



# MAPPING THE STRAIN ON WATER FOOD AND ENERGY





# Towards resource sustainability

*Ensuring there is water, energy and food to meet growing demand is essential for society, but first a complex web of demands, uses and connections between both resources and stakeholders must be mapped, which is precisely the goal of the WEFWEBs project*

As the world population grows, the strain on the planet's resources grows too. How we manage this strain on water, energy and food (WEF) depends entirely on our ability to grasp where, when, how and why these resources are being stretched. WEF explicitly acknowledges that these crucial resources are connected. Water is used to drink and grow food, and energy is used to treat water and harvest food, for example. Each of these resources does not provide a single benefit but rather each is used to impact multiple areas of human society. In a similar way one solution to managing each resource separately will also not be enough.

Ensuring sustainability of our essential WEF resources is the goal of the WEFWEBs project and, specifically, they aim to map the so called WEF nexus. In doing so the goal is to educate stakeholders from all levels, such as local citizens in households, to industrial and agricultural users and producers to nations, on the interconnectedness of WEF and how we can all better manage these systems..

## MULTIDISCIPLINARY TEAMS ARE ESSENTIAL

The nature of the WEF nexus is in itself multifaceted, with three interconnected resources, which are pulled in different directions to meet ever increasing demand. This type of issue specifically requires multiple areas of expertise. Born out of a so called 'sandpit' meeting hosted by the Engineering and Physical Sciences Research Council, whose specific goal was to bring together diverse groups of academics, professionals and stakeholders to think laterally, define and propose solutions to complex WEF issues, the WEFWEBs team did just this and received funding for their proposal.

Members of the team come from nine different universities and represent backgrounds in fields such as urban studies, computing science, high performance computing, law and governance, life cycle analysis and data analysis. According to Marian Scott, Professor of Environmental Statistics at the University of Glasgow, and WEFWEBs' Principal Investigator, 'the key aspect of our work is that we have forged a team with the necessary multi-disciplinary skills.' This diversity is essential, explains Scott, because 'each of the three systems need to be studied through the data that exists concerning their flows, resources and connections, but also through individual and civic understanding of the systems', hence the need for the range of disciplines. Scott continues, combining 'the physical, environmental, computational and mathematical sciences, with economics, social science, psychology and policy is essential'.

Together the team aims to collect, assimilate and synthesise existing models and data with newly acquired data from advances in sensing technology and, even, social media. In doing so they have examined the nexus in three different, place based, case studies, to deliver dynamic maps showing different dimensions of the problem, reflecting current status and changes, and the interactions of these in space and over time. The three case studies currently underway are located in the Plymouth, Dartmoor and Tamar area, the city of Oxford and a winery in southern England. Each location was chosen, Scott says, because 'scientifically they presented interesting but also different systems, for a successful workshop due to differences in scale and scope, plus we wanted to have contrasting systems, both

urban and rural'. The locations cover a range of different stakeholders and levels of governance providing a robust test of the program's methods and abilities. The team have also held smaller workshops in London and plan one in Leeds to consider some of the essential infrastructure in our cities.

## COMPLEX LANGUAGE AND DATA

The project, now 28 months old (and due to end in September 2018), has overcome some early challenges. Namely, defining something as complex as the WEF nexus required all team members to speak the same language. 'Language is important, and there are potential issues in different disciplines using the same language but with different meanings.' Scott admits this was a challenge but one she feels they have successfully overcome, allowing the team to more effectively focus on the project's specific objectives. Along with communicating with each other, communication with stakeholders is also key. With such a wide variety of stakeholders and sources of data, organising everyone's concerns, input and schedules is not easy. The project workshops have been essential in this process, as they have forged links between groups. They also 'give back' to the stakeholders that participate. Members of the team from the University of Exeter have even worked with a local artist to represent the nexus through art, providing a unique way to disseminate the results to the local community.

Overcoming the challenge of data availability, while difficult, has also led to success for the WEFWEBs team. Aside from collecting their own data, the team relies heavily on public data that can be incorporated to accurately model the nexus

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at many scales. These data also need to be presented to the public, so issues of privacy are always at the forefront. Data availability is not a unique problem to WEF work and the team fully respects the sensitivity and need to protect certain data, especially at the level of personal citizens, as well as the commercial value of certain data types. The strength and trust of the collaborations the team has built have helped to overcome this and the team is starting to produce some very promising results. These include multi-level mapping efforts of water, energy and food systems and nested spatial scale maps, combing disaggregated water and energy uses, with supermarket and agriculture water and energy uses across a given region.

## EXPANDING WEF NEXUS UNDERSTANDING

As the final year of the project begins, Scott says 'many of our plans are coming to fruition and we can see the outputs from



The WEFWEBs team at a Newcastle workshop

work begun in year one' which has only encouraged them to pursue further work in this area. The group is eyeing what they consider is an area with a large amount of opportunity, in the developing world, as well as potential collaborations and opportunities in Europe. They have even implemented some joint workshops in China.

In the absence of the WEFWEBs project there does not exist any systemic, participatory, multi-stakeholder mapping efforts for the WEF nexus in the UK or elsewhere. This project, however, is providing the innovation, in terms of the diversity of the team and variety of methods being used. With methods like systemic intervention, data analytics and crowd sourcing techniques the project is demonstrating that such complex research questions are no longer beyond our ability to answer. And this is good news because, as this project also demonstrates, questions of sustainability do not hinge on a single issue, factor or community, they are inherently connected. There is not one single nexus, and each will be context specific, requiring a variety of language and disciplines to continue to work towards sustainability. There is, however, only one Earth and understanding how actions by one group effect the lives of others is a key to making sure the whole planet is productive, sustainable and liveable.

## Project Insights

### FUNDING

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### ALIGNED WEF PROJECTS

SteppingUp and Vaccinating the Nexus were also funded at the same time as WEFWEBs.

### PARTNERS

- Imperial College London
- University College London
- University of Cambridge
- University of Exeter
- University of Glasgow
- University of Newcastle
- University of Oxford
- University of Reading
- Science and Technology Facilities Council (STFC)

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### PRINCIPAL INVESTIGATOR BIO

**Professor Marian Scott** has been Professor of Environmental Statistics at the University of Glasgow since 2000. She has a BSc (Hons) in Statistics from the University of Glasgow, and her PhD was in radiometric dating (jointly with Chemistry and Statistics). She is a chartered statistician, an elected fellow of the International Statistical Institute and in 2005 was elected a Fellow of the Royal Society of Edinburgh. Scott was, until 2006, chair of the Royal Statistical Society, Environmental Statistics Section, and is a member of the Environmetrics Society.



WEFWEBs



## Impact Objectives

- Examine the data and evidence for the nexus of water, energy and food systems and their interactions and dependencies within the local, regional and national environment
- Addresses the challenges of understanding and identifying the dynamic, interlinked inter-dependencies across the nexus networks

# Mapping the strain on water, food and energy

*Professor Marian Scott discusses the WEFWEBs project efforts to discover and map the water, energy and food nexus, so a sustainable future for all three connected resources can be built*



**In what ways are the Earth's water, energy and food systems (WEF) under strain?**

The WEF nexus was described as being part of the 'perfect storm', we have finite natural resources which more and more people wish to have access to. We live on one small planet, yet many parts of the world are consuming resources equivalent to three planets. Competing demands on limited resources can bring conflict and tensions and thus the WEF nexus is a means of describing and conceptualising these strains, hopefully offering some potential solutions.

**What is meant by the 'water-energy-food nexus'?**

The water-energy-food nexus is easiest described in terms of sustainability, or, whether there is enough for everyone. Our water, energy and food systems are all interconnected, there are dependencies between them, as examples, we need energy to treat wastewater, we need water to grow crops, etc. As our population grows, and uses land for multiple purposes, then we have competing demands on limited resources. This is true at local, national and international scales. The WEFWEBs goal is to better describe and define the

interdependencies between these systems and improve our understanding and ability to effectively predict and manage them.

**How are you ensuring that WEFWEBs' findings translate into real-world impact among regulators, policy makers, industry and other stakeholders?**

Communication is key and our workshops have been great ways to meet and discuss the issues and co-develop new understandings with stakeholders. For example, we have been working with vineyards/wineries in the South and linked associations to allow them to better understand their nexus and its sustainability/economic impacts, now and in the near future. We have held a workshop on site to showcase what can be done with some new sensor technology. Also, we are developing those same technologies and algorithms to measure the nexus in households. In this way, our technology developments are not only useful in industry but extend to others in the agricultural sectors and other industries. We have also, through our Exeter team, worked closely with a local artist to prepare an installation to represent the WEF nexus through art. Images of the art work can be seen on the WEFWEBs website.

**Your quantitative assessments have been hampered by a lack of openly accessible**

**data. Moving forward, how could this problem be reduced?**

Yes, this has proved challenging, but this is not unusual, since much data needs to be 'protected', for example, health data which are sensitive. There have been systems put in place, such as safe havens to allow work to continue, and a considerable degree of scrutiny before any data linkage or analysis is allowed by the data custodians. The issue of data availability is one which will remain for some time to come, and we respect the sensitivity, and sometimes commercial value of such data. This issue is especially evident at the local scales, like households, but less so on national levels. Collaboration, trust and mutual benefit are key to data sharing.

**A multidisciplinary approach is at the centre of the WEFWEBs project. Why is this?**

This approach is essential for WEFWEBs since improving our understanding of the water-energy-food nexus requires knowledge about environmental systems, economics, law and especially important social and political systems. Many of the global grand challenges (which the WEF nexus represents) don't simply present technological challenges, they also represent personal challenges for individuals and society which we need to address, hence the need for a multi-disciplinary approach. ●