Sustainability in the Urban Nexus

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Different Nexus Concepts
Nexus Challenges in maintaining food security and sufficient access to freshwater and energy (also inclusive economic growth), whilst sustaining key environmental systems functionality, particularly under variable climatic regimes.

The urban nexus is defined as the interlinkages amongst water, energy, food and accompanying physical and natural infrastructure, coupled with the populations that rely on them and the institutions for their governance.

Urban nexus can be harnessed as a holistic policy tool to incorporate a holistic approach to build societal and ecosystem resilience to global change.
Berlin’s virtual water imports. Country colors indicate the primary export product to Berlin (in terms of virtual water export) arrow widths are proportional to virtual water import volumes

Holger Hoff et al. 2014 “Water footprints of cities - indicators for sustainable consumption and production”
Wasted water means waste energy

• Water and energy are tightly linked but these links are poorly understood and rarely used in policy.

• Inefficient water use leads to inefficient energy use

• Policy makers should better integrate water and energy policies.

• Failure to do so will lead to disruptions in the supply of both water and power.

• Water and energy are also linked to climate change through the emission of greenhouse gases.

• A key element to any climate strategy will thus be to reduce the greenhouse gas emissions associated with water systems by developing non-carbon energy sources.
Saving water saves energy

Energy efficiency initiatives offer opportunities for delivering significant water savings, and likewise, water efficiency initiatives offer opportunities for delivering significant energy savings.

In addition, saving water also reduces carbon emissions by saving energy otherwise generated to move and treat water.
Indirect Influences of water on water on Energy are Substantial

- Resource Loss
- Water Use
- Water Supply

Source: Kenway and Lant 2013: How does Energy efficiency Affect Urban Water System
Page et al 2008: The Integrated Resource Management (IRM) model – a guidance tool for sustainable urban design
Source: Kenway 2013:
The Water-Energy Nexus and Urban Metabolism - Connections in Cities
Estimates of water-related energy use range from 4% to perhaps 13% of the nation’s electricity generation.

In California, for example, as much as 19% of the state’s electricity consumption is for pumping, treating, collecting and discharging water and wastewater.

A 20% decrease in water demand across all sources in Tucson, Arizona, corresponded to a 20% decrease in water-related energy consumption.

Energy consumption by public drinking water and wastewater utilities, which are primarily owned and operated by local governments, can represent 30-40% of a municipality’s energy bill.

The energy demands for water in Australian cities is anticipated to grow to 200-250% of 2007 levels by 2030.
Understanding total Urban Balance of Water and Energy in a three dimensional framework
Should we optimise the system

A mass-balance defined boundary, consistently applied, could provide a reference point against which optimization of resource flows (converting water, energy and nutrients into human well-being) could be achieved.

Without a consistent boundary, it is likely harder to fully understand
1. the energy implications of water management or other urban strategies.
2. Factors which offer the highest potential for influencing the system.

Adoption of different boundaries could lead to inclusion or exclusion of very different sets of linkages and consequently analysis could reach very different conclusions.
Urban Metabolism

• Urban metabolism looks at the city as a giant organism or ecosystem and analyzes the inputs, transformations, outflows, and possibilities for recycling resources within the urban sphere.

• Urban metabolism is most useful for (1) sustainability indicators, (2) inputs to urban greenhouse gas accounting, (3) dynamic mathematical models for policy analysis, and (4) design tools.

• How to deal with environmental externalities- Still needs to be resolved.
Partially closing loops could significantly reduce inputs of energy, water, materials, and nutrients.

Greywater was used for toilets, and outdoor use;

Sludge from waste water was used on community gardens for food production.

Energy from the imported municipal waste powered the buildings.

Kennedy et al 2011 “The study of urban metabolism and its applications to urban planning and design”
Extending the Metabolism model in bringing Consumption Sustainability perspective and Well being

Extended metabolism model to included indicators of health, employment, income, education, housing, leisure and community activities. (Newman 1996, 1999)

Connections between urban metabolism and quality of life have subsequently been made-Stimson et al., 1999; Lennox and Turner, 2004.
Possible solutions

• Develop incentives to conserve water and uptake of more efficient technologies: pricing water (which accounts for water as a basic right)

• Problems with water pricing
  – Politically determined
  – Urban poor pay much more

• Establish transitional arrangements to achieve efficiency and sustainability

• Foster more bottom-up, community-level governance approaches
Possible solutions

• **Raising awareness**
  – Promote transparency and awareness of businesses and consumers by establishing useful indicators, such as “Water footprinting”

• **Technological change**
  – Promote investment in technology hubs, research and education on water management
  – Modern technologies - possible solutions to tackle water scarcity, renewable energy and environmental degradation.
  – Improvements in water efficiency alone may meet half of the projected increase in water demand by 2025 (Comprehensive assessment of water).
  – Lack incentives to adopt modern technology-
Several SDGs are directly tied to the Urban Water–Energy–Food nexus

Goal 6: Ensure availability and sustainable management of water and sanitation for all.

Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all.

Goal 11: Make cities and human settlements inclusive, safe, resilient, and sustainable.

Some additional goals

Goal 2: End hunger, achieve food security and improved nutrition, and promote sustainable agriculture.

Goal 8: Promote sustained, inclusive and sustainable economic growth, full and Productive employment, and decent work for all.

Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation.

Goal 12: Ensure sustainable consumption and production patterns.

Goal 13 Take urgent action to combat climate change and its impacts.

Goal 17: Strengthen the means of implementation and revitalize the global partnership for sustainable development.
Integrate scientific and practical knowledge and support a demand driven innovation process that will result in lasting, efficient and effective solutions to water-energy related problems.

Solving problem, understanding nature of problem and its underlying causes

Brings out a library of solutions (global, regional, local) from academics and industry

Identify feasible Solutions, (cost effective, social environment)

Implementation and monitoring

Capacity and skills development

Nexus Solution Lab Network

Assessing feasibility, profitability and sustainability of innovative ideas and products
SYMPTOMS : PROBLEM

Problem: nature, cause

Solution: inventory

Solution: rationalisation

Implementation

Monitoring effectiveness

Capacity: legacy
Nexus Solution Lab Network

- Address Broad SDGs Agenda
- Achieve multiple objectives simultaneously
- Connects science to policy makers
- Benefit private small and medium enterprise
- Reduce transaction cost, increase confidence and transparency
Conclusion

• Water end use dominates water related energy
• Fundamental framework need to understand linkages and boundaries
• Urban Metabolism provides a rich conceptual basis
• Connects solutions with Problems to achieve resource use efficiency
• New forms of management and governance of water and Energy