Briefing on Quantitative Story Telling for the Land Use Transformations Project JHI-C3-1.

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Contents

1 Summary

This briefing is a deliverable from the Land Use Transformations project (JHI-C3-1) within the Scottish Government Strategic Research Programme (SRP) 2022-27. The purpose of the document is to share with SG analysts and policy leads the **Quantitative Story Telling** (QST) approach to working across the **science-policy interface** that will be deployed in the project. The aim is to raise awareness of the methodology, illustrate its potential and to act as a reference document for policy and other stakeholders collaborating on the research.

The briefing introduces the scope of the land use transformation project, with a focus on how land use needs to change to deliver net zero and other environmental objectives. The research delivered includes policy-relevant and policy led elements and is integrative and interdisciplinary. The QST approach is a crucial element in operationalising these ambitions as it clarifies how social, natural, and computational research can be better combined to support deliberations on policy design and evaluation with SG and other stakeholders.

The briefing presents the origins of the QST approach, referring to the evolution of policy-oriented and systems research within SG SRPs since the early 1990s. QST was formalised in the EU Horizon 2020 MAGIC project on the water-energy-food nexus and added knowledge from Science and Technology studies and Post-Normal Science to the SRP experience.

The stages of QST are outlined, highlighting that QST emphasises the importance of both 'semantic' phases (work with stakeholders to understand how issues are framed i.e., what is included and excluded and how evidence is interpreted) and 'formal' phases where data is collated and analysed via a variety of methods. For the Land Use Transformation project quantification typically uses mapping and computer-based land use systems models, but qualitative research methods lead in consideration of policy coherence and land use narratives. QST is also ideally an iterative process with three phases planned.

The briefing also highlights how QST can help to achieve a practical balance in science-for-policy between the need for a systems overview while avoiding generating overwhelmingly complex data that defies interpretation and discourages stakeholder engagement. From previous experiences, the briefing also notes the key lessons for QST: negotiating scope to ensure salience; the importance of building credibility with stakeholders by ensuring they have opportunities to interpret and critique the analysis; the challenges of working within policy timelines and the need to recognise existing norms of science-policy interactions.

The first application of the QST process will be to look at the Tier 2 Enhanced Conditionality Measures (Track 2 in the National Test Programme), as one of the ways in which SG is seeking to transform land use systems in Scotland.

The briefing concludes with key messages – the most important of which is that while QST is a demanding process for participants and researchers, it can be very effective in generating conceptual change to support instrumental outcomes, especially when issues are complex or contested and there is the need for a space in which deliberation on issues can be supported.

2 Briefing

2.1 Introduction to the Land Use Transformations project

The focus for the Land Use Transformations project is on the changes in land use needed to deliver the net zero and other environmental objectives while considering the consequences of such changes for a range of stakeholders. In this context, Land Use is an example of a complex, coupled social ecological system[1] with both biophysical and socio-technical components that need to be better understood if the ambitious transformative objectives of public policy and wider society are to be delivered. Land Use Science [2] is a form of interdisciplinary research that uses a wide range of natural, social and computational research methods to address issues of interest to wider society (i.e. Mode 2 interdisciplinarity[3]). The research is systems focussed and integrative, with new combinations of well-established Hutton research teams cooperating to generate insights by synthesising and exploiting data, tools and knowledge from within the Land Use Topic, with other SRP Topic teams (C5 Large Scale Modelling and D5 Natural Capital) and with a community of practice for science-policy[4].

Central to operationalising integrative land use science are deliberative inclusive processes, whereby participants not only provide data but also co-construct the framing and research questions and then interpret and act on the implications of the analysis (this is transdisciplinary research). Within the literature on working across the science-policy interface, there is increasing attention to how knowledge is used [5, 6] and the importance of iterative research cycles to improve engagement and impact[7]. The research on Land Use Transformations is in all cases policy-relevant, and where appropriate, policy-led (see Section 2.6). The project seeks to deliver a range of impacts with, and for, stakeholders through transdisciplinary working, contributing to ongoing policy and other stakeholder processes. The specific approach to transdisciplinarity used is Quantitative Story Telling (QST).

2.2 Origins of Quantitative Story Telling

QST was first formalised and tested in the H2020 MAGIC project in which it was used to support social learning regarding water-energy-food nexus issues and governance in complexity (multiple land use sectors, multiple objectives, multiple scales) [6, 8-10]. The approach formalised knowledge and experiential learning insights from Hutton researchers in a range of fields over several Scottish Government Strategic Research Programmes. These included land use decision support [11], soft system analysis [12], deliberative inclusive processes [13, 14], research communication [15], evaluating the impact of using environmental modelling and software [16, 17], policy options appraisal [18] and transdisciplinary working with policy teams [19]. The experiential learning was combined with insights from the science and technology studies, in particular the field of 'post-normal science' (see Section 3.2) that highlights the need to think differently about how scientific data is undertaken and deployed to support decision-making, when facing complex, contested and urgent transformation challenges. QST responds to these challenges: it is a process designed to help scientists work with stakeholders to prompt reflection on, and potentially reframing of, sustainability problems and to develop shared understanding of

the issues even when stakeholder values and trade-offs mean that a consensus outcome cannot be delivered.

2.3 What happens in a QST process

QST is a cyclical, iterative process that balances both 'semantic' phases – work with stakeholders to understand how issues are framed (what is included and excluded) and how evidence is interpreted - and 'formal' phases – work to quantify these issues, see Figure 1. QST typically incorporates data and expertise arising from different disciplinary perspectives (e.g., social, and natural sciences) as well as from stakeholders themselves. In this diagram, the top represents both the start and potential end point of the cycle, but successive iterations are desirable [20]. The figure highlights the importance of semantic-formal and formal-semantic interfaces where translational processes are undertaken and where co-construction can be crucial.

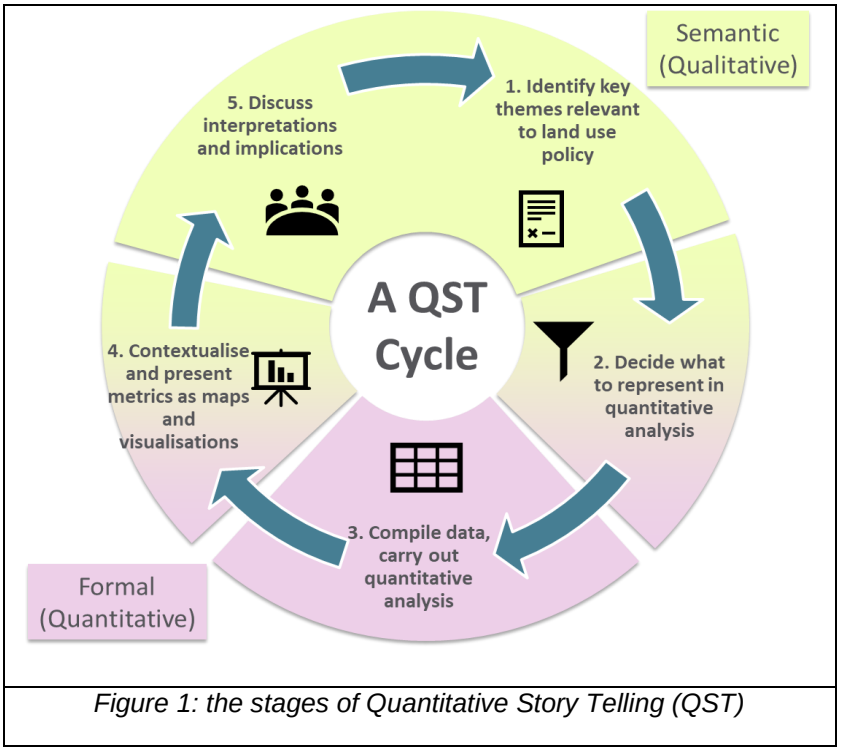

Figure 1: the stages of Quantitative Story Telling (QST)

Five stages of QST can be recognised. Although these steps are described sequentially, there may be occasions to move backwards and forwards around the cycle to modify the analysis. The intention is not to pursue ever-greater depth of analysis, but to complete the QST cycle and generate meaningful outputs that stimulate deliberations with stakeholders. The text of the QST stages has been modified in this instance to reflect the focus of the Land Use Transformation project.

1. **Identify key themes relevant to land use policy**. This part of the cycle can draw on analysis of documents as well interviews to identify the issues and ideas of relevance to stakeholders. This establishes if and how problems are represented, and which actors are involved. The outputs shape and initiate the formation of 'Mixed Teams' comprising non-academic stakeholders as well as researchers.
2. **Decide what to represent in quantitative analysis**. This entails progressively moving from higher-level priorities – i.e., the type and number of themes to analyse – towards decisions on the specific aspects of systems that will be represented – semantic definitions. Further choices also shape the analysis – i.e., setting system

boundaries, scales of analysis, functional and structural types, and indicators. The result is a specific shared understanding of what will be analysed.

3. **Compile data and carry out quantitative analysis**. The contents and duration of this stage can vary greatly between QST topic and the capabilities of the QST research team. Initial iterations of any QST have an overhead of investment in sourcing data, integration, quality control and visualisation. This stage can see the deployment of statistical, simulation and agent-based models. The MAGIC project used societal metabolism analysis, see Giampietro et al, [21] and as described in a companion briefing [4], and website.
4. **Contextualise and present metrics as maps and visualisations** that can be used to assess the system's feasibility (within biophysical limits), viability (within socio-economic limits) and desirability (compatibility with societal norms and aspirations). The process of summarising and communicating the outputs also aims to convey uncertainties and sensitivities arising from all parts of the analysis.
5. **Discuss interpretations and implications**. This stage sees deliberation and interpretation of the significance of the outputs of the QST analysis with stakeholders, and the shaping of any further cycles – with either new themes or alternative cases.

2.4 Why do we need to do QST?

Many analytical tools and methods are available to probe different aspects of land use transformation challenges, but these tools alone rarely enable a systemic overview of interlinked issues to be taken. It is also rare to reflect on the application of these tools and the accompanying knowledge production processes [22]. As such, many existing methods and tools do not enable a full appraisal of the system, nor of the quality of evidence created in terms of its utility within decision-making (policy) processes. A selective approach to framing delivers a very partial understanding of problems, stakeholder perspectives and the uncertainties involved in land use transformations. Systemic approaches can though generate overwhelming complexity that can defy interpretation and thus discourage stakeholders from engaging with the issues.

The expected outcomes from QST reflect post-normal ideas about the role and relevance of science, and the scale of current sustainability challenges. As a result, QST processes are not typically concerned with refining specific aspects of scientific evidence, but instead questioning whether any existing science-policy consensus ignores existential threats by taking a too partial or narrow view of the challenges faced. The process of QST aims to help scientists and stakeholders to reflect on the situation and its causes e.g., potential problems of policy inertia, the importance of articulating hidden conflicts, and the processes shaping evidence use. Thus, QST can help governance in complexity: providing a structure within which to navigate complexity rather than trying to control or eliminate it.

2.5 Lessons from applying QST

Previous applications of the QST process for EU Common Agricultural Policy [23] and UN Sustainable Development Goal topics [20] in the MAGIC project have highlighted lessons worth noting for researchers, policy analysts and other stakeholders. Some of these lessons

are summarised below but the key message is that while QST is a demanding process for participants and researchers, it can be very effective in terms of generating conceptual change in supporting instrumental outcomes especially when the issues are complex or contested and there is the need to generate a space in which deliberation on issues can be supported.

The **Salience and scope** of a QST topic may need to be negotiated and renegotiated as stakeholders or participants in the QST change. Contested narratives or options can be good topics for QST processes but participants need to have a mandate or willingness to engage in deliberation and the alternative perspective should be represented to ensure that an adequate interpretation of the QST outputs in possible. Confidentiality concerns also need to be considered. Outcomes of QST processes can be uncomfortable knowledge – so it is important to agree in advance how outputs are shared beyond participants. Particular sensitivity is likely needed where QST is examining the *status quo* (diagnosis mode) rather than future alternatives (simulation mode) as the latter can imply criticism of recent and ongoing activities.

The **credibility of quantifications and analysis** used in the QST need to be built up though the process. New methods and framings can be used but this means the need to invest more effort in communications and building capacity of participants. This may mean the need for starting with more familiar examples, more iterations and taking smaller steps, so that the participants can both buy into the methods and where possible shape them. This can be very challenging for participants with limited time availability. Key aspects to focus on testing with participants are visualisations of complex data (e.g., as maps) with participants helping to refine both what is crucial data and how it can be best presented. For contested issues it can be important not to allow such (re)shaping to move the analysis onto areas in which there is already agreement.

Fitting QST with policy timelines is clearly necessary and shaping the analysis so that it fits with the phases e.g., of opening up where alternatives may be desirable, and closing down when the focus needs to be on evaluation and deeper characterisation of one or two options. This may mean curtailing scope or depth of analysis or prioritising, but also having the confidence to work with QST participants on best-available rather than best-possible analysis.

Recognising the **norms of science-policy interaction** is crucial. For the EU Commission Directorates General it was notable that many individuals (who participated in the QST) did not usually engage directly with scientists as part of their normal practice. They were typically recipients of “finalised“ results, and were thus unaccustomed to being interviewed and discussing and shaping research-in-progress. A key role of analysts and advisers within government can thus be a as knowledge brokers and facilitators of the QST or in identifying policy entrepreneurs who can initiate or champion the QST process so that it generates an enduring community of practice.

2.6 QST in the Land Use Transformations Project

The Land Use Transformations project has both *research-led components* – e.g., climate change mitigation and adaptation, governance and land use narratives, and *policy-led components* which were outlined and budgeted for but not defined in the research proposal. These provide capacity to deploy the research capability developed to address policy questions and support options appraisals or other kinds of analysis. These policy-led analyses make use of the QST process defined above.

The climate-change *opportunity mapping* and *gap analysis* and the *reviews of governance arrangements* within the project are complementary to the QST process. The project team are also able to draw on an extensive background of Scotland-wide environmental and farm structure data and a variety of land use and other systems modelling capability. The QST may also link across to the *EARS project* on Future Agriculture Policy Support (RESAS/005/21).

The first cycle of QST for the project (till March 2023) will look at the Tier 2 Enhanced Conditionality Measures (Track 2 in the National Test Programme), as one of the ways in which SG is seeking to transform land use systems in Scotland. To structure the initial stages of the QST process (Step 2: Decide what to represent in quantitative analysis), we propose to focus on:

1. The testing "in theory" of measures that are judged by SG as not feasible to test "on farm". This will consider the mix of measures that could be taken up, and/or the effectiveness of measures in differing geographical or sectoral settings.
2. Considering the enhanced measures in the context of other elements of the agriculture support system – for example conditionality for basic payments, Voluntary Coupled Support schemes, payments to offset disadvantage (Less Favoured Area Support Scheme/Areas of Natural Constraint), elective schemes and potentially complementary funding such as for capital aspects of peatland restoration.

The QST 1 proposals are further elaborated in **Milestone 5 QST 1 Decision on Focus**. Subsequent QST phases may also be deployed – QST 2 (2023-24) and QST3 Y4-5 (2025-26).

2.7 Key Messages

QST is a demanding process for participants and researchers, but it can be very effective in terms of generating conceptual change in supporting instrumental outcomes especially when the issues are complex or contested and there is the need to generate a space in which deliberation on issues can be supported.

For interdisciplinary working QST has a benefit of deepening the mutual understanding of research members roles and skills, enabling participants to step into more easily or across each area of responsibility, improving project resilience without decreasing efficiency. This resilience does require a substantial investment of staff time meaning that QST is most relevant to larger scale and/or strategic research, though this initial investment may subsequently be deployed in an agile way on smaller-scale analyses.

The QST process is particularly relevant to integrative modelling projects where it can generate new opportunities to deploy existing research capacities to new problems or improving the outputs of systems models by including new datasets. QST is particularly important for the latter as it gives prominence to deliberating on and deciding which aspect of the issues are most salient. This promotes refinement, refocusing or redeployment of capabilities (e.g., computer models) and the level of detail required rather than having these capabilities dictate how and issue is framed.

QST can help illustrate the wider context in which quantified data (from models, field data or maps) can be used helping connect the science more explicitly to policy concerns but conversely it can help illustrate the strengths and limitations of existing science so that social scientists are better able to understand what evidence is available and why things might not have easy answers.

3 Supporting Materials

3.1 Annotated Bibliography

Matthews, K.B., et al., ***Old Wine in New Bottles: Exploiting Data from the EU's Farm Accountancy Data Network for Pan-EU Sustainability Assessments of Agricultural Production Systems***. Sustainability, 2021. 13(18).	This paper presents the outputs from a QST process conducted with EU institutions using data from the Farm Accounts Data Network (the old wine) and a novel sustainability assessment method (societal metabolism analysis, the new bottles). The paper reflects both on the need to supplement the financial data of FADN with physical data and on how QST is an exemplar of tools/approaches for Sustainable Agricultural Land Management (SALM)
Blackstock, K.L., et al., ***Implementing post-normal science with or for EU policy makers: Using Quantitative Story Telling to discuss the Common Agricultural Policy and Sustainable Development Goal 2***. Sustainability Science, 2023,	This paper reflects on lessons learned from doing two QST cycles with actors from the European Commission. It highlights the need for approaches like QST but illustrates how the approach is more demanding that conventional 'knowledge exchange'. QST requires commitment by both science and policy to engage with the cycle even when it generates difficult or challenging results.
Waylen, K.A., et al., ***Questioning the roles of scientific experts in science-policy interfaces: Reflections from our work on the Water-Energy-Food 'nexus'.*** Environmental Science and Policy, 2023, Vol 141, pp158-167.	This paper highlights the challenges that scientists need to navigate throughout a QST process, and emphasizes the need to reflect early and repeatedly on science – policy interactions. It suggests that opening up to consider reflecting on tools and the overall framing of policies is more likely where participants have had a chance to build relationships, and come to see the QST process as relevant and credible.

3.2 Post-Normal Science (PNS)

Post-normal science (PNS) is an approach to improving the uses of science, especially for issues where "facts [are] uncertain, values in dispute, stakes high and decisions urgent" [24]. In contrast to modernist expectations of how science facts can be used, PNS brings attention to the process of science and knowledge (co)production, its (non)uses and consequences.

PNS recognises multiple, legitimate, non-commensurate perspectives. It encourages the process of science production and use to be carried out with an "extended peer community", rather than seeing non-scientists as passive recipients of scientific knowledge. PNS emphasizes the need for rigorous examination of current framings and interests that dominate decision-making, and their consequences in terms of priorities, perspectives and problems that are articulated (and importantly, what are not articulated). Such reflections and reframing are particularly important when facing complex sustainability challenges which require transformative systemic change [25].

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