Developing an outcome-based web application: principles and requirements specification

RESAS1.2.4.3 [D5 outline of revised approach]

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Executive summary

This research briefing sets out our refined approach to developing an outcome-based approach to aid land managers decide where to intervene (and why) e.g. where to place a Scottish Rural Development Programme management option for one or more environmental outcomes. This report builds on findings from earlier project outputs (deliverables) including stakeholders' perspectives on what is needed in terms of tools to support outcome-based land management decisions (Figure 1).

In this report we summarise key points from phase two of our research, setting out the principles supporting our approach, and how we refined our software application requirements. At the heart of our approach, we are developing a spatially explicit Facilitated Outcome-based Land Management (FOLM) web application that is designed to work offline on a range of devices. Our development process is based on best practices for people-centred software development: including interviews, workshops, developing and testing of prototypes, and setting out requirements as user stories. A related technical report (D6 in Figure 1) presents a summary of our development of a series of prototypes spanning phases one to three: including development options and how they relate to stakeholder prioritised requirements.

Figure 1 Outline of our process to develop an outcomes-based approach
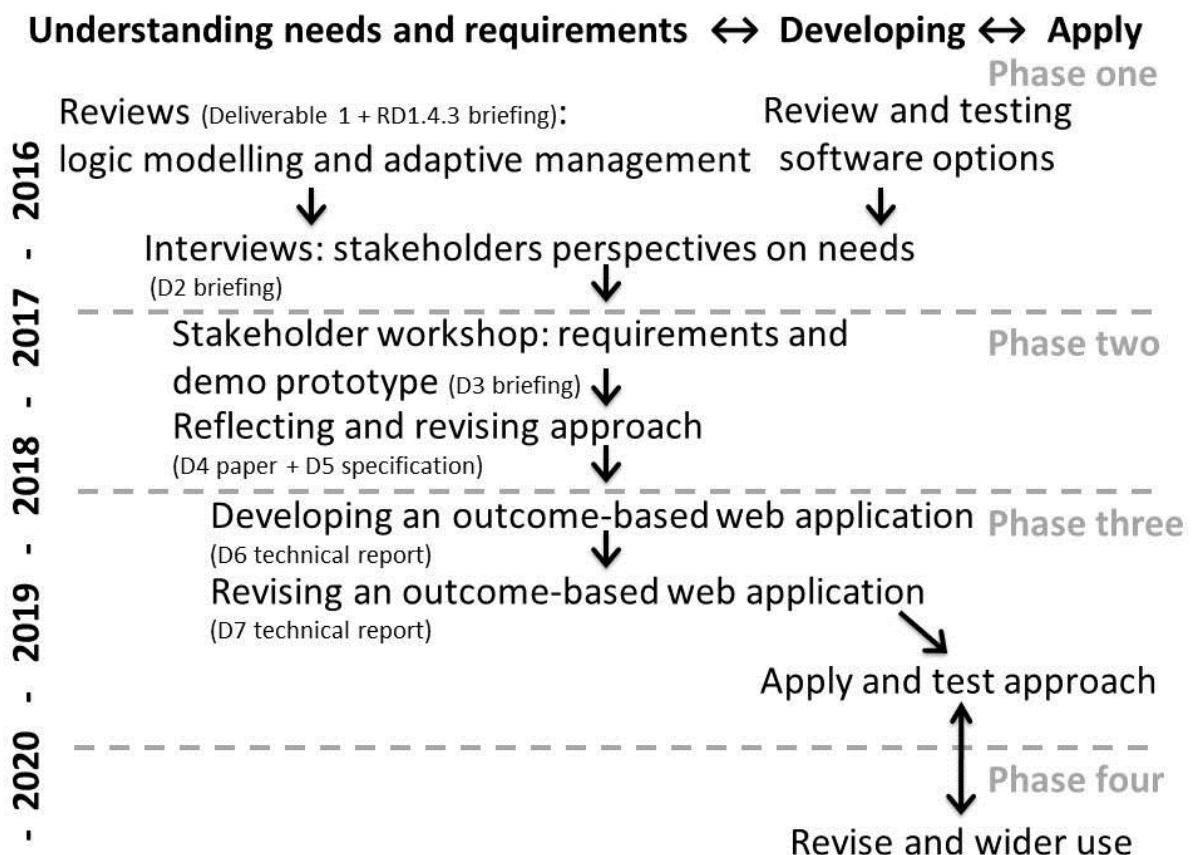
Glossary

Term	Definition
Agri-Environment Climate Scheme	A scheme under the Scottish Government Scottish Rural Development Programme 2014-2020. The Agri-Environment Climate Scheme promotes land management practices which protect and enhance Scotland's magnificent natural heritage, improve water quality, manage flood risk and mitigate and adapt to climate change.
CAP Pillar II	The Common Agricultural Policy (CAP) is the European policy that provides financial support to farmers. Payments are provided as either direct income support (Pillar I) or through country specific rural development schemes (Pillar II).
Development principles	A set of principles that are used to guide the development of a software application.
Environmental decision support system	Is a digital tool for use in by people to aid their decision making related to environmental issues e.g. how to manage their land for water quality and biodiversity.
Functional software requirements	Functional requirements are what software applications should actually do e.g. show spatial location of a management action.
Interventions	Cover a wide range of land and water management actions that can be carried out by land managers, and other individuals and organisations. One group of interventions are management options under the Scottish Government rural development Pillar II schemes.
Mobile-first web design /offline	A software application that is designed to work on mobile devices e.g. tablets, and offline i.e. no wifi or mobile connection.
Multiple benefits	Consider the delivery of more than one single benefit e.g. nature conservation or food production from land and water management. One objective of the Scottish Land Use Strategy is to deliver multiple benefits from our land.
Non-functional software requirements	Non-functional requirements are the properties the software should have e.g. be freely accessible.
Outcome logic modelling	A graphical way to present and understand the relationships and linkages between strategies and actions, intermediate results and desired outcomes e.g. targeting land management to improve water quality status.
Prototyping	Producing early examples of a software application to test a concept or process or to act as a thing to be replicated or learned from.
Regulations	Regulations based on policies e.g. The Water Environment (Diffuse Pollution) (Scotland) Regulations are referred to as the Diffuse Pollution General Binding Rules (DP GBRs). The seven DP GBRs focus solely on rural land use activities. All rural land users have a responsibility to ensure they are working in line with the DP GBR's.
Stakeholder	Individuals or organizations having a right, share, claim or interest in a system or in its possession of characteristics that meet their needs and expectations.
User stories	A software development technique that involves writing and discussing high-level short descriptions of software functionality i.e. high-level definition of what the software is capable of doing.

1. Introduction

As part of the Scottish Government Strategic Research Programme (SRP) project 'Assessment of the effectiveness of interventions to achieve water policy objectives (RESAS 1.2.4 Objective 3)', this research briefing sets out our refined approach to developing a spatially explicit Facilitated Outcome-based Land Management (FOLM) web application to aid land manager decision-making for multiple benefits. There is increasing interest in how we improve targeting of land and water management actions e.g. Scottish Rural Development Programme (SRDP) options for one or more environmental outcomes.

This report builds on findings from earlier project outputs that have explored stakeholders' perspectives on what is needed in terms of tools to support outcome-based land management decisions (Table 1 and Figure 1). This research has included a participatory workshop with representatives from Scottish Environment Protection Agency (SEPA), Scottish Natural Heritage (SNH) and Cairngorm National Park Authority (CNPA) to prioritise the requirements e.g. what it will enable a person to do, and co-construct an initial set of principles for developing and applying our approach (Table 1).

*Table 1 Key points from previous research outputs (see Figure 1)*

Outputs/deliverables	Key points
D1 Macleod (2016) How can logic modelling improve the planning, monitoring and evaluation of policy measures and wider interventions for multiple benefits?	Provided an overview of uses and potential benefits of logic modelling, including outcome/results based approach.
D2 Macleod and Hewitt (2017a) 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.	Stakeholder views on integrated approach to land use and catchment management using incentives and regulations for multiple benefits. Stakeholder awareness and understanding of logic modelling and outcome-based approaches, and requirements for an approach. Initial development of a web application to support an outcome-based approach.
D3 Macleod and Hewitt (2017b) Workshop summary: developing an outcome-based approach for understanding the effectiveness of interventions in catchments for multiple benefits.	Understanding perspectives on people's needs. Developing principles to guide development and use of application. Demonstration and discussion of software options and requirements.
D4 Hewitt and Macleod (2017) What do users really need? Participatory development of decision support tools for environmental management based on outcomes.	What are stakeholders' views on key non-functional requirements i.e. properties of environmental decision support systems (EDSS). Review of software options for producing EDSS.

The purpose of this research briefing is to summarise our refined approach to developing an outcome-based approach to aid land managers decide where to intervene (and why) for one or more environmental outcomes. From representatives of end users we have learned that there is a need for easily accessible tools to aid land manager decisions about how management actions e.g. SRDP Agri-Environment Climate Scheme (AECS) management options could help achieve a range of environmental and financial outcomes. In the following sections we summarise key points from the

first two phases of our development process (Table 1 and Figure 1), and the principles underpinning our approach (Section 2). At the heart of our approach, we are developing a web application that is designed to work offline on a range of devices. Our development process is based on best practices for people-centred software development, including understanding user requirements as user stories (Section 3).

Our research is structured around a series of development activities that range from understanding people's needs and requirements, to developing, using and testing our spatially explicit outcome-based approach (Figure 1). These activities are grouped into four phases. The first phase of this work has been completed, and involved collecting information on people's needs and potential software options for developing an application that would meet one or more of these needs (Figure 1 and Table 1). A second phase of the work involved working with a range of national and regional stakeholders, and researchers with expertise in developing tools to aid land management decisions, to co-develop principles and requirements underpinning our approach. A more detailed description of our development of a series of prototypes is presented in a technical report (D6 in Figure 1); including development options and how they meet prioritised requirements. Feedback from people how may use our application and their representatives will guide further development of our spatially explicit Facilitated Outcome-based Land Management (FOLM) prototype (D7 in Figure 1).

*Figure 1 Outline of our process to develop an outcomes-based approach*
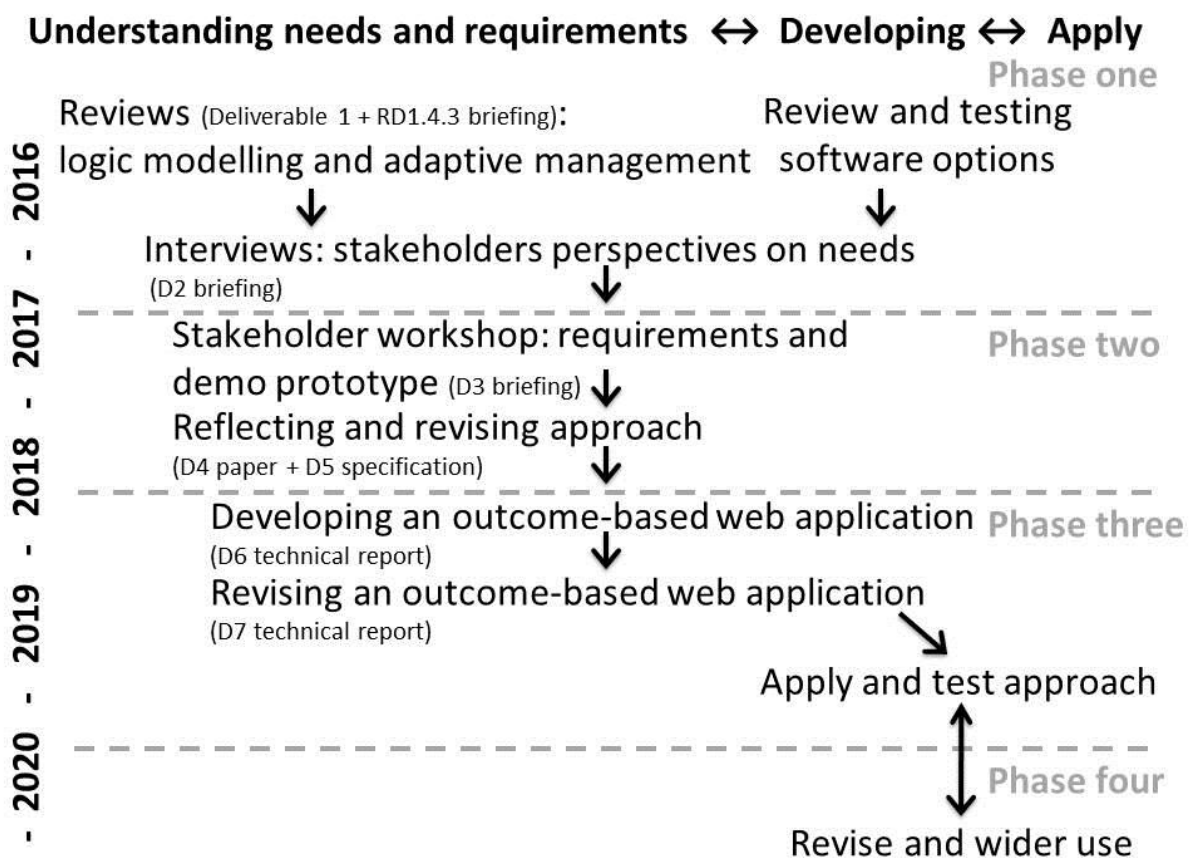
2. Principles supporting our outcome-based approach

This section covers the principles for how we are developing our approach, and how we envisage it being used.

2.1 Principles guiding development of our approach

In terms of development process we are following best practices for making software that is useful for people; we are building on long established practices e.g. 'user-centred system design' for software development (Norman and Draper, 1986). This places people at the centre of the design process, and seeks to maintain this focus throughout the whole development cycle through structured interactions between end-users and developers (Figure 2). Our development principles are based on those of Gulliksen *et al.* (2003), and these include understanding people's needs and requirements, use of prototypes to aid design and evaluation, and iterative development based on feedback (Figure 2). Our use of these principles is demonstrated through, previous and planned, engagement with relevant stakeholders and other people who may use our approach and web application (Table 1 and Figure 1).

Figure 2 People-centred systems design process (Gulliksen et al., 2003)
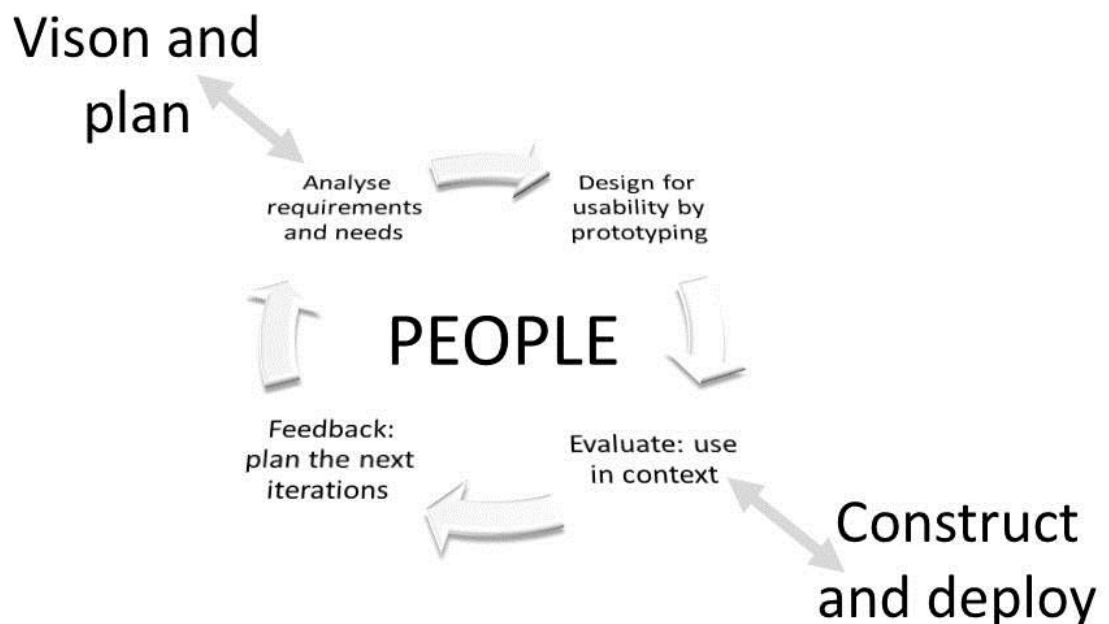
2.2 Principles for applying our approach

During a stakeholder workshop we co-developed a series of principles to guide the development and use of our application (Table 2). The participants suggested that the principles would be more informative if written as sentences (Macleod and Hewitt, 2017b). We will utilize these principles when applying our approach.

Table 2 Principles for applying our approach

The approach will help **facilitate** decisions about land and water resources.
The approach will be designed to be **easy to use** and **efficient**.
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 by linking with evidence that supports exploration of those options to achieve those objectives/outcomes.

3. Refining our software requirements

A key activity in our development process was to establish an initial set of high level requirements for the software- based on the needs of end-users and their representatives. During a stakeholder workshop a list of needs or requirements was prioritised (Macleod and Hewitt, 2017b). Software requirements are often split into two groups, functional and non-functional: where functional requirements are what the software should actually do e.g. show spatial location of a management action, and non-functional requirements (sometimes called constraints) are the properties software should have e.g. be freely accessible. To guide development of the next prototype, we plan to employ a standard technique called 'user stories' based on the prioritised functional requirements.

3.1 Overview of user stories

User stories are written from the perspective of a user, and are short, high-level descriptions of functionality i.e. high-level definition of what the software is capable of doing. They describe functionality that will be valuable to either the user or purchaser of a system or software (Cohn, 2004, 4). The focus is on why and how the user interacts with the software. A software requirements process based on user stories often has three parts: the first is to articulate the initial user story based on a template. Here is an example of a user story template <where this text varies, based on the user story>: **As a** <person in a particular role>, **I want to** <perform an action/task or find something out>, **so that** <I can achieve my goal of>. User story templates are meant to be flexible- to aid thinking.

The second part of the process is when the functionality related to a particular user story is implemented. At this point a conversation is initiated with one or more users of the software, or their representative/s. A conversation between all those involved is preferred over a detailed requirements document: to aid common understanding of what is needed, how it will be implemented and what it will result in.

The third part of this process is about confirmation (using non-technical language) and demonstrating that the functionality associated with a particular user story has been implemented (often called acceptance tests).

In this report we focus on the first part of the user story process. Initial user stories are often very broad and it can be difficult to estimate what is required to implement them (referred to as epics). Smaller and more measurable user stories are often created based on the initial stories, whilst leaving the implementation flexible.

3.2 Functional requirements as user stories

The functional requirements rated (by at least five of the six workshop participants) as being very or extremely important are presented in Table 3 (Macleod and Hewitt, 2017b). We have drafted initial user stories based on these five requirements.

Table 3 Prioritised functional requirements and draft user stories to guide development of our approach and web application

Prioritised needs[1]	Justifications from the stakeholder interviews[1]	Draft user stories
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"	As a land manager, I want to see the spatial location of interventions, so that I can decide where to implement 'water margins in arable fields' SRDP AECS management option.
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 (…)"	As a land manager, I want the information to be provided in a digestible format so that I can decide where to implement SRDP AECS management options.
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"	As a land manager, I want to see information on SRDP incentives and regulations, so I can decide where I could implement SRDP AECS management options.
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"	As a land manager, I want to see the potential outcome on water quality objectives as well as biodiversity at the same time, so I can decide where to implement what SRDP AECS management options.
Linked to financial incentives/ins truments 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.	As a land manager, I want to see information on the finances of SRDP AECS management options, so I can decide if I want to implement it.

[1]These needs (and justifications) were produced from interviews with 13 stakeholders, see Macleod and Hewitt (2017a) for more details.

3.3 Non-functional requirements as user stories

During our workshop we revised our non-functional requirements with stakeholders (Figure 1 and Table 4). These high-level requirements have been presented as an initial draft set of user stories (Table 4).

Table 4 Initial non-functional requirements and draft user stories to guide development of our approach and web application

Non-functional requirement	Draft user stories
It will be accessible for anyone to use.	As a land manager, I want to access the application from my tablet in a field.
It will be relevant and practical for land managers.	As a land manager, I want to explore relevant SRDP AECS management options for farm, so that I can understand the environmental benefits.
It will aim to be credible, with transparency in the information and methods used.	As a land manager, I want to be able to see the information and methods used in the web application.
It will be designed to be updateable with new information as it comes available.	As a land manager, I want the software to have the latest information on the SRDP AECS management options.

In this section we present summaries of these non-functional requirements (see earlier reports in Table 1 for details):

3.3.1 It will be accessible for anyone to use

A requirement arising out of stakeholder interviews identified that any application developed should be free at the point of use and easily accessible. This is an essential requirement of our outcome-based approach, which requires transparency and effective exchange of knowledge and data between all stakeholders. The application will be web-based (with the code placed in an open repository), and designed for a range of mobile and desk based devices.

3.3.2 It will be relevant and practical for land managers

Relevance, or salience, is one of three criteria (together with credibility and legitimacy) that are frequently found in the literature on environmental decision-making e.g. (Cash et al., 2002). The need for an outcome-based application to be practical and useful for land managers was clearly stated during the stakeholder interviews and workshop. To achieve this, it is essential that the application is useful to people and organisations who may use the approach and web application.

3.3.3 It will aim to be credible, with transparency in the information and methods used

For a decision-support tool or approach to be credible it should be trustworthy. To achieve this, our workshop participants emphasized the need to deal honestly with uncertainty, both in terms of data and of model/application outputs. Participants also agreed about the importance of being transparent about what the application can and cannot do.

3.3.4 It will be designed to be updateable with new information as it comes available

The importance of updateability was identified in early consultations with colleagues, and during stakeholder interviews and our workshop. This is particularly important in the context of the rapidly

evolving nature of environmental policy and the need to be adaptable and responsive as a result. Participants emphasized the highly changeable nature of both the policy context and data availability. Web and mobile applications are easier to update than software downloaded onto desk top computers.

4. Next steps

This specification document (alongside the related technical report D6, see Figure 1) will be shared with stakeholders involved with our development process. We will continue to seek feedback to guide our development of our approach and web application for spatially explicit Facilitated Outcome-based Land Management (FOLM). In the current third phase of our development process we will focus on implementing the stakeholder prioritised functional requirements, whilst trying to satisfy the non-functional requirements.

Acknowledgements

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