WATR7700 - Urban metabolism: resource and energy recovery systems (2 units)

Integration module (Specialisation stream #2: Urban water)

Module description

As more than half of the global population now call the urban environment home, ensuring the sustainability of water dependent services including water supply, food and energy generation to urban areas is crucial. There is a need to reduce the linear flow of water, material resources and energy, through promoting technologies and practices which achieve recovery, re-use and demand reduction.

Viewing urban areas as systems that 'metabolise' resource inputs, ultimately releasing them back to the environment as wastes, this module challenges current patterns of water, energy and nutrient use in cities as inefficient and unsustainable. Emphasis is placed on water, with coverage of technologies and management approaches to manipulate water flow in urban systems so as to improve 'metabolism' by reducing raw water intake and recovering and using the resources that wastewater carries, particularly energy, nitrogen and phosphorous. In doing so the course covers theories of urban metabolism and more broadly resource efficiency and how they relate to sustainability, cities and water; mass balance modelling; Life Cycle Assessment and Input / Output modelling; water recycling and reuse; energy and nutrient recovery technologies; water-energy interactions in cities; issues surrounding the best scale for the recovery and re-use of water, energy and nutrients; urban agriculture, permaculture and alternative production and consumption models as ways of improving the urban metabolism and consequently sustainability.

The aim of this module is to equip participants to be able to critically assess the resource efficiency and sustainability of urban systems from household through development to whole city scales; to be able to systematically quantify physical flows in complex urban systems; to construct and use urban metabolism models to characterize and evaluate options for improving urban sustainability.

This course comprises key skills that are important for a rigorous understanding of integrated water management problems.

Key topics include: resource efficiency, urban metabolism and sustainability; defining systems and subsystems; mass balance modelling; life cycle assessment; water recycling; energy recovery; nutrient recovery; urban agriculture; water-energy nexus; decentralisation.

IWC Graduates receive a co-badged degree from four leading Australian universities, ranked among the top 1% of the best universities in the world for teaching and research. (QS World University Rankings)

Module introduction

This module equips participants with the skills, tools and technologies for studying urban areas as systems with inputs and outputs (wastes); to critically assess the relationships between metabolic information and urban sustainability, and; to understand the strengths, weaknesses and opportunities of urban metabolism and more broadly resource efficiency as a framework for informing policy and management.

The module is developed in three sections, covering topics as follows:

- Principles and techniques of a 'systems approach':
  - scale
  - boundaries
  - units and relationships
  - data requirements and sources
  - modelling and analysis approaches
- Urban areas as systems that metabolise input:
  - principles of and approaches to understanding urban metabolism
  - urban sustainability, policy and management
  - relationships between urban metabolism and sustainability
- Infrastructure for flow management and resource recovery:
  - types of intervention for resource flow management
  - infrastructure options for managing resource flows in water and associated systems

Module delivery

- **Full-time** (on-campus) students, including international students, are required to enrol in the internal offering in Semester 2.
- **Part-time** (external) students are required to enrol in this module in Semester 4. The Semester 4 intensive six-day workshop is held at the beginning of the semester. The remainder of the module is taught externally online.

Assumed background

The following modules are pre-requisites for this module: 'New perspectives on project management', 'Science of water', 'Water, sustainability and development', 'Water governance and policy'.

Learning objectives

After successfully completing this module participants are able to:

- Define systems by identifying appropriate system boundaries
- Understand accumulation and the difference between steady-state and dynamic models
- Conduct material balances to quantify material flows, inputs and losses
- Understand and be able to critically appraise urban metabolic theory as a basis for delivering urban sustainability
- Construct an urban metabolism model based on mass balance principles, urban metabolic theory and resource efficiency frameworks
- Critically use urban metabolic theory and models to characterize and assess options for improving urban sustainability through improved water, nutrient and energy recovery
- Describe and assess the strengths and weaknesses of key water management and resource recovery approaches and technologies for improving urban metabolism including recycling and energy and nutrient recovery
- Appreciate the importance of engagement and collaboration in delivering changes to urban production and consumption behaviours and systems
- Have improved (1) their ability to manage their own study and (2) their ability to work effectively in a multi-disciplinary team
- Have participated in an integrated group project exploring detailed aspects of integrated water management.

Teaching staff

Lead Lecturer: Dr Brian McIntosh (International WaterCentre)

Lecturer: Dr Steven Kenway (Advanced Water Management Centre, The University of Queensland)

Lecturer: Mr Joe Lane (Advanced Water Management Centre, The University of Queensland)

Lecturer: Dr Marci Webster-Mannison (School of Architecture, The University of Queensland)

Lecturer: Dr Dick Copeman (Northey Street City Farm)

Brisbane river (photo: Brisbane Marketing)