A Nexus approach to Catchment Scale Intelligence

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Stream

The Industrial Doctorate Centre for the Water Sector

Catchment Scale Intelligence (CSI) Project aim:
To identify **cost effective** methods of enhancing the **resilience** of water and wastewater service delivery, by applying a **nexus** based approach at the catchment scale.

1. Development of an interventions database, including both hard and soft intervention measures to meet a required level of resilience,
2. Identify and model the interactions between the key components of the urban water cycle under a range of stress scenarios to demonstrate system resilience,
3. Development of a cost/benefit analysis tool for resilience interventions that can be analysed against various scenarios,
4. Development of a probabilistic assessment tool to asses cost implications of extreme events against potential mitigation/adaptation interventions and associated risk levels,
5. Case-study demonstration within Exe catchment under various scenarios,

The Catchment Scale Intelligence (CSI) project also contributes to a further project that South West Water is involved with called SIM4NEXUS, which looks at the policy and resource interactions between the water, energy and food sectors.

1.

The **Scope of the work** covers the region of the South West of England which is under the operational control of **South West Water** Ltd, and examines in detail a **specific case study** on the **Exe Main** catchment.

The area roughly aligns to the UKK30 and UKK43 NUTS boundaries **Devon** and **Cornwall**, covering an area of approximately 10,300 km2.

There are 1.7 million residents in the region, with the majority of the population (45%) located in just 13 urban centres,

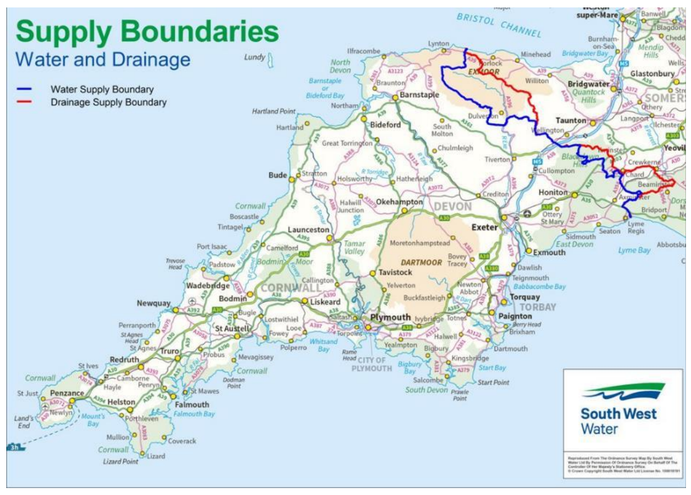

Figure 1 operational area

2.

The project is conducted a **two spatial scales** offering insight at **strategic** and **tactical** levels:

1. At the strategic, regional level, a whole Nexus approach is taken which models the interactions of the Water, Energy and Food sectors.
2. At the tactical, catchment level, a detailed **case study** on the **Exe Main** catchment, models the operational considerations of the Urban water Cycle

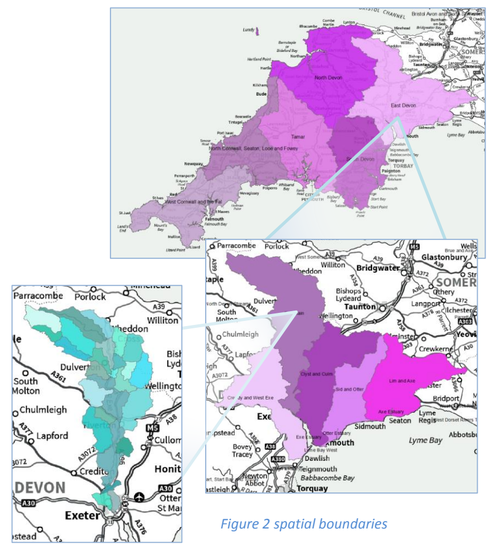

Figure 2 spatial boundaries

3.

Two **conceptual models** have been developed to provide a framework for understanding the interactions of the 4 nexus sectors at the **regional** and **catchment** scales.

These models inform the subsequent development of **System Dynamics Models** (SDM) which simulates these sectors over a time horizon of 2020 to 2050.

Both SDMs have the same basic structure and similar arrangement of sub-models which are tailored to suit strategic or tactical objectives.

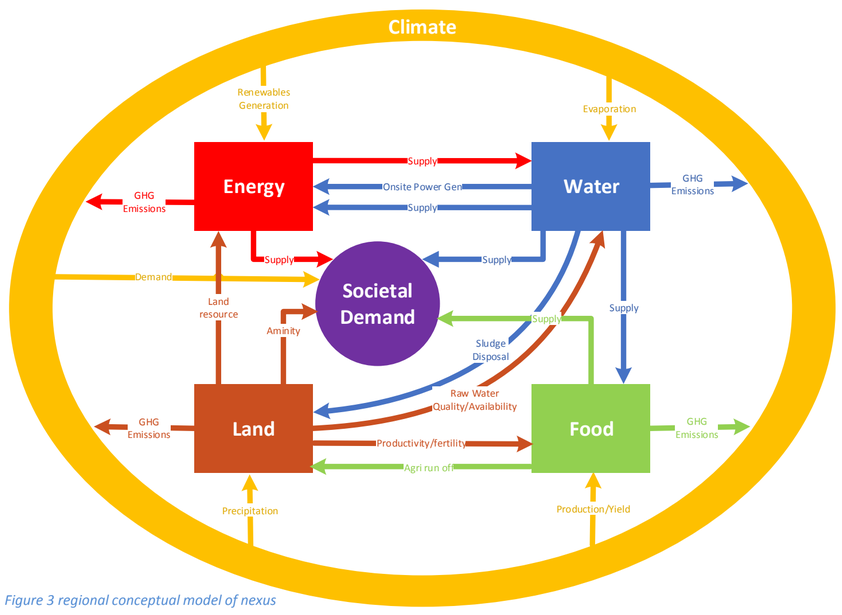

Figure 3 regional conceptual model of nexus

At the regional level the conceptual model concentrates on the macro interactions between the sectors, considering resource flows, policy interactions and global level environmental impacts.

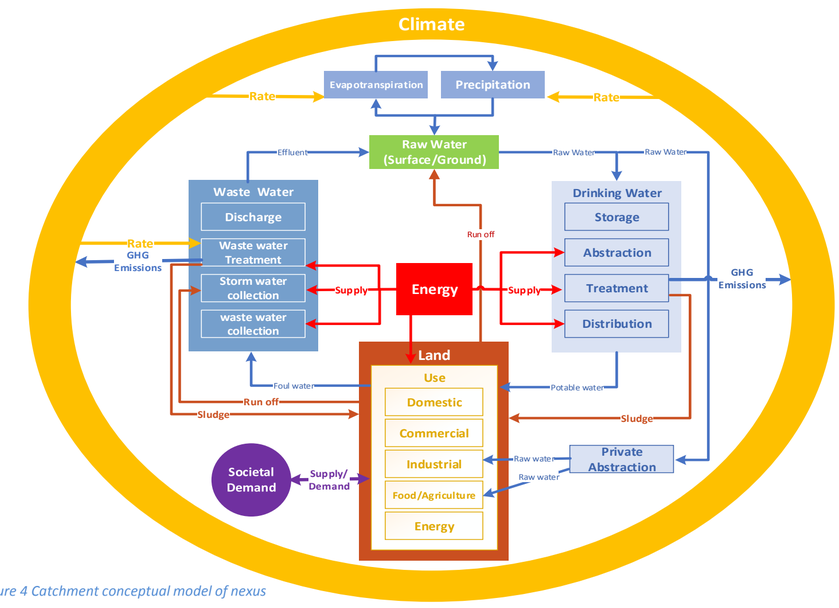

Figure 4 Catchment conceptual model of nexus

At the catchment level the conceptual model concentrates on the specifics of the urban water cycle, where individual treatment works and population centres are considered

4.

Both SDMs have the same basic structure and similar arrangement of sub-models which are tailored to suit strategic or tactical objectives as illustrated here:

The **Societal Demand** sub model sits at the heart of the nexus and simulates the demands placed upon the nexus sectors arising from society. This includes demands associated with domestic, commercial and industrial activities linked to GDP and population.

The **Climate** sub-model focuses solely on calculating total greenhouse emissions from the four nexus sectors and is split into four sub-models one for each sector.

The **water sector** sub-model is subdivided into *drinking-water* and *wastewater* supply chains which when linked via raw water resources describe the urban water cycle. The primary focus of the sub-model is resource management, whereby the supply, demand and consumption of drinking water are the driving factors.

Within the **catchment scale** model the water sector model is expanded considerably and seeks to integrate the objectives of the **Water Resource Management Plan (WRMP)** and **Drainage and Wastewater Management Plan (DWMP)**

The **energy sector** sub-model examines the balancing of supply and demand of electrical and thermal energy. All local forms of renewable and fossil fueled energy generation including electricity imported via the transmission grid. The energy sector model is subdivided into three modules representing: 1.Local Electricity from renewable sources, 2. The Distribution and Transmission Network, *and* 3. Thermal Energy.

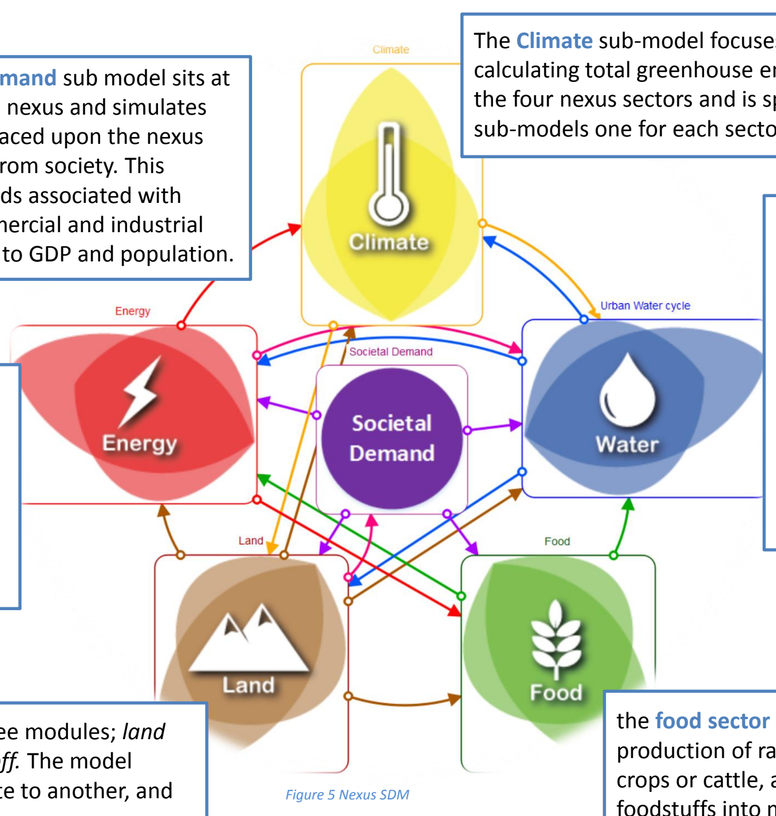

Figure 5 Nexus SDM

The **land sector** sub-model is subdivided into three modules; *land use*, *waste management* and surface *water run-off.* The model simulates the transition of land use from one state to another, and the associated impacts.

the **food sector** sub-model simulates the production of raw foodstuffs, i.e. the cultivation of crops or cattle, and the processing of those raw foodstuffs into marketable food products.

Next Steps for the project:
- Populate the model with data and begin model validation
- Develop system dynamics model of SWW's existing Resilience model and implement within the nexus model
- Develop cost benefit analysis framework for identified interventions

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