Groundwater - linked options for reducing urban water and energy costs

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Sixth Framework Programme (2002-2006)

Talk outline

- Urban Sustainability and Resilience
- Underground Resources
- Expanding Groundwater Options
  - Urban Heat Island
  - Pluvial Flood Mitigation
  - Urban Harvest
- Some speculation?
- What Next?
- Concluding remarks

GGE Indicators

- Greenhouse Gas Emission Footprints –
  - 40% generated within the urban boundary
  - 60% from outside
- Spread of GGE activities (USA cities)
  - 47% building/facilities energy
  - 34% transport (including fuel production)
  - 15% food
  - 2% materials
  - 2% water and waste water

Sustainability and Resilience

- Sustainability – ability to continue functioning for a specified time period
  - Current city models are no longer sustainable!
- Resilience – ability to recover /adapt in response to a dynamic change
  - Future changes could be large and fast
    - Climate, Energy, Food scarcity, Population, Economy,
  - Current city models may lack resilience

Underground Resources

- Accommodation Space
- Groundwater
  - Supply
  - Storage
  - Purification
- Geothermal
  - Heating
  - Cooling
- Geomaterials

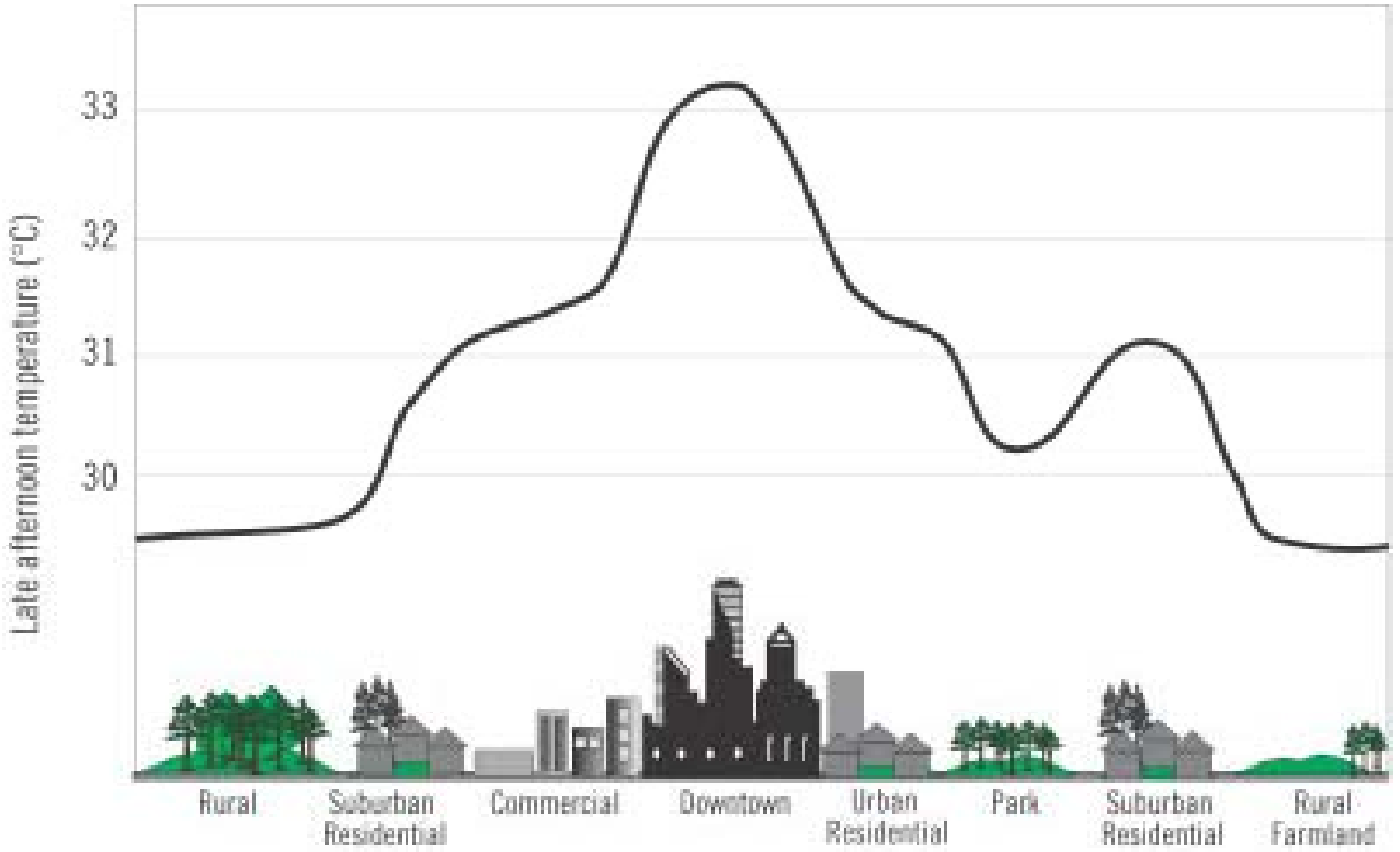
- Potential for conflicting demands
- Potential for complementarity

- Requirement for Integrated urban management

Groundwater Options

- Heat
  - Addition
  - Removal
- Water
  - Supply
  - Storage
  - Detention
  - Transport
  - Remediation
- Nutrient recovery?
- Urban Heat Island
  - water supply, heat removal
- SUDs
  - water storage, detention and remediation
- Urban Harvest
  - Water storage, transport, remediation
- Others?

The Urban Heat Island



Differences up to 12° C at night…..

Source: EPA 2008

Collective options for reduction are feasible

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Extensive green roofs

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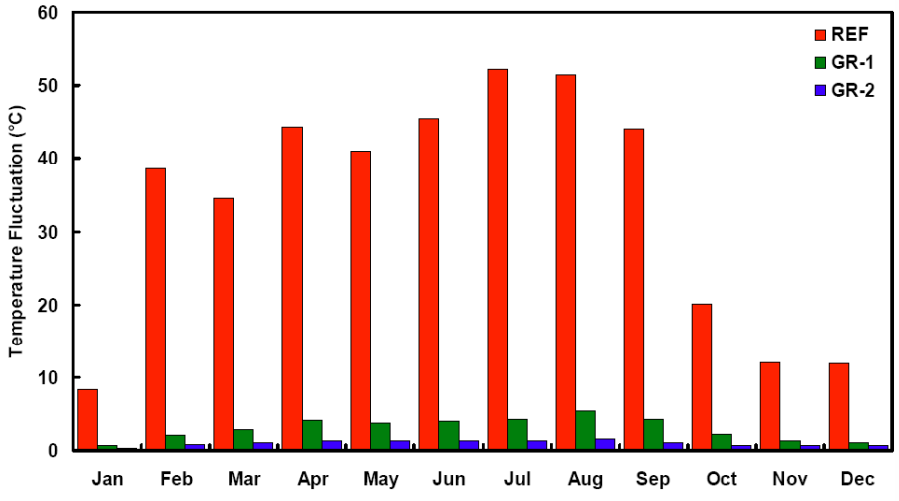
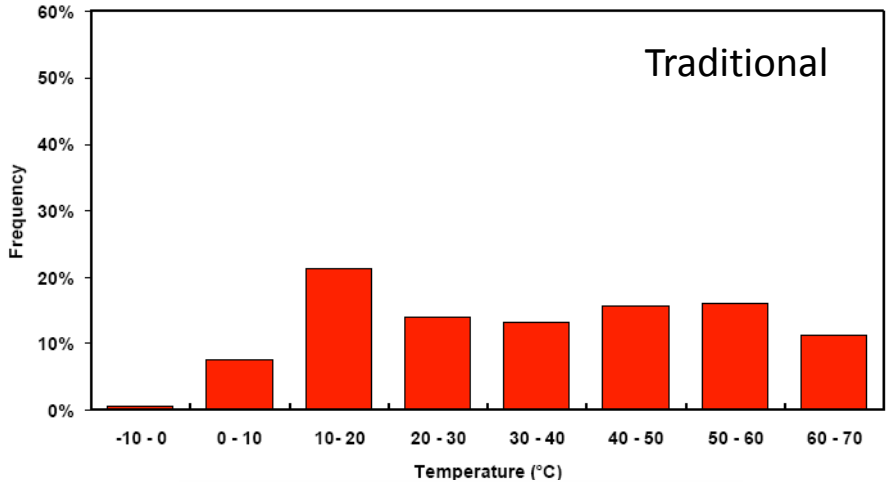
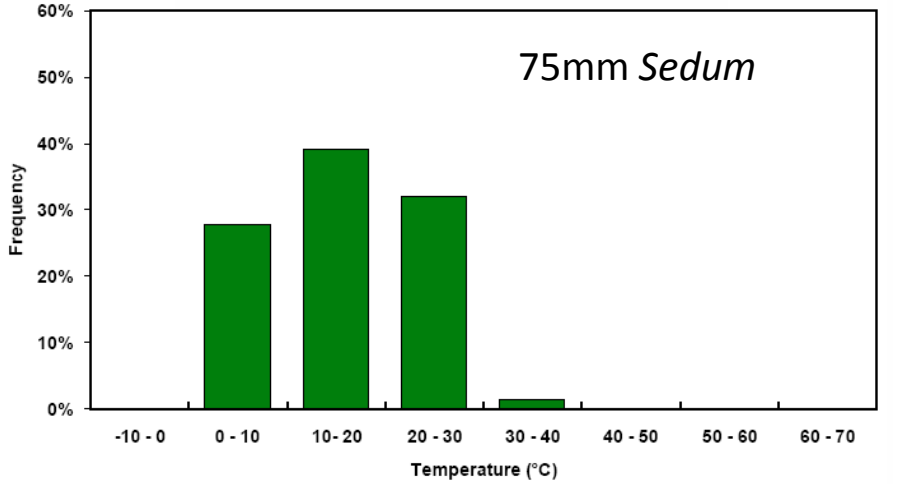
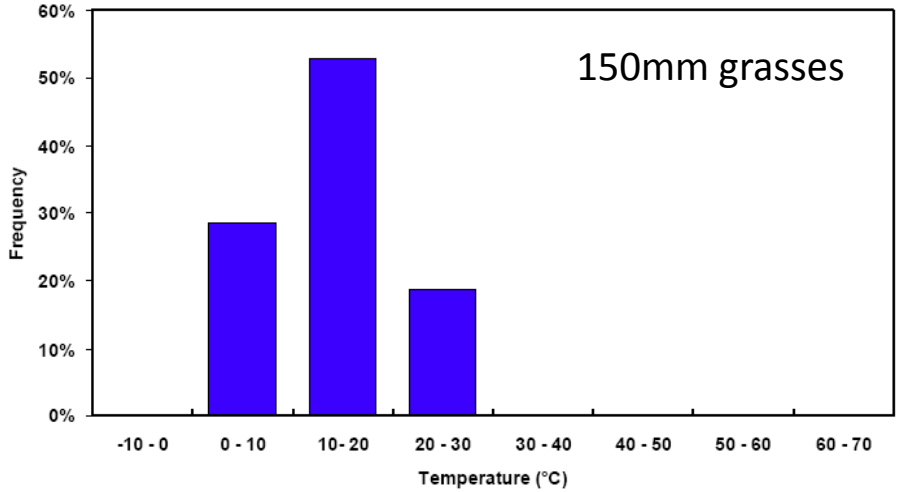
Roof temperature fluctuations



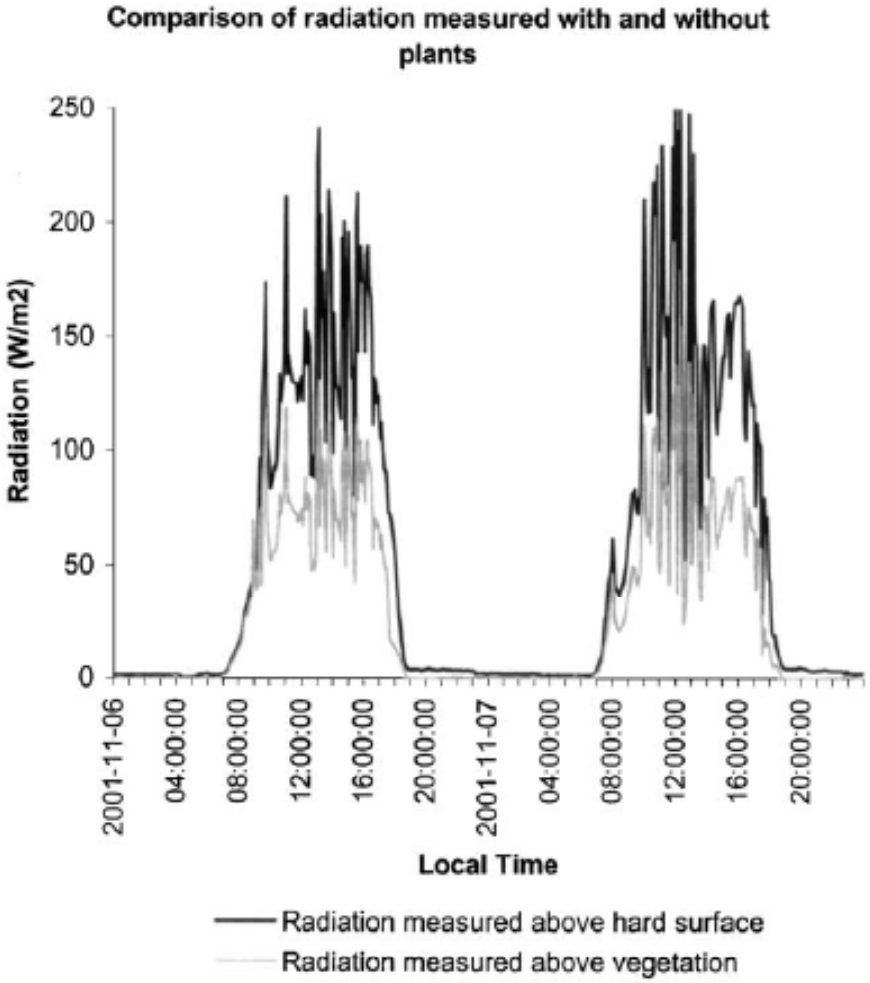


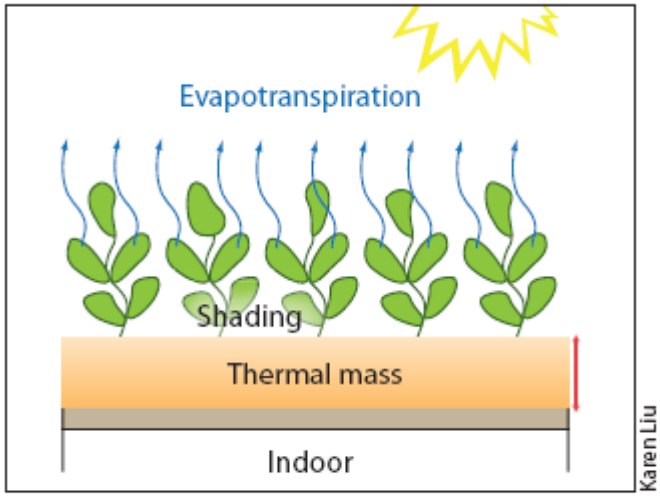




Connelly *et al.* (2006)

Roof Thermal Responses - Illustrated





Plant shade reduces the sunlight that reaches the roof. Evapotranspiration further cools a green roof by using heat to evaporate water from the growing medium and plant surfaces

Evapotranspiration provides cooling

But only when moisture is available.

Irrigation with Groundwater

Wong et al, 2003

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Pluvial Flooding

Integrated Urban Drainage Pilots

defra
Department for Environment
Food and Rural Affairs

It isn’t just urban flood risk that is of concern – excess water and unnecessary pollutant loading at the water treatment plants lead to expensive treatment energy + costs.

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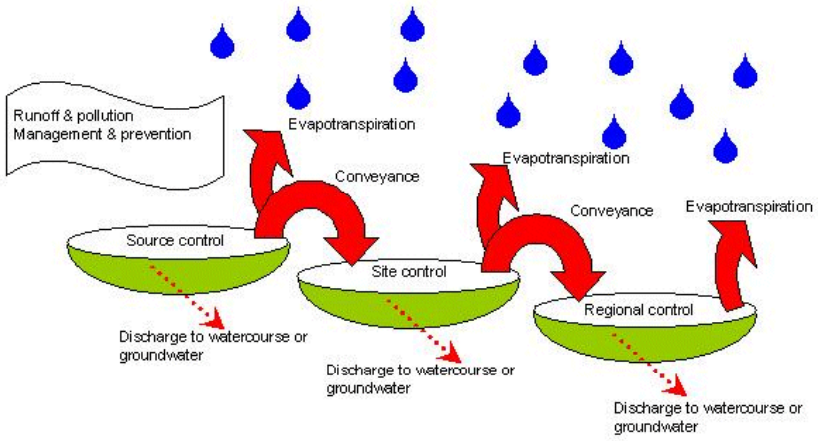
SUDS Treatment Train



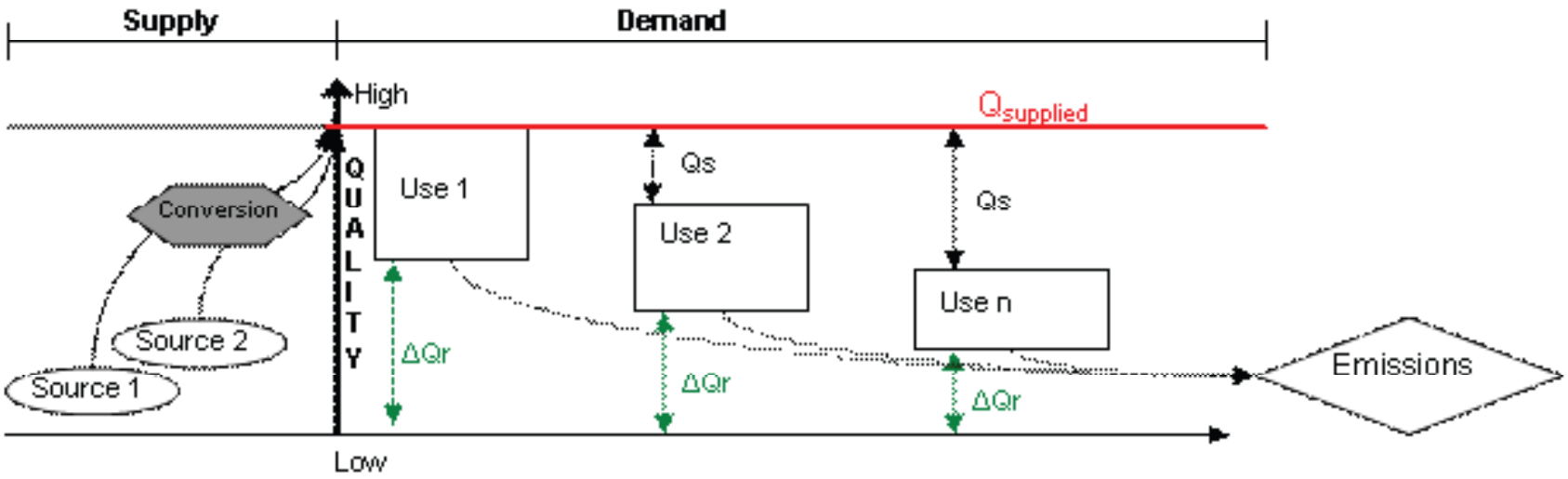
- Detention typically provided by soil and groundwater paths.
- Interception and separation of pollutants between SUDs features
- Natural remediation
  - Enhanced groundwater recharge
  - Space for recharge essential?
  - Impact on groundwater?

Pervious Pavements + GSHP

Scholtz et al, 2010…. ongoing research

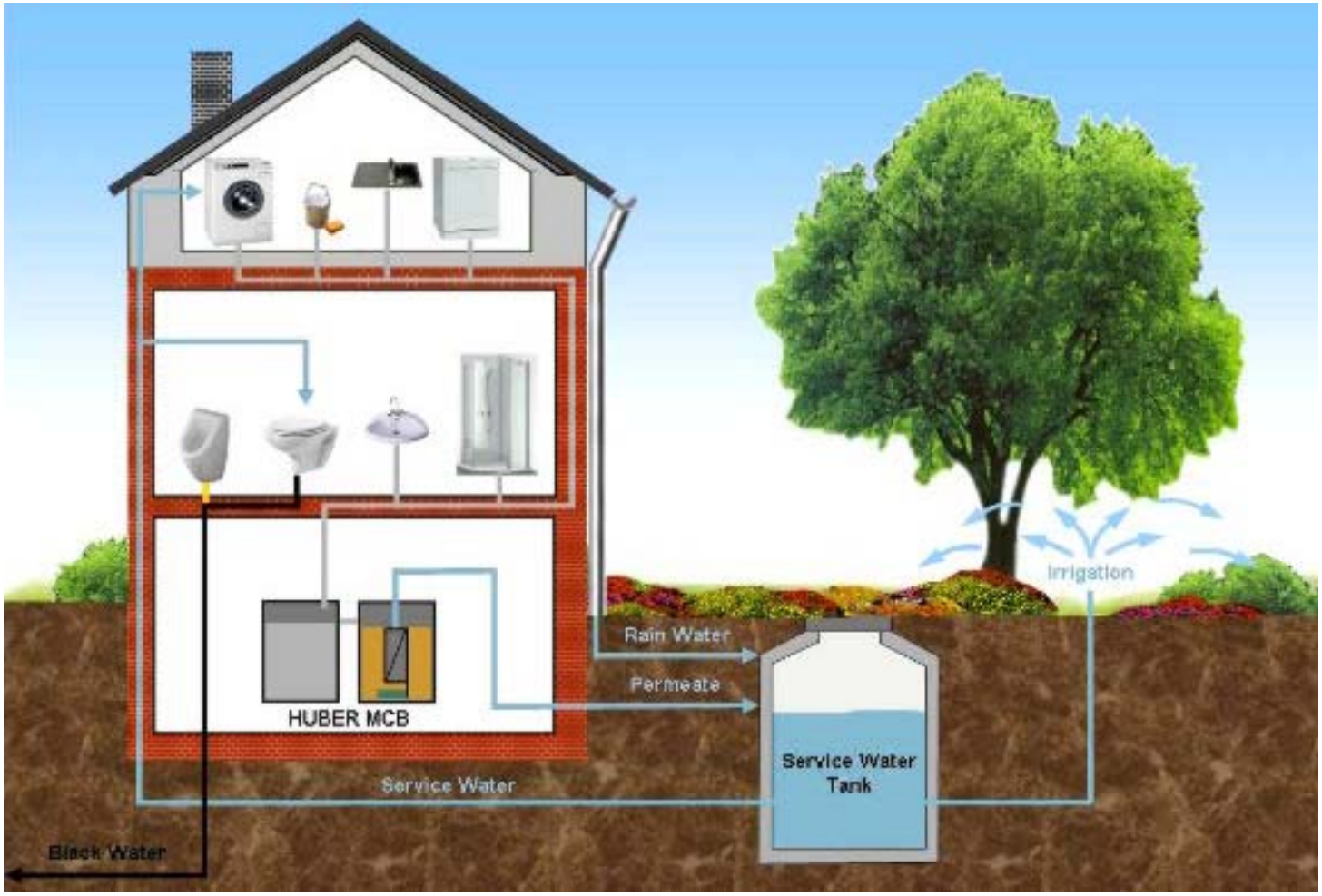
- Rationale
  - Emplacement of a GSHP source at shallow depth in accessible location
  - GSHP heating of the subbase in summer for building cooling to enhance biodegradation of organic effluents
  - Improved recharge water quality with fewer pathogens

Urban Harvest



The URBAN Harvest approach has been developed as a strategy to investigate all possible options for harvesting local resources and (re)using emissions and wastes.

Greywater Recycling



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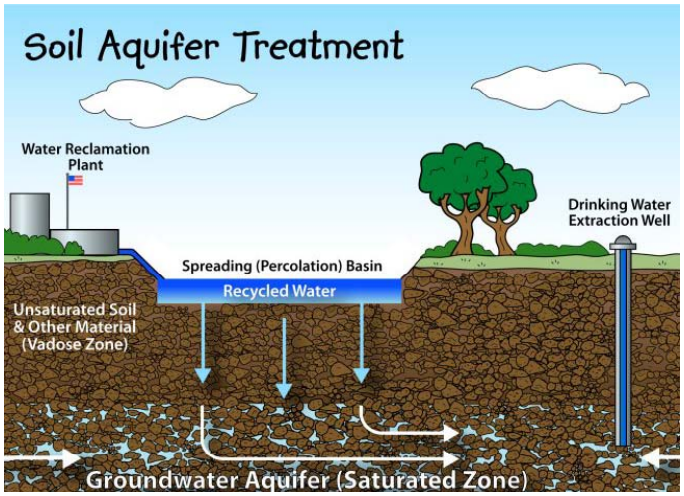
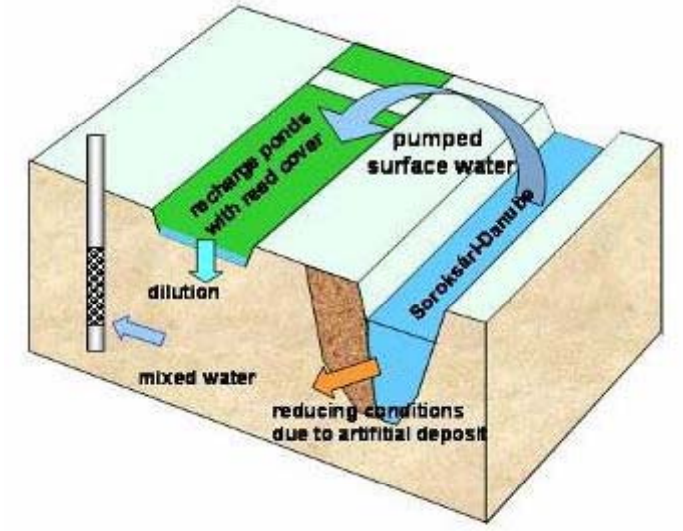
Soil aquifer treatment





- Extensive development of SAT and IBF elsewhere in the world for a partial/full restoration of water for reuse…..

- Should/could these techniques be used to support Urban Harvest approaches?

Some speculation….

- Other possible activities in Urban areas for GGE reductions and improved living space with potential for groundwater exploitation:
  - Urban agriculture
  - Biogas generation
  - River restoration
- Issues with energy implications
  - PCP removal
- ?

What next?

GW exploitation depends on

- Continual upgrading and mapping of our understanding of
  - 3D geology, geohydrology, geochemistry, biology, microbiology of urban areas.
- Advancing the required research to explore groundwater options alongside alternative strategies
- Embracing IUWM – seeking win-win scenarios!

Concluding remarks

- Urban groundwater cannot simply be seen as an unprotected resource
- Opportunities exist and will present to exploit groundwater for a range of energy mitigation actions in addition to ATES and Deep Geothermal
- Expansion of recent developments in urban geosphere mapping will enhance our ability to use urban groundwater resources better
- Research to explore the opportunities for Urban Groundwater Management within an overall strategy for IUWM will pay for itself.

Thanks

Questions?

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