Workshop summary: developing an outcome-based approach for understanding the effectiveness of interventions in catchments for multiple benefits

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Executive summary

A workshop was held at The James Hutton Institute in order to improve understanding of national and regional level perspectives on what was needed from an outcome-based approach to aid individuals (and groups) to make more informed decisions on land and water management interventions for a range of outcomes. The workshop was designed to utilise the expertise of the participants to steer the Scottish Government funded development of an approach and digital application (tool) to aid land and water management. The workshop followed on from 13 telephone interviews with regional and national level policy and management stakeholders that highlighted the need for practical tools to facilitate decision making about land and water management based on a range of environmental and financial outcomes. The workshop was attended by six participants, including land and water management representatives from the Cairngorm National Park Authority, Scottish Natural Heritage and Scottish Environmental Protection Agency; as well as three researchers involved with developing practical tools to support land and water management for multiple benefits.

The workshop was structured around four activities. The first focussed on refining a list of needs i.e. what we want to address with the approach, and provided an opportunity for the participants to add additional needs. A list of 10 needs emerged as being rated very or extremely important by four or more of the participants. Additional participant needs could be grouped around what they would enable a user to be able to do e.g. “helps indicate areas to 'invest' in interventions”, “helps to 'value' wider benefits” and “understand business as well as environmental needs”; and how the approach went about this e.g. “Stakeholders provide data interactively”, “dynamic approach that can adapt with funding landscape” and “transparent methods” whilst providing “iterative evaluation of options”.

During the second activity three pairs, of researchers and non-researchers, were invited to suggest principles the approach could consider using based on the identified needs and wider experiences. Twelve principles were suggested and discussed. When compared to the authors draft list of principles, the necessity to include “efficient (use of time)/easy to use”, “updateability” and “credible” to our draft list of principles was apparent. It was suggested that the principles would be clearer if expressed as sentences, and not just as single words.

The final two activities focussed on demonstrating our review and hands on testing and development of potential software options that could be used in our digital application. This included a hands-on demonstration involving a touch table, where participants were invited to experiment with a prototype application.

Key points raised during the workshop will inform the development of our approach and digital application and these were grouped under:

- improving our understanding of the needs we will focus on;
- clarity in what we are producing and for whom;
- a revised list of principles that will guide the development and use of our approach; and
- improved understanding of the user, functional, feasibility and data requirements.

A list of additional suggestions will also inform our next steps: that will be focussed at the farm to estate level.

1. Introduction

The purpose of this workshop summary is to provide a record of the RESAS Strategic Research Programme (SRP) workshop we held on 23rd May 2017 in Aberdeen, and provide an outline how the valuable contributions of the workshop participants (and earlier interviewees) will influence the development of our approach (and digital application). The aim of the workshop was to work with a small group of national and regional level expert stakeholders (and researchers) to discuss their needs as part of our development of a digitally facilitated approach to outcome-based assessment of the effectiveness of land management interventions (policy measures e.g. Scottish Rural Development Programme) in catchments for multiple benefits. To meet this aim we set out four objectives:

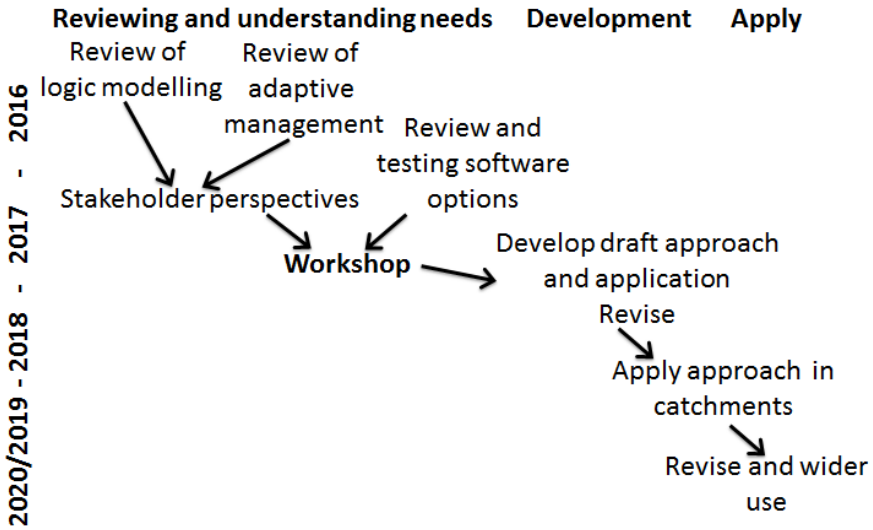
1.1 Objectives of the workshop

1) To improve our understanding of national and regional level stakeholder's perspectives on what was needed from an outcome-based approach to aid individuals (and groups) to make more informed decisions on land and water management interventions for a range of outcomes.
2) To explore and discuss key principles and functionality of a digital facilitated outcome-based approach.
3) Demonstration and discussion of relevant digital applications and their functionality, and one or more prototypes to guide how we could develop and apply our approach.
4) To help steer the development of our approach and produce a workshop summary.

1.2 Context of the workshop and wider project

This workshop was an important step in the development of our approach (Figure 1). The structure and focus was developed based on 13 regional and national level interviews that highlighted the need for practical tools to facilitate decision making about land and water management based on a range of environmental and financial outcomes (Macleod and Hewitt, 2017[1]).

Figure 1 Position of this workshop in the wider project



[1] Macleod, C.J.A. and R. Hewitt (2017). Summary of research on developing a more integrated approach to land and water management using incentives and regulations for the delivery of multiple benefits: exploring national and regional level stakeholder views and needs.

2. Workshop activities

A half day workshop was designed, by the report authors, to meet the four objectives- in particular to steer the development of our approach. The workshop comprised of a short introduction to the workshop and wider project, and four participatory activities. These activities were designed around gaining a better understanding of perspectives on the needs that this approach could address i.e. what for/why, the principles that would underpin the approach i.e. how carried out, and related to these the user, functional, data and usability requirements that will form a requirements specification for our development. The workshop design was tested in advance, and refined by the authors. A small group of experienced regional and national level land management professionals and researchers, with an interest in developing practical tools to support land and water management were invited to participate (Table 1; Appendix one: workshop invitation).

Table 1 List of workshop participants

Participant	**Organisation**
Andy Ford	Cairngorm National Park Authority
Alessandro Gimona	James Hutton Institute
Duncan Stone	Scottish Natural Heritage
Justin Irvine	James Hutton Institute
Mark Wilkinson	James Hutton Institute
Roger Owen	Scottish Environmental Protection Agency

2.1 Introduction

As part of an introductory presentation (Appendix two), the workshop participants were asked to suggest the one thing that they would like to take from the workshop (Appendix three).

2.2 Activity one: understanding perspectives on needs

The purpose of the first activity was to improve our understanding on what was needed from an outcome-based approach to aid individuals (and groups) to make more informed decisions on land and water management interventions for a range of benefits. To achieve this (first workshop objective) the participants were individually invited to rate, the same set of, 17 'needs' which had been extracted from the earlier regional and national level interviews. A need was defined as something we want to address with the approach (and digital application). Each need was added to an A5 card that asked the participants to "please rate how important is this need for developing tools to support decisions about the effectiveness of land management interventions for multiple benefits?" (Figure 2). A seven point Likert scale was provided, ranging from 'not at all important' to 'extremely important'. Each 'need card' also included the justification for the need, these were quotes taken from the interviews (Appendix four). The use of verbatim quotes from the interviews as justification was intended not only to show how we arrived at the needs presented, e.g. 'showing our working', but also to make explicit the direct link between this workshop and the information previously provided during stakeholders interviews, as two elements of the same participatory process chain. This helped to emphasize the 'bottom-up' nature of the development process we propose and to show stakeholders that the information they provide is the information we will use. They also included a space for participants to add comments "e.g. to justify your decisions, or raise any other points". The participants were also provided with three blank 'need cards' and invited to

add any additional needs and rate them, after first going through the 17 needs. The participants were given 15 minutes for this first part of activity one (Figure 3).

Figure 2 Example of an A5 'need card' that the participants filled in

Participant: **Andy Ford**

Need: Policy and on the ground connections **Theme:** Integrated approach that supports place-based partnership working	**Step one:** please rate how important is this need for developing tools to support decisions about the effectiveness of land management interventions for multiple benefits? **Step two:** add any additional needs and rate them.
	If you would like to **add any comments**, e.g. to justify your decision, or raise any other points, then please add them here:

Not at all important	Low importance	Slightly important	Neutral	Moderate importance	Very important	Extremely important
1	2	3	4	5	6	7

Figure 3 Participants filling in the 'need cards'

The participants were then invited to add the ‘need cards’ to a wall with seven labels matching the Likert scale (Figure 4), and to spend five minutes looking for patterns in the added ‘need cards’. The ‘needs cards’ contained a coloured symbol for each need: to aid visual grouping. A group discussion was then facilitated to provide the participants an opportunity to reflect on the material added to the wall, and what needs we should focus on.

Figure 4 Participants adding their ‘need cards’ to the wall

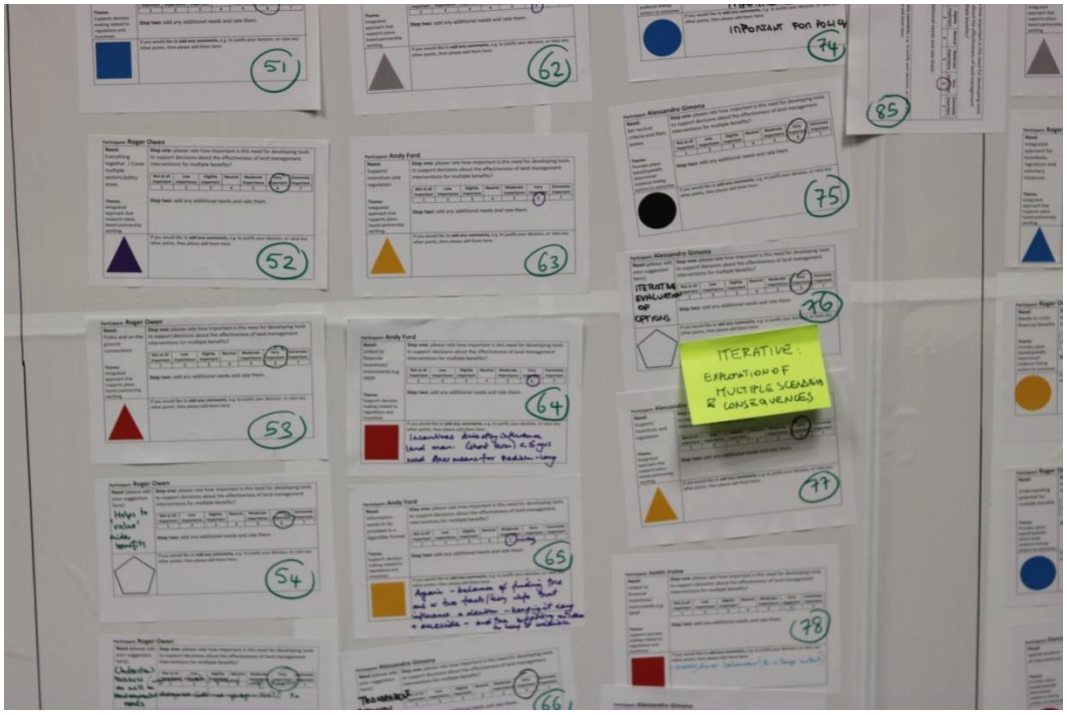
2.3 Activity two: developing principles

The purpose of the second activity was to identify a set of principles that could underpin our approach and digital application. A ‘principle’ was defined as a starting point for how to address one or more identified needs.

Prior to the workshop the participants were paired: such that each pair included a researcher and non-researcher. The participants were then invited to work together in these pairs to look at the ‘needs’ rated as important, and suggest principles our approach could consider using. A sheet of existing principles from related approaches or applications was provided to the participants (Appendix five). After the participants had written down their suggested principles on Post-It notes, they were invited to place them on the wall of ‘need cards’ close to a need that the principle was related to (Figure 6). There was an opportunity to place a principle on a separate sheet if the principle applied to many or none of the ‘need cards’.

Figure5 Participants discussing potential principles

Figure 6 Example of a participant principle added to 'need cards'

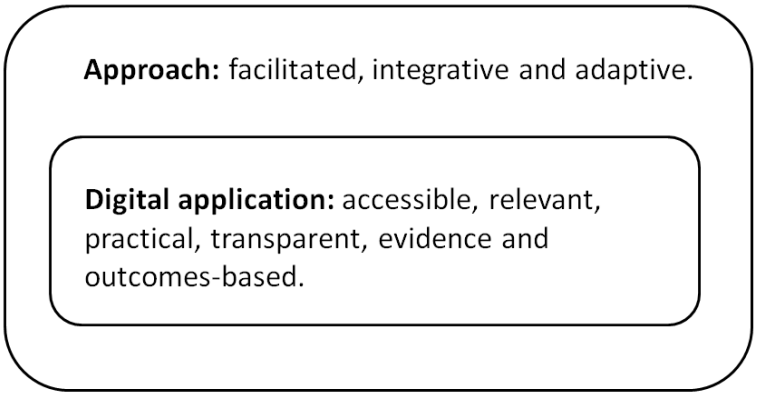


After the participants had added their principles to the wall of 'need cards' they were invited to study and reflect on the suggested principles. A group discussion was used to collect their reflections (Figure 7).

Figure 7 Group discussion on suggested principles

The next step of this activity was for the workshop organisers to reveal their draft principles (Figure 8). These were produced prior to the workshop, and were based on reviewing principles used in similar approaches and based on previous experiences. Comments were then invited on how the prior principles matched up with the principles suggested by the participants.

Figure 8 Draft principles produced by the workshop organisers



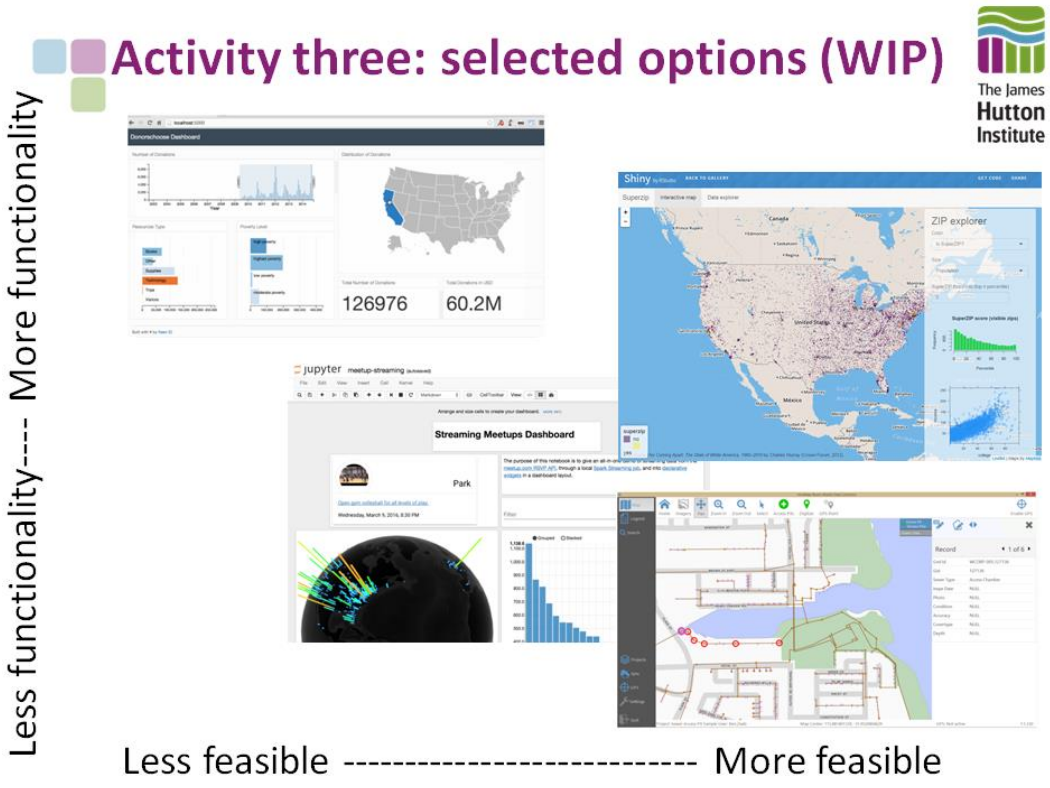
2.4 Activity three: overview of software options and requirements

The purpose of this activity was to present earlier work by the authors that reviewed a wide range of (over 20) software options based on seven initial requirements, and the short list of four options that are currently being explored in greater detail. The initial requirements were: free to use, potentially to use on touch device (as well as desktop), ability to interact spatially, potential to include logic models/results chains, ability of project team to develop/extend, innovation potential, and status of development. An earlier report[1] by the authors contains a more detailed description of this work.

To aid the second stage of reviewing the software options the authors developed a set of advanced of functionality and feasibility requirements. These comprised of the functional requirements for a responsive/smooth interaction e.g. slippy maps[2], potential for a dashboard format, ability to query the output of selections, ability to interact spatially with the information, and the requirement for the software option to be feasible for the project team. These are being used by the authors to review the four potential software options: Javascript based application, R Shiny based application, Python based application, and a QGIS based ROAM application (Figure 9).

An overview of how one of these options (QGIS based ROAM) faired against these advanced functional and feasibility requirements was presented (Figure 10). A discussion was then invited on 'have we missed any requirements?'

Figure 9 Screenshots of the software options that are being evaluated



[2] By "slippy maps" we refer to smooth seamless behaviour of the kind seen on popular map websites, like Google maps or Bing, specifically the way the map follows exactly the users' hand movement through the mouse and the instantaneous loading of map tiles when scrolling or zooming. This behaviour is notably absent when using just one or two map layers in a desk-based GIS.

Figure 10 Presenting a review of a software option based on requirements

2.5 Activity four: touch table demonstration

The purpose of the touch table demonstration was to present examples of the functional requirements and gain feedback. This activity was based around a large touch table (Figure 11). A prototype based on R Shiny was presented and feedback elicited. Examples of Javascript web applications with interactive functionality were briefly presented. Finally a related web-based multi-criteria analysis tool was presented by one of the participants.

Figure 11 Touch table demonstration

The workshop was brought to a close by asking for any general comments, and two specific questions were posed to the participants “what would you do next?” and “how could we best keep you involved?”

3. Material collected and initial analysis

This section contains a record of the material collected during the workshop, and our initial analysis of the material.

The one things that the participants expressed they would like to take from the workshop (Appendix three) were broadly based around the necessity for dialogue between researchers and non-researchers about what was required for developing accessible tools that can increase public benefit/interest at the landscape scale.

3.1 Activity one: understanding perspectives on needs

In addition to the 102 (6 x 17) completed ‘need cards’ the participants produced an additional eight ‘needs’ and rated them. A spreadsheet of the 110 ratings of ‘need cards’ is available in Appendix six. Over two thirds of the needs were rated as being of moderate importance or greater (82 out of 110) for developing tools to support decisions about the effectiveness of land management interventions for multiple benefits (Table 2). There was no difference in how many needs were rated as moderate importance, very important or extremely important by researchers and non-researchers. The participants added 38 comments, and these included statements supporting their rating, and in other cases qualifying that though the need maybe desirable e.g. ‘Everything together/cover multiple sectors/policy areas’, it may be “complex to achieve”, another said “Yes, agree but needs to consider <u>everything</u> (participant’s underlining), this is tricky.”

Table2 Participant rating of the needs and comments added

Category of need rating	How many ‘need cards’	How many comments	How many rated by researchers	How many rated by non-researchers
Extremely important	25	8	13	12
Very important	38	11	18	20
Moderate importance	19	6	10	9
Neutral	15	7		
Slightly important	5	1		
Low importance	8	5		
Not at all important	0			

In addition to the 17 needs rated by the participant only eight additional ‘participant needs’ were added across the six participants, which may suggest that the extracted needs from the interviews were reasonably comprehensive. However, the short time allocated to this activity and the large number of existing needs that the participants had to evaluate might also have played a role. A separate activity targeted at free “brainstorming” of needs might have produced more, or different participant needs. This activity was designed to build on the earlier regional and national level interviews. The additional participant needs could be grouped around what they would enable a

user to be able to do e.g. “helps indicate areas to 'invest' in interventions”, “helps to 'value' wider benefits” and “understand business as well as environmental needs”; and how the approach went about this e.g. “Stakeholders provide data interactively”, “dynamic approach that can adapt with funding landscape” and “transparent methods” whilst providing “iterative evaluation of options”.

To highlight the needs rated as important, those rated as very or extremely important by four or more of the participants are presented in Table 3.

Table3 Needs rated by four or more participants as very or extremely important

Need	**Number of participants rated very or extremely important**
Spatial location of interventions	6
Everything together / Cover multiple sectors/policy areas	5
Information needs to be provided in a digestible format	5
Linked to financial incentives/ Instruments e.g. SRDP	5
Support/ incentives and regulation	5
Enable understanding of change	4
Integrated approach for incentives, regulation and voluntary measures/ balance is key	4
Place-based	4
Understanding potential for multiple benefits	4
Provide evidence of benefits	4

During the facilitated discussion on this activity the following points were made by the participants. These highlighted additional suggested needs, the focus of the approach and need to balance ease of use with the evidence underpinning the interventions. Curved parentheses indicate insertions by the speaker during their own intervention; square parentheses indicate insertions by the facilitator, either during the intervention or while compiling the report. The facilitators’ insertions were attempts to clarify something that was evident, but not directly mentioned by the speaker.

- A land management business needs to know where to invest, how to spend its resources. Land managers want to know the “value” (not necessarily just in monetary terms) of a project benefit. This wasn’t clearly present as a need.

- [in response to above] *A business would normally have an agent who would do these kinds of value assessments and provide investment advice, this is not the role of the public sector/authority. So how to provide the information best so that land manager or their agent can use it?*

- Evidence is vital. Need to be very careful how to present it given its inherent uncertainty. For this reason often tools that support advice are given at the level of indicators for example in one previous project a participant stripped out numbers and communicated direction of change.

- [in response to above] *Problem with this is that it is prediction that is important to people [anticipating what will happen] and uncertainty causes a problem. But no good to have very*

general approximations, better precise statements than general indicators, but with randomness in the model, different approaches [no one size fits all], some way of presenting different options [scenario planning approaches], that allow more precise statements to be made under certain conditions.

- Objectives are consistent but mechanisms are uncertain.
- Tool must be adaptive to political changes/policy changes e.g. Brexit.
- People want detailed information, but this is place specific, so a generic tool may not help. There is a clear tension between site-specific information and general approaches.
- Balancing and managing risk under uncertainty. Greater local focus may mean more uncertainty in data available.
- Land managers need to prioritise their activities based on the value of benefit to them. They are used to making decisions under uncertainty, evidence helps reduce any risks.
- Interventions can change what is needed (at later times and in other locations). There is a cumulative effect [around uptake of SRDP options] such that there may be diminishing returns, i.e. once my neighbour does it may be less valuable for me to do it. Could this be reflected somehow in tools?
- Key question is the scale at which the tools operate.
- There is in fact no single answer to "what's best". Need a system tool that is weighted towards obtaining diverse outcomes.
- There is a trade-off between diversity (of habitats, species) and [ecological] connectivity. Thus, while more diversity may be desirable in some respects, it may reduce connectivity.
- We are talking about options – multiple options under diverse scenarios.
- Key consideration is how easy is the tool to use? Complex technical tools may not get used.
- Two main users for a potential tool can be identified:

  (i) Grant giving body – want to know how best to use public money.

  (ii) Land manager – wants to know what impact will this have, what options are available to me?

- A third user can be identified:

  (iii) Communities – need to help communities in collective decision making. These are to some extent "new customers" for these types of tools.

3.2 Activity two: developing principles

The three pairs of researchers and non-researchers produced 12 suggested principles (Table 4). The 'need cards' the principles were placed next to, are also presented in Table 4. These included the need for the approach to be "credible and trustworthy" and "accessible/easy to use".

Table 4 Principles suggested by the participants

Principle	**Where placed in relation to one or more needs**
Updateability	None
Agile development. Multiple versions	5- Dashboard format 7- Support/ incentives and regulation
Provides cost-benefits of options	32- Participant's own: helps indicate areas to 'invest' in interventions
Clarity of objective: public interest, land manager, community	70- Policy and on the ground connections
Iterative: exploration of multiple scenarios and consequences	76- Participant's own: Iterative evaluation of options
Credible/transparent	86- Provide evidence of benefits 87- Information needs to be provided in a digestible format
Credible and trustworthy	87- Information needs to be provided in a digestible format
Practical relates to users experience and needs	96- Provide evidence of benefits 97- Spatial location of interventions
Accessible/easy to use	98- Information needs to be provided in a digestible format 99- Place-based 106- Information needs to be provided in a digestible format 107- Spatial location of interventions
Clear on operational scale	102- Integrated approach for incentives, regulation and voluntary measures/ balance is key
Dealing honestly with uncertainty: avoid large-scale uniformity of outcome, diversity manage via incentives/regulations	105- Participant's own: Tools should promote diverse outcomes, even to similar places and objectives
Limited need for time in using tool. Must not take ages to complete (lose will to live)	97- Spatial location of interventions 98- Information needs to be provided in a digestible format 105- Participant's own: Tools should promote diverse outcomes, even to similar places and objectives 106- Information needs to be provided in a digestible format

The participants were invited to reflect on their suggested principles, and they raised the following points:

- Updateability – very important as policy context, data etc. frequently change.
- Dealing honestly with uncertainty.
- Credibility/Trustworthiness etc. What is credibility and what does it mean to each user. It's a thorny issue, what's credible to me may not be credible to you –scientists frequently disagree about reliability/ appropriateness of approaches and datasets. Seems like it might be impossible for something to be credible to everyone.
- [Response to above] *But credibility is at least important as a principle, isn't it? Even if it's not really achievable.*
- Need to apply a filter to data beforehand to avoid credibility issues.
- Some repetition/commonality observed amongst needs but also quite a lot of diversity. E.g. agreement that credibility and accessibility are important but disagreement about the importance of cost-benefit information.
- RO suggests that there is a need to provide cost-benefit information on some level. But who is best placed to do this? Each actor would require a different cost-benefit analysis to suit their land/circumstances.
- Tool must be practical and useful.
- It must be clear that the tool supports, but does not actually make decisions.
- Openness is really important, openness about uncertainty and what a tool can and cannot do.
- Need to be clear about the scales at which the tool does and does not operate [note – some datasets need to disappear at zoom levels higher than those for which they are intended to be used].

When looking at the list of suggested principles the participants could see agreement and disagreement. For example there was a lot of discussion around the principle of credible/trustworthy including openness and updateability, and the need for the application to be focussed and practically useful. Looking through the list of suggested principles, then the clarity of the applications' focus e.g. objective and operational scale was highlighted. Several of our draft principles were included by the participants including transparent, accessible and practical.

A revised set of principles based on our draft principles and those suggested by the participants will inform our development of the approach and digital application (Table 5). Our development will involve developing versions early and often i.e. agile. We will be clear on the clarity of the applications' focus (what need is it addressing) e.g. objective and operational scale.

Table 5 Draft and additional principles that will inform our development

Origin	Approach	Digital application
Draft	Facilitated, integrative and adaptive.	Accessible, relevant, practical, transparent, evidence and outcomes based.
Additional	Efficient (use of time)/easy to use.	Updateability and credible.

It was suggested that the principles should be set out as sentences (rather than single words) to provide greater understanding of what was meant. A provisional list of these sentences is in Table 6.

Table 6 Provisional principles that will inform our development

Approach The approach will help **facilitate** decisions about land and water resources. It will aim to be **integrative** through considering a range of environmental and financial outcomes. It will aim to support **adaptive** management though clarity of objectives/outcomes, and linking with evidence that supports exploration of those options to achieve those objectives/outcomes. The approach will be designed to be **easy to use** and **efficient**.
Digital application It will be **accessible** for anyone to use. It will be **relevant** and **practical** for land managers. It will aim to be **credible**, with **transparency** in the information and methods used. It will be designed to be **updateable** with new information as it comes available.

3.3 Activity three: overview of software options and requirements

During our presentation of initial and advanced requirements a series of points were raised by the participants:

- Linking of input in one location with another, for example changing what required in the future.
- Inclusion of a third dimension of requirements (in addition to functionality and feasibility) for the user from less to more complexity (ease of use).
- Need front face (front end) for accessibility, and behind (back end) for confidence in.
- Based on the resource need to be able to complete the development, previous projects e.g. local exemplar in NERC EVOp not 100% finished.
- Is it possible to hide complexity for less advanced users?
- Can it be used to work in the field offline? Another participant asked if we were thinking of being able to use it in the field. Kit Macleod replied saying that was our starting suggestion.
- What would the suggested changes (interventions) mean for the landscape. Related to this was what would a change to polygon result in terms of multiple benefits.
- Possibility of virtual and augmented reality to present information was raised.
- The focus on touch was questioned by one participant. Kit Macleod replied saying we are aiming at desktop and mobile/touch, and need to be aware of greater use of mobile devices.

3.4 Activity four: touch table demonstration

During the touch table demonstration several comments and questions were raised. These included:

-Like the interface (slippy maps on touch table), but issue is about the datasets you put in a tool like this and the presentation of uncertainty.

-Can you use this to collect data e.g. where the starting dataset (national land cover) is incorrect at the local scale.

-It would be useful to automatically add user inputs, as in earlier projects needed to digitise the information over night.

-The map interface is good (use of the slippy maps) as standard GIS layers have large jumps between scales (zoom levels).

-Issue of credibility, if data is wrong; as people look to test it based on their knowledge. Leading to reduced credibility. Related to this was the challenge of using national extent land cover datasets at the local scale, need to use the right data for the context.

3.5 Final summing up

In answer to the question "what would you do next", the following points were raised:

1. Who are you going to use as a sounding board for future development? Kit Macleod replied potentially Rivers trusts e.g. Tweed Forum, and friendly land managers e.g. Eric Baird at Glentanar. RO suggested the new sub-group of the Scottish Natural Capital Forum would be an option, it has been suggested it could act as a sounding board for our RESAS SRP research. RO willing to be our contact, as he chairs this sub-group. MW emphasises the importance of this next step.

2. AF suggested to move on to develop practical case-based applications, define target users clearly (cannot please everyone) and scenarios under which tool will operate.

3. Compare model outputs to reality (DS). Ecosystem services, are they being successfully protected at present? [note- current ongoing work with AG in 1.4.2 seems relevant here].

4. Add concrete information on status and water body quality, e.g. phosphate levels, status, change over time.

5. Think about scale. Can this be used at a field scale? [earlier comment about whether it would be intended for use in the field].

6. Tie in to climate modelling. Can model be run at +2 degrees over present day temperatures to identify refuges and priority areas, and thus target resources appropriately?

7. Demonstrate the value of the tool as a practical application to enable targeting of resources, to guide policy, SRDP grants, woodland expansion etc.

4. Discussion of key points raised and how they will inform our approach

Improving our understanding of the needs we will focus on

During the introduction the question was raised what the workshop organisers wanted to get out of the workshop? Kit Macleod replied “A better idea of what’s needed within the framework of the project and remit of ‘digital tool/application’ (arising from previous reviews and telephone interviews), whose precise form remains at present undecided.”

From the workshop we have a revised list of needs that our approach will focus on during our next phase of development. These will be based on the ten prioritised needs (Table 3) and key additional needs raised by the workshop participants. Additional participant needs could be grouped around what they would enable a user to be able to do e.g. “helps indicate areas to 'invest' in interventions”, “helps to 'value' wider benefits” and “understand business as well as environmental needs”; and how the approach went about this e.g. “Stakeholders provide data interactively”, “dynamic approach that can adapt with funding landscape” and “transparent methods” whilst providing “iterative evaluation of options”.

Clarity in what we are producing and for whom

Related to the needs we will address was the point that we must be clear who the user will be i.e. what type of user, using this application to answer what types of question at a particular spatial scale. There was a lot of discussion during the workshop of the scale/extent of focus. The focus of this SRP research is on the effectiveness of policy measures e.g. SRDP Agri Environment Climate Scheme. Our initial focus was on supporting land and water managers working at the field to landscape scale, and not on producing a regional to national scale screening or targeting tool. We will approach ‘local scale’ i.e. farm to estate scale potential use-cases to help us develop our approach (and digital application). The need to work with a friendly end-user in the next phase of development was repeated several times. We will approach a potential end user to discuss how we can collaborate on the development of our approach and digital application. We also need to be mindful there are a range of different user groups, and different needs/requirements within each group e.g. farmers.

Revised principles that will guide our development

The workshop participants provided useful additions to our draft principles; these will form the basis of how we develop our approach (Tables 5 and 6).

Improved understanding of the user, functional, feasibility and data requirements

In addition to the user and functional requirements in our initial list of requirements and additional functional and feasibility requirements in our advanced list, we will ensure that in the provisional list of requirements that we start development with we ensure user and data requirements are explicitly covered. The participants seemed supportive of our touch table prototype, in particular the use of maps that could be easily zoomed into and out i.e. slippy maps, and the potential for interactivity.

Additional key suggestions that we will incorporate

The need to include spatial information on the environmental status of the area e.g. WFD status or Natura 2000 feature status.

The importance of balancing the accessibility of the ‘front-end’ with the evidence that would sit behind this was raised several times. Related to this was the need to provide credible and transparent information, this may involve presenting information in ordinal categories or direction of change, rather than in precise interval format. The ‘front- end’ needs to be relevant and easy to use, and not include inappropriate data e.g. coarse national scale land cover polygon at a field scale. We will explore the potential of remotely sensed images to provide the familiarity of the land cover to the user.

There was a lot of discussion on the evidence base in terms of its credibility, transparency, consideration and presentation of uncertainty, and ability to be updated.

The need to be clear how and why someone may use this application is clear, and an understanding that there are a range of different user groups (and different needs/requirements within each group e.g. farmers).

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Appendices

Appendix one: workshop invitation

Workshop invitation: developing a digitally facilitated outcome-based approach for understanding the effectiveness of interventions in catchments for multiple benefits

Aim

Our aim is to work with a small group of national and regional level expert stakeholders (and researchers) to discuss their needs as part of our development of a digitally facilitated approach to outcome-based assessment of the effectiveness of land management interventions (including SRDP measures) in catchments for multiple benefits[3].

Workshop objectives

1) To improve our understanding of national and regional level stakeholder's perspectives on what is needed from an outcome-based approach to aid individuals (and groups) to make more informed decisions on land and water management interventions for a range of outcomes.
2) To explore and discuss key principles and functionality of a digital facilitated outcome-based approach.
3) Demonstration and discussion of relevant digital applications and their functionality, and one or more prototypes to guide how we could develop and apply our approach.
4) To help steer the development of our approach and produce a workshop summary.

Where and when

At the James Hutton Institute in Aberdeen (http://www.hutton.ac.uk/about/directions; Macaulay A Boardroom) on 23rd May 12.30 (lunch for visitors) for a prompt start at 13.00 (finish at 16.00).

Background

Recent interviews with stakeholders highlighted the need for practical tools to facilitate decision making about land and water management based on the range of outcomes they provide. Digital dashboards and related web-based applications are increasingly being used to present spatial information on the state of land and water resources, and their management to a range of audiences in support of decision making[4]. This workshop is part of the RESAS Strategic Research Programme[5], a summary of planned deliverables provided in Table 1.

Table 1. RESAS deliverables related to this workshop.

Deliverables	**Timescale (due)**
Stakeholder workshop on approach (D3.4/KE8).	Summer 2017
Outline of revised approach (D3.5).	Summer 2017
Short draft report and database on effectiveness of interventions (WFD). Based on feedback develop the approach in context of WFD and RBMPs including digital version of logic models (D3.6).	Spring 2018
Revised report and database.	Autumn 2018
In years three to five apply our approach in catchments with a WFD focus, including SRDP measures and drinking water protected areas.	2018-2021

[3] We use multiple benefits in a broad sense to mean more than one potential benefit to the environment, land manager or wider society. The term multiple benefits is widely used by policy and management stakeholders in Scotland e.g. in the Land Use Strategy.

[4] An example from SEPA is the WFD RBMP information http://www.sepa.org.uk/data-visualisation/water-environment-hub/

[5] This research is part of two linked projects: RESAS 1.2.4 Effectiveness of water management, Objective 3: Assessment of the effectiveness of interventions to achieve increased effectiveness of water policy objectives; and RESAS 1.4.3 Practical interventions to realise multiple benefits and manage trade-offs. Objective D: To use adaptive management (AM) to integrate SRDP interventions with Natural Flood Management (NFM) and General Binding Rules (GBR) for the delivery of multiple benefits.

Appendix two: workshop presentation

Workshop presentation is available separately.

Appendix three: one things

The 'one thing' that the participants would like to take from the workshop

KM: Understand requirements for developing practical tools

JI: Build on a dialogue to make science more applicable/useful to land/resource managers (scientists come down from ivory towers)

RO: Accessibility - how to provide tools that are accessible to everyone.

MW: Explore what we need for catchment based approaches (trying to get to the holy grail of the catchment scale)

DS: Extent to which techniques/technology can allow us to promote the public interest and change people's minds

AG: To explore and understand what attributes should a tool/support system for the purpose we describe actually have

AF: To deliver maximum public benefit, e.g. win-win with business interest (not trade-off), and to keep the dialogue going

RH: Clearer orientation from decision-makers for practical development of the tool/system

Appendix four: list of needs and justification

List of the 17 needs and justifications taken from the earlier interviews.

Need	Justification
Integrated approach for incentives, regulation and voluntary measures	"we have been thinking for some time that we need an integrated approach for incentives, regulation and voluntary measures (…) and the balance is key"
Policy and on the ground connections	"not just about on the ground connections, also policy connections"
Support/ incentives and regulation	"pretty evident that you need both support and regulation tools to be effective, one doesn't work without the other, because the private sector and the open market doesn't really react unless you kind of have both"
Everything together / Cover multiple sectors/policy areas	"if you were looking at your farm (…) if you were able to look at everything in one go, in one plan that would help you put something in place that not only helped biodiversity (…) could be effective tool for mitigating diffuse pollution" "rather than taking this very sort of niche approach, that we do our sectoral approach" there is a need to move towards a situation where we get better balance, and better understanding."
A common approach	"everyone does their own thing", and went on to suggest it would be good to have a set process outlining the best approach.
Place-based	"we are in a pretty challenging economic environment, and efficiencies to get a place based approach in catchments with problems that I believe is probably quite an efficient way to go"
Support partnership working	"I would like to see a place-based team which had the relevant expertise from the national park authority, SEPA, SNH, Forestry Commission, and RPID who would work together from an agency level (…) deliver the best kind of benefits and not step on each other's toes, be efficient, work with local communities and local land owners."
Enable understanding of change	"if you want people to make change to their business, they need to understand why, they need to understand what's in it for them, they need to understand how, and you need to give them space, and the headspace to reach those decisions."
Linked to financial incentives/ Instruments e.g. SRDP	Several of the interviewees talked about the Scottish Rural Development Programme (SRDP), and the importance and challenge of financial mechanisms for delivering multiple benefits.
Understanding potential for multiple benefits	"better understanding of potential of measures for multiple benefits"

Information needs to be provided in a digestible format	Land managers have limited time to absorb new information to support their decision-making. They provided an example of good communication practice where the "diffuse pollution priority catchments have put that information in front of the farmer in a very digestible way, a very personable way and have signposted where the financial help and guidance is available (…) rather than, you know well we have produced a leaflet surely they should just get on and do it and understand what's required of them."
Structured approach	"it would be more helpful to have a more structured way, it varies a lot." They said this was more than a checklist to judge success related to "have we delivered more ecosystem services, and what are the trade-offs (…), and how does a land manager do this?"
Spatial location of interventions	"have potential for multiple benefits for flooding, soil erosion, all of these only if they are put in the right place" "in terms of diffuse pollution measures, they need to be in the right place for them to be effective"
Needs to cover financial benefits	"need to talk the language of business so that farmers, estate owners, foresters, local communities, government agencies can get around a table" "it must have a cost benefit, that is the outcome, we want to see improvements to water quality, but that has to be cost beneficial for the customer."
Provide evidence of benefits	"need to be clear what are the public benefits and need science evidence how lead to those." "identify what [is] that shared outcome" and then said "we are interested in evidence of those being achieved, and [to] have the evidence that those interventions are having an effect"
Set neutral criteria and then assess	"can we set up neutral criteria and measure different land uses to that (…) need a number of factors, you can restrict this to a manageable list, then land use X does not score well on money, carbon etc then maybe need something else that comes further up the list"
Dashboard format	"helps if in a dashboard format, [we are] seeing them in digital reports."

Appendix five: examples of principles

Example of principles used in sustainability tools

Participatory GIS principles (Ball 2002): Accessibility—the information technology and data must be freely accessible; Understandability—the system, and their limitations and uncertainties, must be understood by all users; and Accountability — the way in which the information is used should prevent 'capture' by powerful and self-interested parties.

Five characteristics of the QUICKscan approach have been described (Perez-Soba et al 2012; Verweij et al 2012; Winograd et al 2012) and include: user friendly; flexible, scalable and open; transparent; deals with complexity, integration and iteration; and incorporates qualitative and quantitative approaches and information.

Natural Capital Protocol (2016) principles: relevance, rigour, replicability, consistency (adapted from existing approaches).

Risk-Informed Management of European River Basins Brils (Deltares) *et al* 2014 book "Risk-informed management is this new approach. It involves the integrated application of three key principles: be well informed, manage adaptively, and take a participatory approach. "

The five sustainability principles were: adapting management, broadening options, ecosystem thinking, linking into social fabric, and thinking beyond the estate (p199). Glass *et al* 2012/3 Lairds, Land and Sustainability.

Appendix six: spreadsheet of participant needs ratings

The rating of needs and related material are available in a separate spreadsheet.