Testing the water

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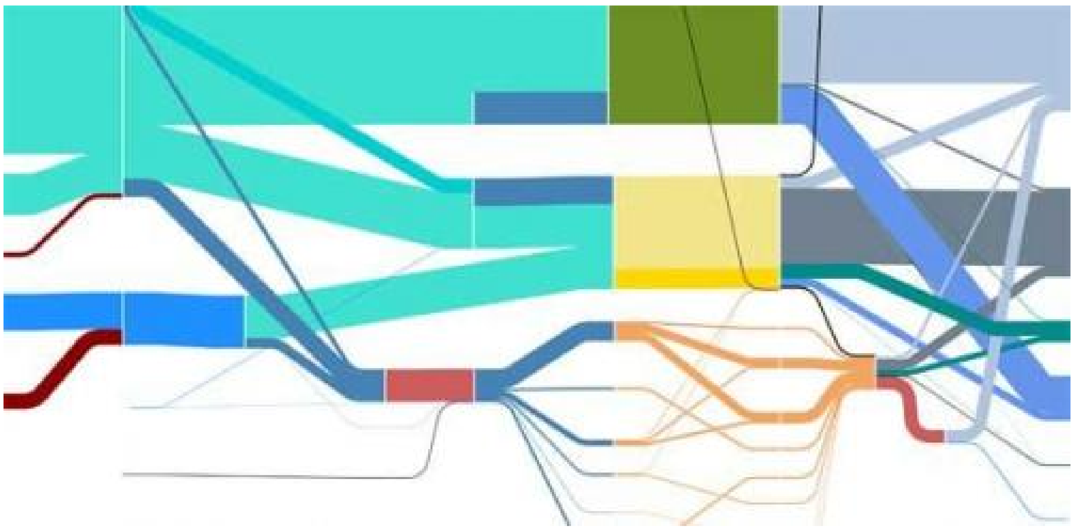

Sankey diagram. Credit: Foreseer Project

A new online tool enables users to assess not only how much water we use and for what, but also how we can mitigate future scarcity.

Water, like many other natural resources,is in both high demand and limited supply. In any one region, this precious substance is needed to sustain the domestic requirements of the population, irrigate crops, maintain ecosystems and assist in manufacturing and energy production.

Focusing on the state of California, a multidisciplinary group of Cambridge researchers has developed a model to calculate monthly and annual water demand. Moreover, because the model calculates future scenarios, it provides a means of assessing what can be done to mitigate water scarcity.

Dr Julian Allwood, who leads the Foreseer Project that created the tool, explained: "We're aiming to create visually compelling messages about resource use now, and in the future, to help users understand the consequences of their choices. We want to help identify opportunities where efficiencies or demand reduction would be effective, and equally we need to demonstrate which actions would have only a little impact."

For resource managers, policy makers and industry, understanding how to sustainably manage the competing demands on a limited resource is a considerable challenge. An estimated 1.2 billion people currently experience water scarcity and, as the population rises, demand will increasingly outstrip supply.

At the heart of the online tool is the Sankey diagram: a visualisation technique that transforms the plethora of data into an intuitive representation. Horizontal lines trace the flow of water from its various sources (rainfall, surface water, ground water, recycled water), through the services that use it (agriculture, industry, domestic and the environment), to where it ends up, with the relative width of each line representing the amount of resource at each stage.

The model is among a suite of similar tools being created by the BP-funded Foreseer Project. The first is focused on energy, land and water use in California, and is now being used by members of industry, academia and NGOs. Recently, the researchers began work to implement and visualise energy scenarios being considered by California energy planners to investigate the land and water resource implications of future energy use.

"There is a certain attraction in being able to see all demands on a resource being traced through to its end point," explained team member Dr Jonathan Cullen. "It reveals the scale and impact of human choices and directs attention towards actions that might make a real difference. Because the tool is dynamic, it's possible to 'toggle' multiple water management policies to see what the outcome on energy, land and water resources might be."

In California, the water resource issues already faced by the state are likely to worsen with the predicted climate-related reduction in snowpack in the Sierra Nevada. At the same time the demand for water for agriculture, urban uses and the environment could also increase, which may lead to intense competition between these different sectors.

It's a gloomy picture but, as researcher Dr Liz Curmi described, the aim of the tool is to look for positives. "We built the tool to be user centred because we wanted people to think about the positive actions they can take to reduce stress on the resource. So, a policy maker might ask whether increasing desalination would make a difference, and the answer, on a state-wide level, is no. But reducing the amount of irrigated water used by the agricultural sector through growing less water-intensive crops could have a dramatic effect."

Key to the Foreseer Project is the ability to look at the whole picture, to create models that go beyond focusing on a single resource to integrate water, energy and land use. It's a strategy intended to understand what Professor John Beddington, former Chief Scientific Advisor to the UK government, termed a "perfect storm" of insufficient energy, water and food.

"This cohesive view differentiates us from other modelling research groups," said researcher Grant Kopec. "By integrating these resources, we think we can identify trade-offs between sectors that you might not normally think of as being connected, for instance between power production and agriculture."

The team, which also includes Bojana Bajželj and Ying Qin, works in the Department of Engineering but is supported by a multidisciplinary group of nine co-investigators from seven different departments. "The collaboration of experts from so many disciplines has been critical to the iterative process we go through to create our models," explained Allwood. "We all have an interest in the demand on global resources but this may be from a geographical, atmospheric, biological, engineering, mathematical or management perspective – all are needed if we want to design mitigation plans that add up."

Now the team is extending its focus to other regions of the world including China and the UK with, respectively, funding from BP and as part of a multi-university consortium (WholeSEM) funded by the Engineering and Physical Sciences Research Council.

Eventually, the aim is to connect regions, countries and continents to arrive at a set of linked global assessments of water, land and energy resources. Already, they have accomplished this for global man-made greenhouse gas emissions: connecting services such as food and transport via the business that delivers them through to the fuel each uses and the emissions that are created.

"By visualising the data as Sankey diagrams, we find out that the scale of intervention really matters," said Allwood. "One of the big things we've learned is how increasing efficiency is not enough – we also have to reduce demand because this can have far more widespread positive impacts than previously considered."

Provided by University of Cambridge