Nexus thinking for food security research



Nexus thinking for food security research: managing land to produce food, water and other ecosystem services

Pathways to delivering a nexus approach

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Executive Summary

In June 2014, the GFS Programme held a workshop to clarify and stimulate nexus thinking, identify interdisciplinary research priorities, and foster cross-sector collaboration. In a world characterised by a rapidly rising population coupled with a declining resource base, new ways of conceptualising the linkages between food, water, energy and land are of precedence to future resource security. Understanding the interactions between these four arenas as a 'nexus' will help decision-makers to understand and optimise 'trade-offs' at multiple scales. There is evidence that a nexus approach would enhance resource security by increasing efficiency, reducing trade-offs, building synergies and improving governance across sectors. The challenge of delivering efficient use of natural resources, for many different purposes, requires an integrated approach; it must be a cooperative, collaborative, interdisciplinary effort. The workshop resulted in a number of key priorities (see below), which will help inform GFS activities in this area.

Summary of key priorities

Session 1. Understanding the nexus for UK multifunctional land use and food security

To understand how to manage land for food production so that other socially important ecosystem services continue to be delivered, the session concluded that the major UK research priorities are:

- Collecting and analysing data across many traditional sectors (water, food, ecology) and at multiple scales (field, farm, landscape, national) alongside developing assessment and optimisation tools;
- Understanding how to increase awareness of the "externalities" arising from land use and their accountability. This is linked to a broader need for research on influencing the choices of land use decision-makers;
- Defining 'resilience' for multifunctional land use, and visualising alternative production and management systems.

Session 2. Understanding the nexus overseas: resilient UK food supply chains

To increase our understanding of the impact of the nexus overseas on UK supply chain resilience and producer countries' national security, the session concluded that major research priorities include:

- · Characterising and improving the resilience of supply chains;
- Understanding the dialogue between retailers and consumers; the relationship between consumer knowledge, values, and choices, and retailer responsibilities;
- Understanding and addressing the 'embedded' water (and embedded "other ecosystem services") in traded commodities.

Session 3. Framing the nexus

In terms of framing the discussions, it was agreed that the following are needed:

- · A clearer understanding of what successful multifunctional land use would look like;
- · A pluralistic approach, using a multiple hierarchy of scales, with an appreciation of regional variation;
- A whole-systems approach on optimising land use to deliver more than two services is needed given that focusing on just water and food (or water and energy) would lead to perverse outcomes.

Development of nexus thinking would not be rapid but a gradual, step-wise process; and would require broad stakeholder engagement. Other consistent points of agreement included the need for: interdisciplinary training of experts and trusted intermediaries ('nexologists'?), metrics (the 'nexum'?), and a greater focus on the relationship between energy security and food security.

Introductory Session

The GFS programme was introduced by Dr Jackie Hunter, the BBSRC Chief Executive, highlighting its added value and achievements to date. This was succeeded by the GFS 'Champion' Professor Tim Benton who introduced the main issues – optimising land use for multiple services, meeting increasing resource demands under climate change, and understanding the impact of changing demand on decision-makers.



CONCEPTUAL FRAMEWORK

Session 1. Understanding the nexus for UK multifunctional land use and food security

This session was chaired by Professor Tim Benton and participants heard three presentations before addressing the panel with questions. Professor Ian Bateman (Professor of Environmental Sciences, UEA) outlined what drives change in the UK's nexus and the impacts of this; the long-term economic benefits of sustainable land use; and the importance of integrated analyses, recreational values and regional variation e.g. between cereals and livestock. Jim Godfrey (Director, Godfrey family farming companies) then emphasised the UK's strengths, weaknesses, constraints and R&D challenges in terms of increasing food production. The final presentation was given by Professor Ian Boyd (Chief Scientist, Defra) who outlined the challenges of optimising land for food, water and energy at the global and UK scales and current activities to address the nexus including Defra's Sustainable Intensification Research Platform, Demonstration Test Catchments, and R&D.

During the Q&A session with the panel, participants challenged the suggestion that 100% more food is needed by 2050. Food security is a multifaceted problem, and the importance of influencing choice and improving efficiency was stressed. Likewise, participants felt that the focus of discussions should be on UK 'nexus systems' as opposed to UK farming systems; solutions must address future nexus interconnections e.g. solar farming. Farmers often want to maximise agricultural production, but it was highlighted that this is only part of the solution. Others emphasised that we should not stop using productive agricultural land for producing food except on extreme occasions. It was agreed that clarity is needed regarding how all land can be used in the best possible way, and the floor was reminded of the political need for scientists to understand complexity and provide simple solutions.

Breakout Session 1

(a) What is the most appropriate spatial scale (farm level, national level, or other) for managing land using a nexus approach, and why?

Key points of agreement:

A multiple hierarchy of scales is needed. Each scale accounts for a unique assortment of elements, processes and actors and all scales intersect. The scalar perspective best suited to understanding how a particular system may differ to that for managing it. The national scale may be appropriate for target-setting whilst the farm scale may drive the most change. The landscape scale is important for uniting different needs whilst food security is affected by global issues such as export prices and global energy demand.

Regional variation must not be overlooked.

Management approaches must be pluralistic. Managing the nexus necessitates knowing where the biggest wins or risks are. This must incorporate multiple stakeholders and consider both supply and demand.

Definitions may shape the response. The definitions of 'management', 'nexus' and 'most appropriate' need clarification and agreement.

(b) At your chosen spatial scale, what are the major challenges to understanding the nexus?

Agreed major challenges – applicable to all spatial scales:

Lack of data. Limited data is available on, for example, the environmental performance of farmers. More data is also needed on feedback loops - stakeholders need to get 'nexus signals' as well as price signals so feedback must be more immediate.

Scalar bias and externalities. Stakeholders may only relate to the scale that their practices most intersect; for example farmers may not relate to the catchment scale whilst national policy may not adequately account for farm-level decision-making or local food banks. This contributes towards a low awareness of externalities. Increasing decision-makers' awareness of the unintended consequences of their actions may be done through incentives, policy influence or by incorporating externalities into the agri-food sector. Reducing the gap between low- and high- productivity farmers could lead to greater engagement with environmental stewardship.

Political prioritisation. Multiple policy aims need to be understood and quantified. The needs of stakeholders must be balanced, but ideal views of the optimum differ between people. Is optimisation about working our best land the hardest, or managing everything beneficially? Our best soils are worked the hardest yet are the most degraded.

Jargon. To have influence, concepts and objectives must be clear, consistent and appropriate to the desired audience.

Institutional silos. Understanding is limited by an engrained bias to silos. Effective mechanisms for crossdisciplinary and cross-sector working are needed

(c) At your chosen spatial scale, what are the biggest gaps in our current knowledge to understanding the nexus which further research could help to address?

Agreed research gaps – applicable to all spatial scales:

The design, development and implementation of tools. These include tools to: enable decision-makers to understand multidimensional key conflicts and trade-offs; guantify the environmental costs of products; 'rate' environmental performance; collect and integrate knowledge; understand trade-offs; aid understanding and response to extreme events; enable optimisation of different ecosystem services; show movement between ecological states; and monitor nexus performance - a tool which could 'characterise' how the nexus 'looks' in the UK, for example. The development of each tool will require an understanding of the appropriate timescale for its objectives. These tools would aid the understanding of UK vulnerabilities and the likelihood of adaptation through modelling of 'what if..?' scenarios. For example, what if soy went? We would need to understand which compromises are resilient and which are not; this could be done through a risk matrix with further understanding of tipping points. More factors also need to be considered in current land use models and integrated assessments should be broader.

Developing metrics. Developing models and tools requires an agreed set of metrics which demands consensus on what to optimise and for whom. Metrics could be developed for the preserve stock of 'natural capital', or for a new unit of measurement - the 'nexum'. Nexus metrics should account for the nonstatic nature of optimisation due to feedback loops, and given that 'in using metrics you lose dimensions', a 'dashboard of metrics' with acknowledgement of the differences between them is required. Benchmark metrics in the human dimension such as sustainability metrics are also crucial.

Conceptualising scale gradients and variability. Concepts and tools are also needed to enable switching between scales. The ability to scale up or down fluidly would negate the significance of static scales. Associated is a need for deep contextual understanding of the UK's environmental diversity and places that defy regional trends in order to, for example, best optimise the large scale movement of water under climatic extremes. Land use diversity and urban land must also be accounted for.

Influencing awareness and behaviour. This applies to consumers, land managers and political decisionmakers. It concerns the potential for incentivising farmers, and for cultural transformations. The scale of increasing understanding needs to link to that of decision-making.

Defining and visualising resilience. Especially understanding how it can best be put to decision makers.

The impact of energy on food security. A better understanding is required of how feed-in tariffs are distorting markets.

Knowledge synthesis. Synthesis is needed between case studies and trials, akin to Chatham House's linked-up trials on low carbon zones in Ethiopia at the water catchment scale, to be rolled out at the national level. Maintaining synthesis would require a network of expertise and linked projects at the catchment scale. 'Nexologists' could be appointed as advisors, with the role of upholding the network and disseminating research to decision-makers.

Designing and evaluating creative alternative production and management systems. There is a risk of developing systems that replicate the mainstream bias towards silos. There is therefore a need to envision and construct new systems that address interdisciplinary issues such as diet and waste. This requires investment in research on alternative crops, alternative production systems, and alternative management systems across the nexus.

Session 2: Understanding the nexus overseas: resilient UK food supply chains

This session was chaired by Steve Jennings (Oxfam) and followed the same format as the previous session. Professor Bruce Lankford (Professor of Water and Irrigation Policy, UEA) spoke about the local impacts of global food demand overseas in terms of irrigation using the 'virtual' water embedded in asparagus imports as a case study presenting some political, managerial and technological solutions. Dr Tim Hess (Reader in Water Management, Cranfield University) highlighted the impact of UK food consumption on global water scarcity through the blue water embedded in different commodities from countries with varying degrees of water stress. Dr Chris Brown (Head of Sustainable and Ethical Sourcing, ASDA) outlined the changing risks to ASDA's food supply and various measures being taken by the company to address or mitigate them.

> During the Q&A session with the panel, the ethical considerations associated with the nexus - the nexus 'for what and for whom?' - were emphasised as an important component of any research programme. One research suggestion was: 'if you improve water use somewhere, does it create room for mismanagement elsewhere?' There was consensus that this depends on governance. The panel feel more research is needed on irrigation, particularly its 'embeddedness' in traded commodities, such as rice. Given the excessive water demands of rice cultivation, rice was a frequently mentioned commodity example. Professor Lankford reminded participants to be mindful of the bigger picture, however; for example, the rice paddies that stop flooding in Bangkok, so all issues and solutions are framed using a particular lens. A training need regarding irrigation was also voiced; rice is the staple food crop for half of the world's population yet no interdisciplinary training exists on irrigation. Dr Brown outlined that the UK may have to further rely on supply chain intermediaries under climate scenarios, in order to limit disruption to supply chain flexibility.

Breakout Session 2. Given that the UK imports from areas with increasing pressure on local natural resources (land and water), what are the associated risks of this to:

(a) Our supply chain resilience? (how can they best be assessed?)

Agreed research challenges:

Understanding the nature of the global market. Understanding this imperfect commodity market is a major challenge; it is dominated by few countries, large companies and huge geographic diversity. Its associated risks, such as transport reliance, also need to be understood. In some cases there is no global market but discreet relationships between buyers and suppliers (e.g. fruit and vegetables). We cannot address the domestic challenge without first understanding the global dynamic – but it is not clear which comes first.

Characterising and analysing the resilience of supply chains.

This includes understanding: how resilience can be defined using a broad taxonomy; how to include national security and political resilience; the factors that lead to future-facing resilient food supply chains (the role of self-sufficiency, importing, perfect world markets, prediction of extreme events, energy pricing, strikes and food crises); what the trade routes of climate-resilient agriculture will look like; and understanding the distribution and resource pressures of critical commodity supplies as well as input supplies such as phosphate, energy, and other agricultural chemicals. Analysis should investigate disruptions to distribution, the impacts of policies, and the challenges of resistance to agrichemicals. Research could ask what, if any, substitutes are possible (for example to soy), where they are grown, and what the resource and economic implications are.

Increasing access to data. Only a limited environmental data set is currently available on agricultural systems, such as plantations, in developing countries.

Relationships between retailers and consumers. This includes understanding: who manages consumer expectations; at what points values change and what are the triggers; and where the balance lies for supermarkets between competitive and pre-competitive activity. Linked to this is a need to understand what makes a sustainability brand or certification scheme successful.

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Agreed governance challenges:

Incentives vs. legislation. Understanding the appropriateness of incentives or legislation in different situations. This includes addressing unintended consequences, for example, the effect of biofuel regulation on global wheat prices or EU barriers to GM soy.

Accounting for externalities. Whose responsibility are they and how can they be reflected in prices?

Ensuring transparency of supply chains and certification schemes; what do they really mean?

'Managing' the nexus. Exploring the potential for, and challenges of, trans-boundary approaches to managing the nexus, as demonstrated by Nile management in Egypt.

(b) The producer countries' own national security? (and how can they best be assessed?)

Agreed research challenges:

Tipping points. Understanding the limits to resilience and adaptation.

Increasing knowledge and education. In terms of increasing understanding of, and educating others about, the impact of the UK's food supply overseas and the drivers of consumption behaviours.

Understanding embedded water. Interdisciplinary research on irrigation in different contexts is needed; the embeddedness of water plus the ethical considerations (e.g. dynamics between drought risk vs. economic gains). How the concept of other embedded natural resources ("embedded biodiversity" as an emerging concept, Life Cycle Analysis measures of embedded energy) applies beyond water.

Design, development and implementation of tools. This includes tools for scenario modelling and decisionsupport tools for understanding risks. Within producer countries, this could involve looking toward the supply situation in 2030/2050, combined with urbanisation forecasts. It could include predicting the impacts of scarcity - how bad does a bad price increase need to be, how will UK and global producers respond to scarcity and with what implications? Implications will cut across the spectrum of water use, energy requirements and production, nutrition, and consumer acceptability of vulnerable people and responses.

Understanding the impact of speculation on small scale producers.

Bioenergy. Research is needed to understand the circumstances under which bioenergy can enhance food production, and on the water footprint of energy crops. These questions cross sectors, countries and types of energy and require making a lot more data available.

> **Transforming local supply chains in the developing world.** Research is needed on the potential for co-creation of sustainable supply chains.

Agreed governance challenges:

Regulating food prices. These have a strong link to national security.

Transparency. Making nexus issues transparent and accessible to UK consumers.

Bio-energy. Reconciling land pressure associated with opportunities for bioenergy with food pressure.

Ethics. Trading off individual and societal needs against others creates moral dilemmas e.g. by importing asparagus the UK is 'exporting drought'. These trade-offs are a matter of choices that require governmental clarity and leadership.

Session 3: At chair's discretion

(a) In framing the nexus, should we focus on everything (water-energy-food-environment), or just two aspects?

Key points of agreement:

What will success of the nexus look like? Painting a picture of what is and is not deemed desirable will help to clarify the framework and course of action.

Focusing on two aspects leads to perverse outcomes. Any attempt to cut out factors leads to externalities.

A wider systems perspective is needed. The extent of what it is currently possible to analyse is limited by the comprehensiveness of data across different ecosystem services and scales. Does enough data exist to do a multivariate risk register of current commodity crops, nested at different scales? A preliminary audit of where data may be available would be a good first step.

It needs to be a step-wise process. The goal should be multifunctional, but this cannot be done in one leap.

Models need to pick up what the person on the ground is doing or needs.

Closing statements

This horizon-scanning workshop brought together relevant industry and public sector decision-makers with academic communities whose research interests span the nexus. A list of attendees is attached at Annex A.

Through this horizon scanning workshop, a number of key people in the field have been engaged and we have helped facilitate interdisciplinary collaboration.

During every session, and at every scale, the importance of a cross-sector, interdisciplinary approach was highlighted. In this context, the research priorities lie in gaining and creating the knowledge but solutions and advances will only come about through establishing trusted information exchange channels in order to disseminate and use this knowledge as a collective. Data must be continually shared and updated right the way through the system from small scale farmers to decision-makers to global industries.

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