WATER SENSITIVE URBAN DESIGN (WSUD) – A MEASURE OF CLIMATE CHANGE ADAPTATION

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The UAE has a hyper-arid climate with less than 100 mm/yr of precipitation, a very high potential evaporation rate (2-3m/yr), a very low groundwater recharge rate (<4% of total annual water used) and no reliable perennial surface water resources.

The desert greening policies, expansion of agriculture and the projected more than three million populations by 2030 in the Emirate of Abu Dhabi (EAD) will significantly increase pressure on existing water resources.

According to the Arab Forum for Environment and Development (AFED), Arab countries are in many ways among the most vulnerable in the world to the potential impacts of climate change (increased average temperatures, less and more erratic precipitation, and sea level rise).
• Climate Change Scenarios
• Urban Water Challenges
• Water Sensitive Urban Design
• Research Activities
• Conclusion
Climate change scenarios for UAE
Climate Change

Projected climate change scenarios for UAE

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Precipitation</th>
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<tbody>
<tr>
<td>+1.74 to 2.67°C (2050)</td>
<td>-21.20% to +10.33% (2050)</td>
</tr>
<tr>
<td>+3.11 to 4.76 °C (2100)</td>
<td>-37.82% to +18.42% (2100).</td>
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Projected monthly temperature change and variability in UAE

Projected monthly rainfall change and variability in UAE

Sea Level Rise of 1 m would inundate about 1.2% of Sharjah, 8.1% of Ajman and 5.9% of Umm Al-Quwain.

Projected climate change impacts on UAE water demands

Optimistic scenario: +1.7 °C and +10% precipitation in 2050
Pessimistic scenario: +2.7 °C and -20% precipitation in 2050
Middle of the Road (MOR) scenario: +2.2 °C and +5% precipitation

Urban water management challenges
- Household water consumption in EAD is about 185 MCM/year and about 98% of wastewater is collected through a network of sewers.

- About 50% to 80% of wastewater constitutes greywater (shower water, ablution water, washing water etc.) which is comparatively less pathogenic than black water.

- About one fifth of domestic water in EAD is used for toilet flushing, and one third for gardening and irrigation to amenity vegetation. In both cases, high quality potable water is not a requirement.

- Greywater is therefore considered as one of the last major untapped sources of water in the urban landscape of arid region.
The Abu Dhabi Water Resources Master Plan (2009) identified three options to ensure future water supplies:

(a) water demand reduction
(b) water supply augmentation and
(c) a combination of the two.
The challenge for using greywater includes its capture, storage, appropriate treatment, and supply to end uses at cost-effective prices.

Though a highly efficient (98% efficiency) wastewater collection sewer network and treatment plants are available in EAD; end uses of Treated Sewage Effluent (TSE) require development of an expensive distribution network (dual reticulation).

This will increase the marginal cost of water supply.
In some water scarce countries (for example, Australia), decentralized (household level) harvesting and reuse of alternative water resources such as rainwater and greywater shows an economically viable solution for water supply augmentation and capable of fulfilling a potable water savings target.

For example, the SEQ Regional Plan (2009) in Australia set a mandatory potable water savings target of 70 kilo liter/household/year in South East Queensland by promoting alternative water resources.
Water Sensitive Urban Design (WSUD)
WSUD is a philosophical approach in urban planning and design that integrates the management of the total water cycle into the urban development process.

Identified major objectives of WSUD are:

- To manage **water balance** by maintaining appropriate aquifer storage and recharge, preventing flood damage in developed areas and excessive erosion of waterways, slopes and banks;
- To maintain and enhance **water quality** in order to minimize water borne sediment loading and export pollutants to surface or groundwater and to protect vegetation;
- To encourage **water conservation** in order to promote the uses and/or re-uses of stormwater;
- To maintain water related environmental and recreational **values**.
Two of the most widely applied WSUD technologies are permeable pavements and bioretention basins. These two technologies are potential for treatment and reuse of greywater.

The aggregate storage provides a degree of quality improvement through processes such as mechanical filtration, chemical precipitation and adsorption.

Permeable pavements do however have some limitations, particularly blockage (clogging) of aggregate void spaces.
(a) Permeable pavement (b) bioretention basin (Beecham and Chowdhury, 2012)
Design Guidelines for Porous Asphalt with Subsurface Infiltration

- Porous Asphalt Pavement
- Uncompacted Subgrade is Critical for Proper Infiltration
- Filter Fabric Lines the Subsurface Bed
- Riverjacks Open Into Recharge Bed
- Uniformly Graded Stone Aggregate with 40% Void Space for Stormwater Storage and Recharge
Constraints of successful implementation of WSUD can be summarised based on Gardiner and Hardy (2005):

- Necessity of regulatory framework
- The need of professional flexibility of water authorities to support transition to WSUD implementation
- Poor site and allotment management practices
- Necessity of long term data management system for maintenance of structures
- Challenges in assessment of entire project cost
- Lack of appropriate marketing mechanism for WSUD

Research activities
Rainfall, PMP and drought characterization in UAE

Rainfall, PMP and drought characterization in UAE

Conclusion

WSUD concept can be introduced in arid region for decentralized harvesting and reuse of greywater. Bioretention basin and Permeable pavement can provide treatment and onsite storage of greywater. However, researches are significantly important for understanding their performance. A summary of research questions that need to be investigated are:

- What is the greywater generation rate from individual houses?
- What is the potable water saving target at individual household by implementing reuse of treated greywater?
- What are the locations and their relative suitability for greywater harvesting opportunities using WSUD technologies?
- What are the microbiological and chemical greywater quality and the subsequent health risks for a range of non-potable end uses such as toilet flushing, gardening, and irrigation to amenity vegetation? And
- What are the economic and environmental benefits of promoting decentralized greywater reuse system using WSUD, both for new housing development and for retrofitted system in existing housing units?
Thank you so much!