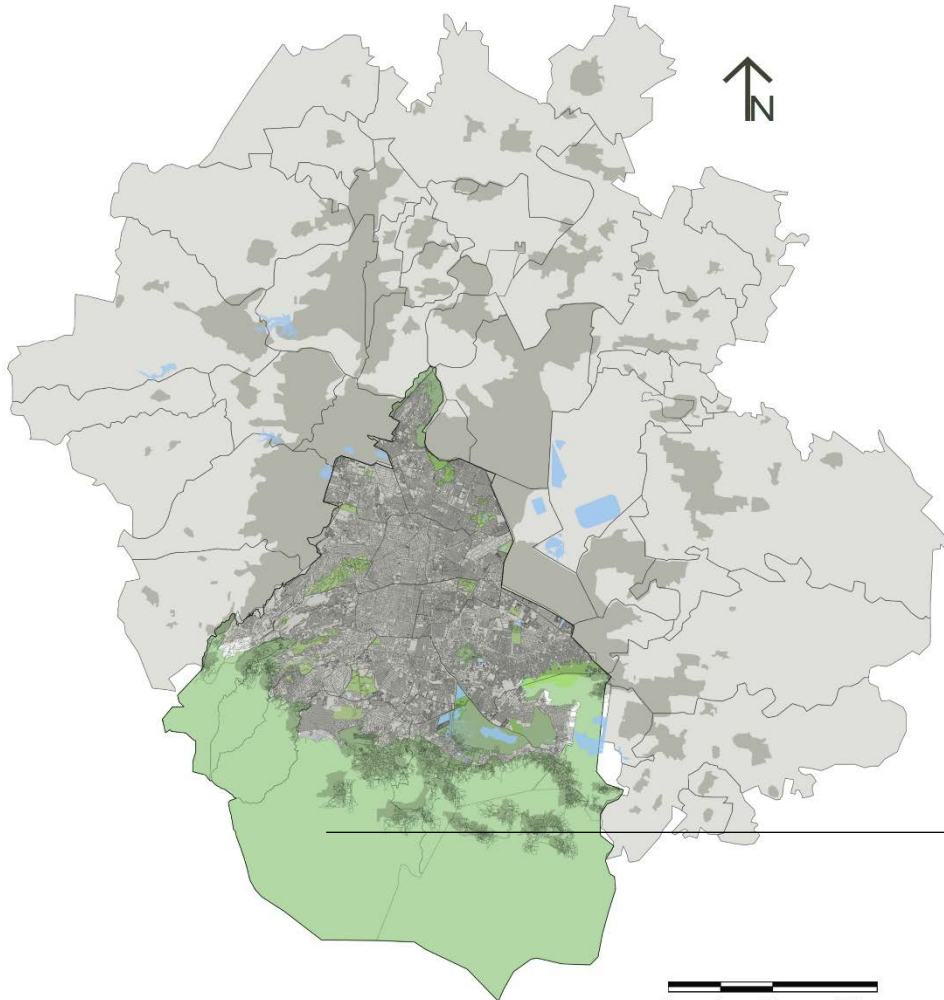
- philosophical attitude towards urban design
- reduce the hydrological impacts of urban development
- use the landscape to integrate surface and storm water management
- incorporates strategies to reduce water consumption
- restore the local watercourses
- mimics the hydrological cycle

## Green Infrastructure (GI)



- natural networks to enhance ecosystem services
- deliver protection against natural
- provide urban amenities, human health and social equity
- adds resiliency to a city
- rely on biodiversity conservation, ecosystem services and climate change adaptation

# Case Study: Mexico City



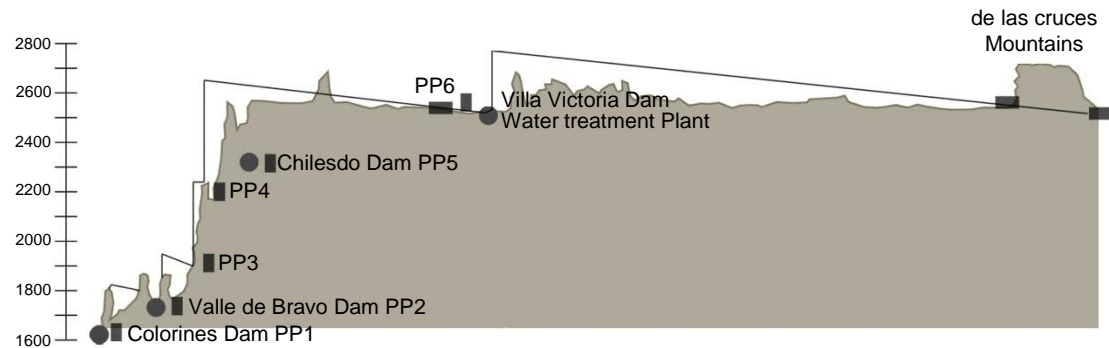
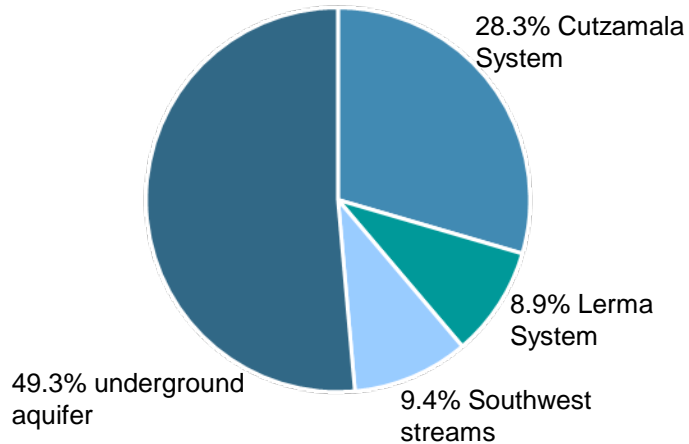
- over 20 million inhabitants
- 7.866 km<sup>2</sup>  
Federal District and State of Mexico
- periodical intervals of tougher flash floods and droughts
- High water consumption  
360 litres of water daily per person
- Uneven water distribution
- Elevated water service operation costs

## Conservation Land

- 8,842ha lost
- More than 60 million litres of water

# Case Study: Mexico City

Mexico city consumes 66 m<sup>3</sup> per second



Cutzamala System

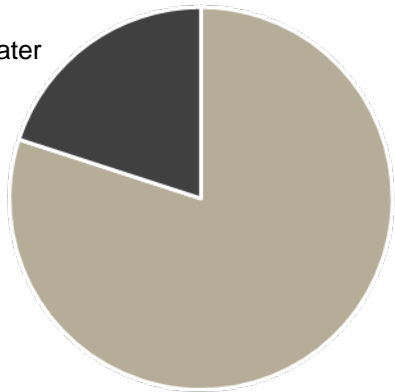
- Dam
- Plumping Plant (P.P)
- Piezometric line



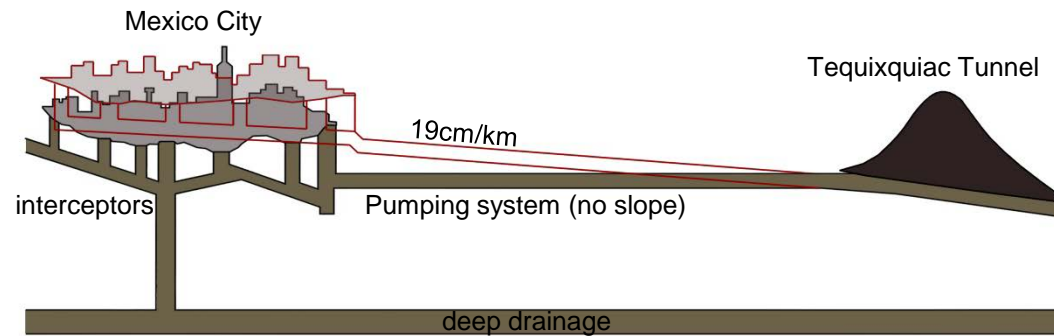
# Case Study: Mexico City

Water disposed is  $210\text{m}^3$  per second

20 %  
Residual water



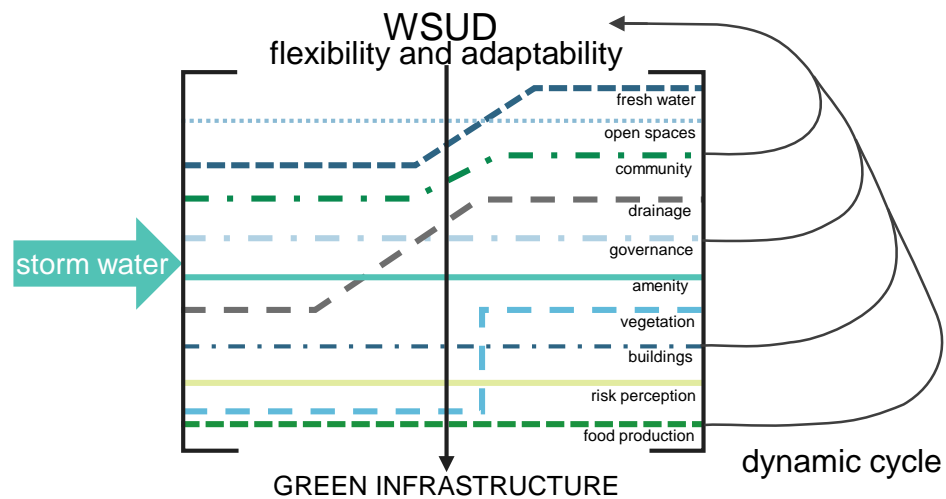
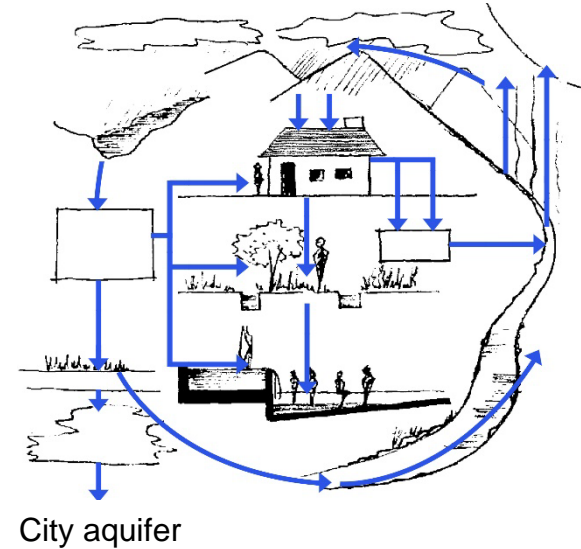
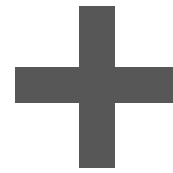
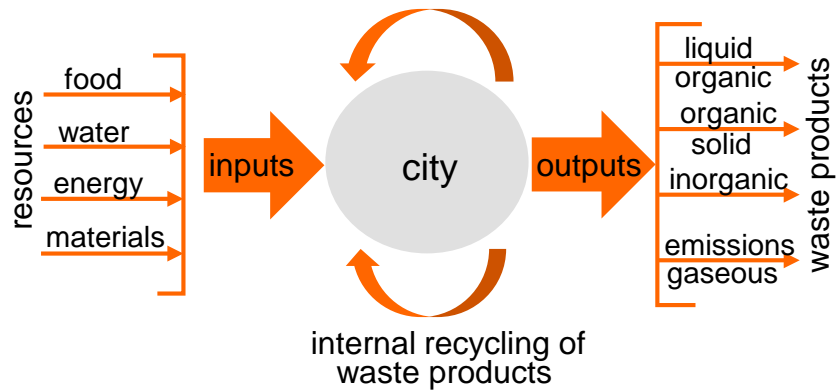
80 %  
Storm water  
(rains about  
700 ml/ year)



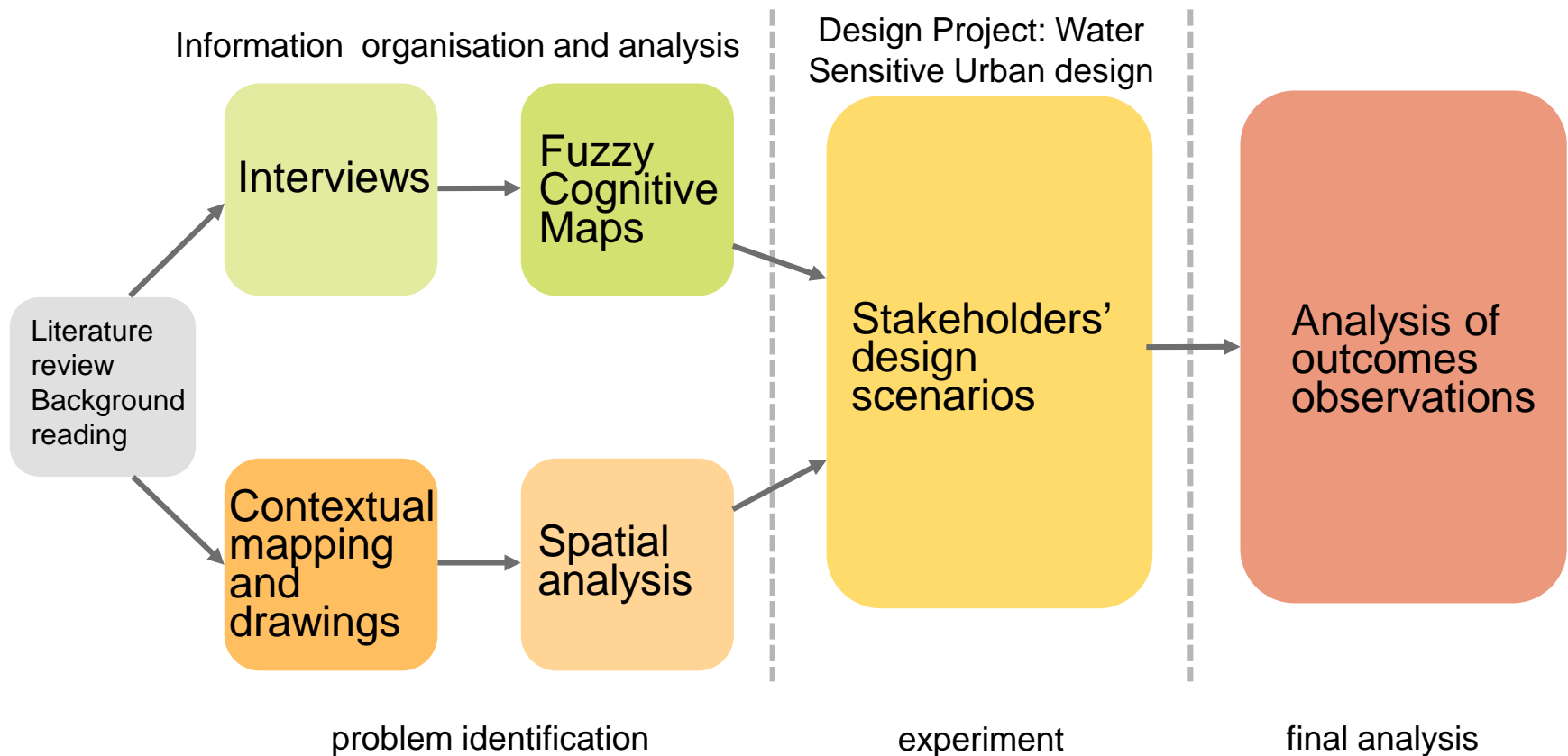
Drainage System

— 1910  
— 1980

# Methodology

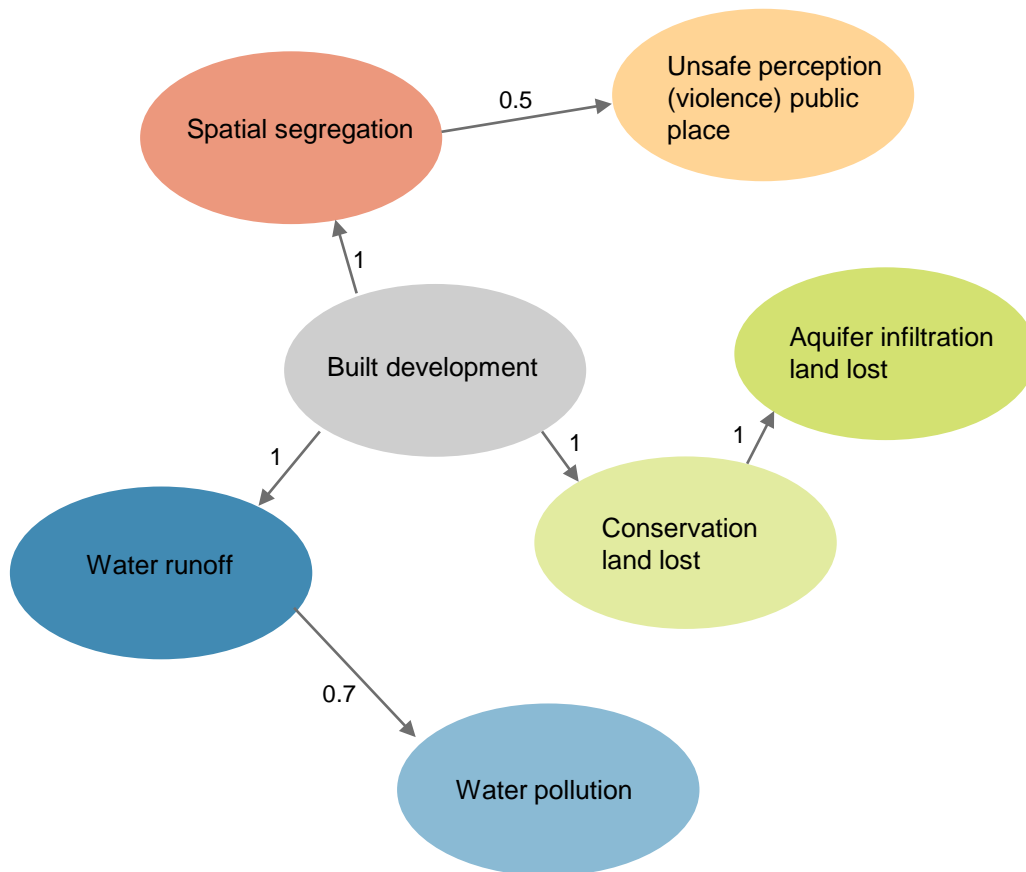
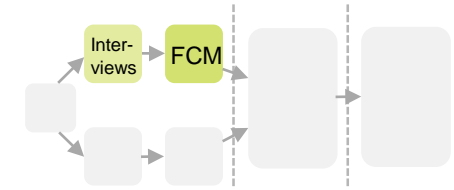


# Methods



# Fuzzy Cognitive Maps

Graphical representations of dynamic networks

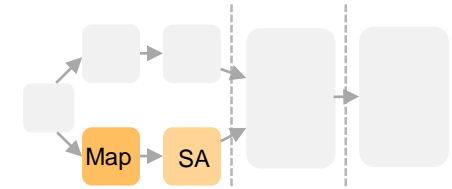


- concepts (variables)
- relations (edges) ranged from -1 to 1
- representing values of positive or negative influences among elements
- expressing causal relationships between concepts

Information:

- Water issues
  - (environmental and social impacts)
- Urban growth
- Environmental loss

# Context Maps



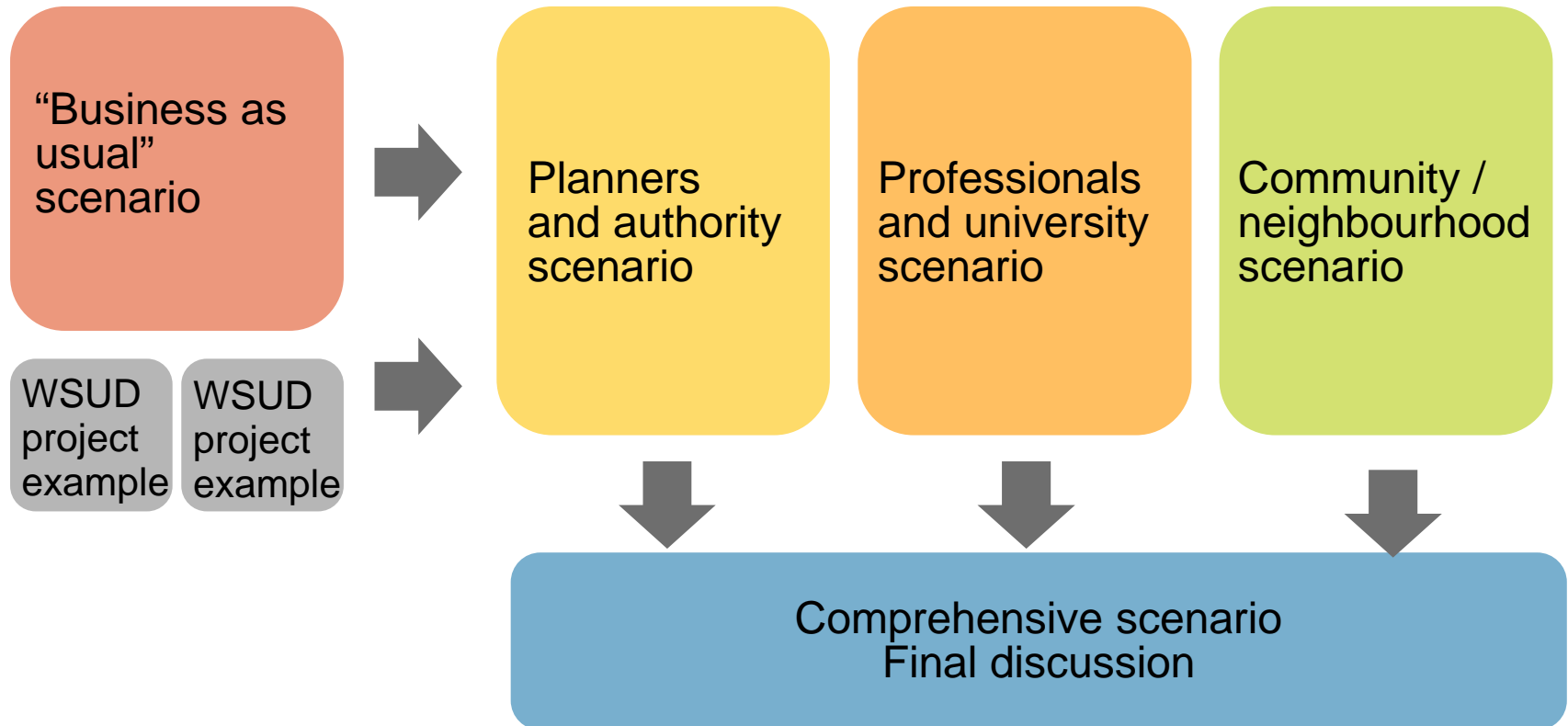
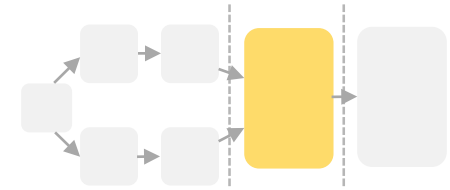
- Observation
- Graphical information  
(maps, drawings and photographs)
- statistical data



analysing the physical urban configuration and its components (infrastructure, constructions, roads, services, and open spaces, among others)

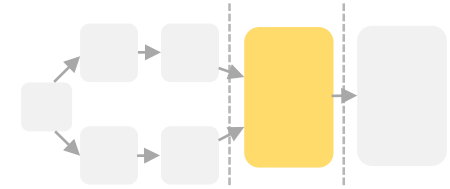


# WSUD scenarios





# WSUD scenarios



Scenario definition



Scenario construction



Scenario analysis



Scenario assessment

To identify main problems and goals —key variables— using the FCM as tool; to recognise predictability and uncertainty patterns.

To design a WSUD, finding desirable outcomes.

To recognise interactions' consequences, driving flows and system components.

To categorise risk, opportunities and trade-offs, visioning future panoramas and the implementation of sustainable activities

# Discussion

Does the metabolic city approach contribute towards creating the right framework for understanding relationships between society and water?

Has Water Sensitive Urban Design (WSUD) the necessary flexibility to deal with socio-environmental dynamics (flows) in an informal settlement?

Can FCM help to understand the dynamics within an irregular settlement, considering it as a socio-environmental system which evolves with time?

Can WSUD encourage a better water metabolism of a local area (increasing water supply —input— while decreasing the volume of water disposal —output—) without compromising other areas of the city?

# Thanks

Contact: [fernanda.garciadiego.14@ucl.ac.uk](mailto:fernanda.garciadiego.14@ucl.ac.uk)

