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# A return to decision support: How can decision support tools be used at the science-policy interface?

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**Abstract:** This paper presents the outcomes and reflections from a policy-led application of the Quantitative Story Telling (QST) methodology within the Land Use Transformation project, part of the Scottish Government's 2022–2027 Strategic Research Programme. The focus of this second QST cycle was the regionalisation of farm support payments in Scotland, exploring how different configurations of payment regions and schemes could better align with policy objectives such as Net Zero and environmental sustainability. The work was conducted in close collaboration with Scottish Government analysts and policy officials and aimed to support deliberation and decision-making on future agricultural support mechanisms.

The QST process, which integrates both formal (quantitative) and semantic (interpretive) phases, was used to co-develop and assess a series of regionalisation scenarios. These included updates to existing schemes, new configurations of Basic Payment Scheme (BPS) regions, and alternative implementations of Less Favoured Area Support Scheme (LFASS) and Voluntary Coupled Support (VCS). The analysis was underpinned by integrated datasets from administrative and research sources and supported by a Scenario Builder tool developed in R Shiny, and Power-BI dashboards. This tool enabled rapid generation, testing, and visualisation of payment scenarios, facilitating iterative engagement with the project steering group.

The research was structured into five phases: baseline characterisation of farm businesses; development and assessment of BPS options; evaluation of LFASS alternatives; exploration of VCS adjustments; and synthesis, reporting, and stakeholder engagement. A key innovation in the context of conducting QST with Scottish Government was the use of dashboards and interactive visualisations to support interpretation and communication of complex results. The Scenario Builder and Dashboards allowed analysts to explore the (re)distributional impacts of policy options in terms of funding per business across farm types, regions, and size classes, and to link payment outcomes to environmental and socio-economic indicators such as peatland extent and land capability.

Despite the technical sophistication and collaborative nature of the work, the study highlights persistent challenges in translating research outputs into policy-relevant insights. The "funnel" effect—where only a small subset of analyses can be communicated effectively within policy processes—remains a significant barrier. While decision support tools (DSTs) like the Scenario Builder can enhance capacity and responsiveness on the research side, their uptake and utility within government are constrained by institutional, technical, and resource limitations.

While DSTs can play a valuable role in capacity building and scenario analysis, their impact on policy processes is mediated by the quality of the underlying QST process and the strength of relationships between researchers and policy actors. Greater investment in DST literacy and infrastructure within government could enhance the shared use of such tools, but this requires sustained collaboration and advocacy. The findings contribute to broader discussions on the role of modelling and decision support in transdisciplinary research and science-policy interfaces.

***Keywords:*** *Quantitative Story Telling (QST); Decision Support Tools (DST); Transdisciplinary Research; Science-Policy Interface*

## 1. INTRODUCTION

This paper seeks to provide insights on how researchers can bridge the science-policy interface based on our long-term (20 year) interactions in support of policy making by Scottish Government across the agriculture, environment and land use policy domains. The paper reflects on the authors returning to the use of decision support tools (DSTs), and the benefits and challenges of using them in science-policy processes that evaluate policy options and provide advice to ministers. The paper draws on both the authors' empirical experience and earlier – but still arguably relevant – theories of the roles that DSTs can play.

This paper is an output of the policy-led analysis within the Land Use Transformations (LUT) research project[1] part of the 2022-27 Scottish Government (SG) Strategic Research Programme (SRP). The LUT project has a focus on how to deliver high-level policy outcomes – especially achieving "Net Zero and other environmental objectives". This is the second of the Quantitative Story Telling (QST) processes conducted within the LUT project. QST is an iterative process defining and interpreting policy options with stakeholders, originating from Saltelli and Giampietro (2017). The QST was conducted with SG Rural Payments and Inspections Division (RPID) officials and Rural and Environmental Science Analytical Services (RESAS) analysts. The focus of this second QST was on decisions between options that would change the way farm support payments are distributed across Scotland and between sectors or size classes, referred to here as "regionalisation options".

Previous papers (Matthews et al. 2023; Matthews et al. 2019; Matthews et al. 2017) have reported on the process of QST, but here we are choosing to focus on how results generated from these kinds of analyses are translated into materials usable by analysts or policy makers and with stakeholders in deliberations with policy. This transition from the data-driven formalised, modelling phase into the semantically dominated interpretation phase is perhaps worthy of greater attention and the challenges encountered by the authors provide insights potentially relevant to the community of practice working at the research-policy interface beyond Scotland.

## 2. BACKGROUND

The Scottish Government's Vision for Agriculture signals the potential for a transformation in agricultural support, particularly via the use of Enhanced Conditionality on at least 50% of direct payments and future Less Favoured Areas (LFA) funding (Matthews et al. 2023). The first QST process (QST1) evaluated the enhanced conditionality measures themselves and the wider factors that would shape their success in delivering the objectives of the Vision for the Agricultural Bill, see Matthews et al. (2023) and the project's Synthesis Report2. A key QST1 finding was that the outcomes for an enhanced conditionality based scheme would be determined, in large measure, by the distribution of funds across Scotland. This funding distribution would be shaped by decisions on budgets, the number and basis regions (e.g. land types) and the use of optional, but influential, measures such as capping or front loading3. Interactions of direct payment region decisions with other measures such as voluntary coupled support, where payment are linked to activity (e.g. livestock numbers) would also need to be considered. The second QST process thus analysed combinations of these policy options (as "scenarios") to assess which best delivered the outcomes sought in the Vision. Process, Scope, Data and Tools

### 2.1. Process - Quantitative Story Telling

QST is a process designed to help scientists work with stakeholders (particularly policy makers and advisers) to prompt reflection and reframing of sustainability problems and to develop shared understanding of the issues even when conflicting stakeholder values mean that a consensus is challenging see (Saltelli and Giampietro 2017). 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. The figure highlights the importance of semantic-formal (Stage 2)

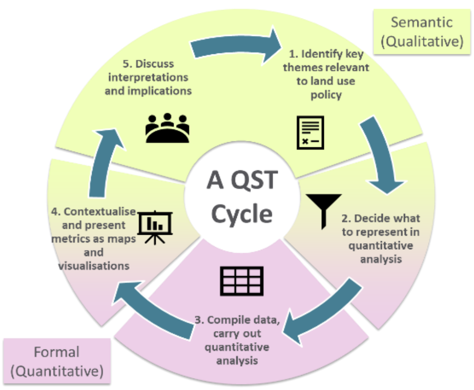


**Figure 1** The stages of the QST cycle

[1] Land Use Transformation project - https://landusetransformations.hutton.ac.uk/
[2] Synthesis Report for QST1 - https://landusetransformations.hutton.ac.uk/outputs/d4-enhanced-conditionality-screening-synthesis
[3] Capping is setting an upper limit on payments, whereas frontloading is increased rates of payment on land up to an area-based threshold (e.g. the first 55 ha) or livestock count.

 

and formal-semantic (Stage 4) interfaces where translational processes are undertaken and where co-construction can be crucial.

### 2.2. Scope

The research had five Phases that were agreed between Hutton, RPID and RESAS staff and refined over the course of the analysis in line with the QST process.

- **Phase 1 Baseline Characteristics** used data from 2022 to characterise farm businesses in terms of their areas, entitlement and claimed areas per basic payment scheme (BPS) region. Stage 1 also summarised payments against phenomena like land capability, presence of peatlands, or socio-economic performance.
- **Phase 2 Basic Payments (BPS) Options** updated the 2 Region scenario with 2022 data, added distributions of change per business, and distributions of payments with Stage 1 data.
- **Phase 3 Less Favoured Area Support Scheme (LFASS) Options** assessed the effects of implementing LFASS as a flat rate top-up payment instead of linking payment to animal numbers.
- **Phase 4 Voluntary Coupled Support Scheme (VCS) Options** considered if any deficiencies in Phase 3 outcomes could be addressed via changes to VCS. This increased payments for the new Region 2 and included a higher rate of payment for both Beef Island and Beef Mainland VCS schemes.
- **Phase 5 Provision of data to SG, write up of analysis, presentation to stakeholders**.

### 2.3. Data

Stage 1 of the QST cycle makes use of integrated administrative, and research-derived datasets held by Hutton. These include payments and farm structure data from the Integrated Administration and Control System (IACS) and the Land Parcel Identification System (LPIS) both from RPID. This is supplemented by farm characteristics data from June Agricultural Census (JAC) from RESAS. The range of research-derived and other datasets such as land capability and peatland extent/condition are detailed on the author's Land Systems Research team webpage and in the Land Use Transformation project Story Map collection[4].

### 2.4. Decision Supporting Tools

The analysis for Phases 2 to 4 used a Scenario Builder. The Scenario Builder is an online software tool (written using the Shiny R package) that allows the Hutton team to quickly generate, test and share, alternative combinations of regionalisation options. The Scenario Builder has the following functionality:

1. Calculates payments per business for regionalisation options using 2022 SAF population as a baseline.
2. Calculates the change in payments from the 2022 baseline.
3. Presents charts of payments and change against farm type, agricultural region and size (area) classes and subsets of these entities or recipients of payments, for individual or combinations of payment schemes.
4. Maps the rates of payment and change in payment per business (again with options for subsets as above).
5. Saves the payments data for further characterisation – via Scenario Dashboards (similar to those used in the Stage 1 Baseline analysis – e.g. assessing distribution of funds against objectives).

The capability and use of the Scenario Builder are fully documented in the Worked Example[5].

### 2.5. Monitoring the QST process

The overall process of undertaking the Regions analysis has been formally monitored as part of the wider research project with technical reporting, policy briefing and a forthcoming journal paper in preparation. The specific focus of the Results section is on the magnitude of the challenge of translating research-based outputs into material for policy advice to ministers (QST Stages 4 and 5) and the potential role for DSTs in that process. Before presenting those results, though, it is useful context to briefly comment on the other QST stages. This Regions QST was strongly policy driven, contributing directly to ongoing processes within-government and to government-stakeholder deliberations. The project steering group were leaders of relevant policy domains and experts from the SG analysis teams. They were all individuals with whom the research team had worked before, some on multiple occasions and over decades. The QST process was well understood by the SG side in terms of process, even if the formalisations of QST were not necessarily used. The period for the scoping, choice of analyses and quantification was short (<16 weeks) but very intense with substantive progress meetings occurring fortnightly. There was deep engagement from both sides as evidenced by the research specification being revised/refined eight times as the evidence emerged from the research. What followed though was a protracted period (>32 weeks) in which the team grappled with ways in which the outputs could made usable by SG analysts and policy makers, including making tools usable within government.

[4] Land Systems Research team - https://ics.hutton.ac.uk/research/land-systems-research-team/
Story maps https://storymaps.arcgis.com/collections/20665a1964b54e429d32ca61f897bd47
[5] Worked Example - https://landusetransformations.hutton.ac.uk/outputs/d87-regionalisation-scenario-builder-worked-example

 

## 3. RESULTS - QUANTIFYING THE TRANSLATION CHALLENGE

The available integrated datasets and software tools generate a multitude of potential views of baseline and alternative options. Past projects have tamed this complexity by agreeing, with SG analysts, subsets of possible views that are most insightful (i.e. via QST Stage 4) and by developing a series of visual presentations (charts and maps) that are in effect an options visualisation protocol, interpretable (in QST Stage 5) by decision makers and stakeholders. Yet for this QST cycle the scope was broader, taking a more in-depth look at the baseline conditions and linking these into the scenario analyses. Previous scenario analysis had focused on presenting degree of change, whereas for this QST there was greater interest in linking the outcome distributions of funds to other phenomena, for example how much funding might nominally be linked to areas of peatland that might need restoration. The magnitude of the analysis reported is set out in Table 1 (a subset of the all the options experimented with within the QST process).

The table brings home the overall magnitude of the selection, interpretation and communication tasks with 356 graphics possible for only five scenarios, the minimum number covering just three previously studied region options, plus scenarios looking more broadly at the overall direct payments scheme. This contrasts with earlier scenario analyses where up to 12 scenarios were simultaneously in play. The table shows the depth of analyses of the Baseline, with 13 dashboards across a wider range of topics. The table also shows the other contrasts with the Options Appraisal and the Scenario Builder having fewer individual dashboards used (3 vs 13) and similar numbers of charts per dashboard but with more views for the scenario-builder (average of 6 vs 1.3).

**Table 1** Numbers of component graphics generated withing the QST process.

| | **Dashboards** | **Charts*** | | **Views**** | | **Scenarios** | **Graphics** |
|---|---|---|---|---|---|---|---|
| | | Avg. | Range | Avg. | Range | | |
| Baseline | 13 | 3.7 | 3-6 | 1.3 | 1-4 | n/a | 66 |
| Options Appraisal | 3 | 3 | 2-4 | 1.3 | 1-2 | 5 | 65 |
| Scenario Builder | 3 | 3 | 3 | 6 | 5+Map | 5 | 225+ |
| **Totals** | **19** | **3.4** | **2-6** | **2** | **1-5+Map** | **5** | **356** |

*Charts per dashboard average and (range) plus any supplementary tables or controls.

**Views for these interactive charts are substantively different representations of the same phenomena – e.g. using alternative measures of area (total vs. paid only), counts of businesses or financial metrics. Beyond this are within-chart options to focus any of the dashboards on individual elements (14 regions, 3 farm-type, and 7 size classes) – for a maximum of 1,274 elements or combinations.

Figure 2 below presents one of the scenario dashboards most frequently used in the analysis as it has the key phenomena used in previous decisions. Each of the main charts summarises the net change in funds for region, farm-type or size class (that is the change between classes) and the gains and losses (£) that show the redistribution of funds within the class (a measure of the level of disruption caused relative to the baseline). The supplementary chart (bottom right) presents the distribution of percentage changes per business – an extra indicator of the relative degree of change – in this case highlighting most losses are <20%, but gains can be over 100% reflecting the extra payments to small businesses (front loading).

This level of results complexity was anticipated by the research team, given the scope of the brief, as was the need to be able to respond to *ad hoc*, and often very specific questions such as on the policy effects on combinations of region or sub-sector that are most politically sensitive. The expectation was also that closer to decision making time there would be the need to have the capacity to experiment quickly with options to refine the final options, respond to suggestions from other stakeholders and to analyse these within the same framework as the options generated within government. To that end the intent within the project was to build an overall capacity to rapidly conduct options appraisals in a more systematic and repeatable way than had been the case previously. In particular, it was important to build the ability to consider all the direct payment (or analogous) schemes simultaneously, given the conclusions from the previous QST, even though strictly the policy-led analysis considered only a subset of policy measures. This was exploited in Phases 3 and 4 of the regions analysis to experiment with reusing existing regionalisation and VCS measures to deliver the intent of LFASS in different ways, an experiment that went beyond the policy-led scope of analysis but was intended to showcase the capability of the tools and to stimulate debate.

Having built the tools for our own use there was the opportunity to go beyond this and experiment with opening up the tools (via online access) so that analysts within government could make use of the dashboard we had built together and conduct their own independent selection of metrics and interpretations (QST stages 4 and 5) either in an exploratory way or to respond to questions from SG leadership. In this way the team sought to deliver capacity building beyond our own organisation. While the technical aspects of making the dashboards and tools are well supported (e.g. access control), and they were compatible with SG IT policies, use by others who did not develop the tools inevitably necessitated the need for more in-depth explanation/training materials.

 

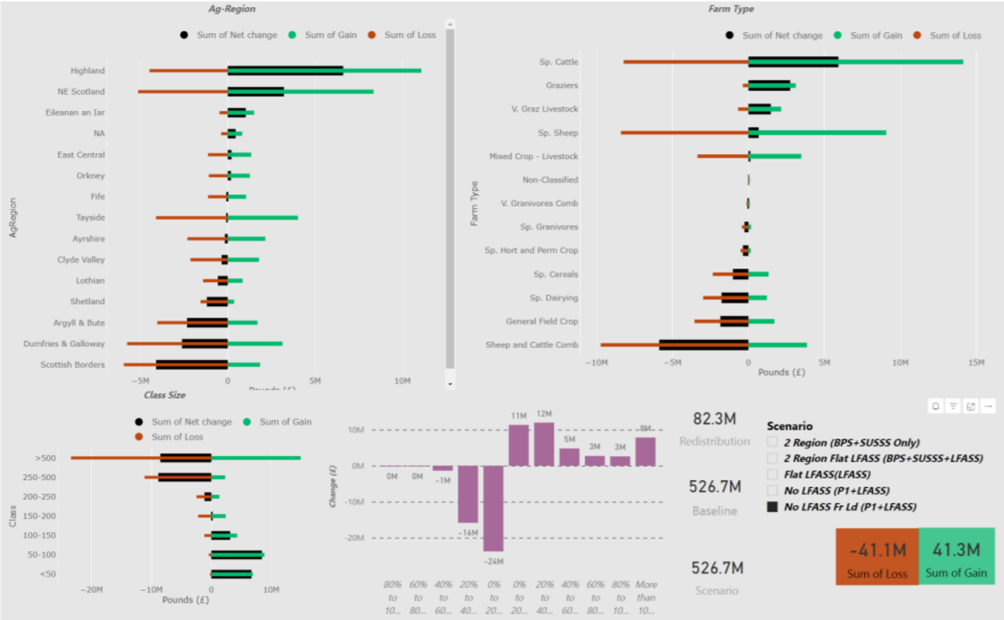


**Figure 2** A QST regionalisation scenario dashboard showing loss, gain and net change for agricultural regions (upper left), farm types (upper right) and area of business (lower left), with the distribution of percentage changes per business (lower right).

The process of publishing QST outputs is illustrated in Table 2. The table highlights the "funnel" through which policy-led work needs to pass for example with 153 pages of published documents presenting only a selection of the 356 possible graphics from Table 1, then reduced to only 15 PowerPoint slides for use with the key stakeholder body the Agricultural Reform Implementation Oversight Board (ARIOB).

**Table 2** QST published outputs, formats and page counts

| Project Stage | Documentation | Links | Pages |
|---|---|---|---|
| Stage 1 Baseline Analysis | Part 1: Baseline Areas and Payments | Slide Deck* | 15 |
| | Part 2: Baseline Characterisation | | |
| Stage 2 Basic Payments | BPS 2 and 3 region options | Slide Deck* | 13 |
| Stage 3 Less Favoured Areas | LFASS region options | | |
| Stage 4 Issues from Stage 2&3 | All Direct Payments | | |
| Stage 5 Provision of data, write ups of analysis, presentation to stakeholders – key forum the Agricultural Reform Implementation Oversight Board (ARIOB) | Project Overview | Slide Deck* | 12 |
| | Scenario Builder - Overview | Slide Deck* | 14 |
| | Scenario Builder - Worked Example | Slide Deck | 31 |
| | Regionalisation Options: Interpretation | Report | 31 |
| | Regionalisation Options: Synthesis | Report | 22 |
| | Presentation to Stakeholders (ARIOB) | Slide Deck | 15 |
| **Overall** | **All Documents** | **Published** | **153** |

While all documents are published (in line with commitments to Open Science) the degree to which any of the materials are used beyond the QST process varies substantially. Much of the documentation is needed largely for quality control or audit. The documentation "breaks the mould" by not being conventional technical reports but rather uses slide decks (PowerPoint files annotated with interpretations from the authors, policy and other stakeholders), supplemented by short Interpretation and Synthesis reports. Note that for the end of project workshop with the wider policy teams the slide decks marked with the asterisks were used. These were thus limited by the quantity of material that could be included for a half day meeting interpreting and deliberating on the issues. This means that despite the substantial page count only a small fraction of the analyses available was presented, relying on the QST processes with the steering group to open issues, identify key phenomena, and prioritise reporting. The limitations of this kind of approach are elaborated in the Discussion section next.

## 4. DISCUSSION

This discussion of DST's, within the QST process, is part of a critical literature on DST use in policy making across a range of domains. For example, Andersson et al. (2012) used case studies and literature to highlight practical usability and data issues but noted that, more fundamentally, DST utility and impact is limited by compatibility with political processes. Stewart et al. (2014), in the forestry domain, highlighted the need for shared cultures and institutions and for higher quality interactions across the science-policy-practice interface.

 

Schumacher et al. (2020) sought to understand DSTs in the context of a perceived science-policy gap. They concluded key issues were gaps in the domains covered by DSTs, the need for greater awareness of existing DST capability and that DST quality in terms of documentation, interoperability and maintenance needed more investment. Each of these papers highlights that while technical aspects of decision support (the tools) can need improvement it is only in the processes of using DST that the root causes of successes and failure for DSTs can be understood. The discussion thus focuses on two aspects, first what impacts (outcomes) can be expected from DSTs and second what are the roles that DST can play in science-policy processes.

### 4.1. DST and Impact

The QST projects are shaped by the desire to deliver five impact types. These impacts are Awareness, Enduring Networks, Capacity Building, Conceptual- and Instrumental-Change. The impacts form a ladder with conceptual and instrumental change (change in policy or practice) as being the hardest to achieve (at least with any degree of attribution). Where are DSTs likely to have an impact that would justify the extra resources inherent in making such tools? DSTs seem unlikely to be more influential for awareness raising or creating enduring networks with the latter being more dependent on investing in relationships (bonding and bridging capitals). Similarly, it is not clear that DSTs are more effective research communication tools to generate conceptual or instrumental change. So, this leaves capacity building and DSTs can have value here in making the undertaking of complex options appraisals more efficient, particularly in responding to the need to consider new scenarios with limited time or in seeking to respond to questions of detail within scenarios. DSTs can thus have a strong impact for the science side of the science-policy interface. Yet for policy, while DSTs can encapsulate data, knowledge and analysis methods, and can be used by non-experts, there are good reasons to expect that their impact on capacity may be quite limited. Partly this is due to the degree of expertise needed to make the DST work and this can be in short supply. DSTs don’t seem to reduce, and the need for funnelling when translating from research to policy making domains. The narrowness of the policy end of the funnel having more to do with institutional expectations and capacity to use the DSTs.

### 4.2. Reflecting on the roles for DST-type tools

The authors’ view of the roles for DSTs, see Matthews et al. (2007) is informed by the earlier analysis of McCown (2002) and Carberry et al. (2002) of decision support systems for agriculture. The four roles were calculator, record keeper, flexible simulator, and systems analysis and learning environment.

The calculator role emphasised dealing with complex but structured calculations and doing so substantially faster than other methods. Such tools tended to have limited flexibility and transparency. Over time users could emulate or anticipate such tools’ outputs, so they had the potential for capacity building through learning, but less so for longer term use. The scenario builder within the Regions QST probably falls into this category and thus had some potential for use by policy analysts. Within the QST there was limited use by policy analysts and no subsequent return use. This likely reflects the match between the tool and the specific questions being posed of analysts or lack of time to invest in familiarising with the DST with uncertainty of the potential payoff.

Record keepers were typically related to management protocols, particularly those related to quality assurance or environmental compliance. The function here is in terms of data organisation and the generation of required views of system performance, and any change over time. The scenario builder and dashboards each embody this functionality – with the ability to generate and store scenarios, make comparisons with baselines, or compare between scenarios. The authors anticipated this as being a key functionality given the plethora of options considered in other previous policy-making processes. Yet with only five scenarios and very limited consideration of wider options, the value of the functionality was less appreciated.

Flexible simulator was the classic role for the DSS or DST, to address less well-structured issues. Yet the complexity of such tools and the degree of expertise needed to set them up and interpret their outputs meant that this role really entails developers using such tools for/with stakeholders. Indeed, this expectation shaped the authors’ development of the overall QST working process. It is also worth noting there is likely a trade-off between flexibility and complexity in DSTs, with the acceptable balance depending on the capacity of the end-users. The DSTs here have considerable flexibility but are constrained as agreed in the QST1&2 stages. The DSTs can be quickly adapted but any modification is only possible by the research team, leading to a developer vs user distinction. To support users implies a considerable investment in manuals, training, etc.

The final role envisaged for DSTs was a systems analysis and learning environment, e.g. using the tools as boundary objects in deliberative processes especially for contested issues. Here the technical aspect of the DST starts to matter less with process and social learning being emphasised – i.e. conceptual and instrumental change. The baseline characterisation dashboards provided new insights in terms of systems analysis but with uncertain impacts. For the Regions QST the use of DST had limited effect as the deliberative processes within government did not make use of the tools with stakeholders, for reasons that are not clear.

## 5. CONCLUSIONS

Even with good processes for awareness, engagement, and capacity building, via QST-like processes, there is a fundamental challenge of the "funnel" implied by translating research into conventional policy making channels (stages 4 and 5 of QST). DSTs are efficient in organising data, making calculations of scenario options, counter-factual analysis and comparisons, but this very efficiency exacerbates the challenge of synthesis and interpretation. DSTs don't widen the funnel with research required to work with existing governance structures and processes. Yet greater investment in DST skills for staff within government (capacity building) may make the shared (research-policy) use of such tools far more effective. This implies researchers and policy entrepreneurs working together to make the case for such investment.

## ACKNOWLEDGEMENTS

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