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Why do NRM regional planning processes and tools have limited effect? Presenting the perspective of the end user

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ABSTRACT

Natural resource managers are required to prepare a plan for managing the natural resources in their regions. Environmental decision support systems (EDSS) have been developed to assist managers and stakeholders make decisions about complex natural resource problems. Research has shown that these EDSS are valuable and used internationally. However, sustainability science literature reports that too often these natural resource management (NRM) plans are not consulted upon completion, and the EDSS are no longer used. To gain insight into why the EDSS are no longer used after the research and development phase of the NRM planning project, we have asked the stakeholders, as end users of the EDSS tool themselves, to share their perceptions of, and experience with development of the tool and then, the tool itself. This paper reports on the perspectives of the end users of an EDSS used in a South Australian NRM planning project from 2011 to 2013. The findings were mixed in that they show that the majority (90%) of respondents felt the EDSS had overall value, yet it was virtually abandoned after the completion of the planning project. Further, just over half of respondents reported that they thought that the EDSS should have been used on a regular basis after the pilot project ended. We conclude that genuine capacity development, aided by the EDSS, took place during the project. However, the lack of use of the EDSS after the pilot project finished was the result of failures both with researcher follow up and especially with the lack of commitment from government agencies who support and influence the array of end users. Unless agencies commit to the changed practices identified by end users that would support ongoing use of EDSS it is inevitable that the legacy value of EDSS development will remain limited.

1. Introduction

Climate change, in all its complexity, has been addressed in recent literature as a 'super wicked problem' (Levin et al., 2012) and one that may well be the greatest collective action problem faced by humanity (Ostrom, 2010). With expected changes in climate, increased regional and community planning and actions will be needed to adapt. Local level planning is often looked to as the instrumental framework and delivery mechanism for such adaptation (Measham et al., 2011; Mukheibir et al., 2013). Some local climate change adaptation plans have already been implemented (Baker et al., 2012; Hurlimann and March, 2012) as well as examples of regional planning that incorporate climate change response policies and strategies (Matthews, 2015). These adaptation measures will complement other mitigation actions. Both will be needed because the effects of climate change are complex and

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dynamic.

Climate change is and will continue to have, a significant effect on the natural resources of the atmosphere, soils, biota and water. This recognition is influencing the development of appropriate adaptation strategies and the incorporation into natural resource management. Natural resource managers are challenged to make difficult and complex choices within an uncertain and dynamic environment. Such decisions need to be based on current and reliable scientific data and also be responsive to economic, political and social interests. Natural resource management (NRM) has been progressively engaging stakeholders in participatory processes, recognizing that regional decisions must be responsive to local communities (Beierle, 1998; Reed, 2008).

In Australia, regional statutory agencies have been tasked with the management of natural resources. To provide NRM organisations with information on potential adaptation responses to climate change, the Australian government offered a $AUS 43.9 million Regional Natural Resource Management (NRM) Planning for Climate Change Fund from 2011-2016 (Clear Horizon Consulting, 2016). This funding source supported climate adaptation initiatives in two regions of southern Australia, the Eyre Peninsula and South Australian Murray-Darling Basin (SAMDB) during 2011–2013. This paper investigates the effectiveness of a supported project – the Envisioning Future Landscapes (EFL) initiative. The ELF project incorporated an envisioning element for NRM planning and developed and used a computer-based environmental decision support system (EDSS) to facilitate knowledge sharing and investigate adaptation options.

The concept of decision support systems (DSS) for organisational decision-making was introduced by Simon (1959) and further developed by Gorry and Morton (1989). Environmental decision support systems (EDSS) have developed to assist natural resource managers explore decision options within the highly complex social ecological regional environment. EDSS have advanced from providing scientific support for decision making through computer based systems to current practice which increasingly incorporates stakeholder engagement in a participatory decision framework (Matthies et al., 2007). The early literature outlined desirable features of an EDSS to provide mostly science informed outputs needed by end users (Rizzoli and Young, 1997). Subsequent developments have increasingly recognized the value of including non-scientific perspectives in the analysis of these complex social ecological problems (Courtney, 2001). Jakeman et al. (2006) recommended steps required to design an EDSS that incorporated the important partnership between system designers and clients. Recent literature continues to promote the need for EDSS design to be inclusive and participatory. The intention is to engage stakeholders throughout the entire process, from development to implementation (McIntosh et al., 2011).

The success of this process has been greater when the EDSS have an appealing visual component. Inputs and outputs associated with computer based land use planning and modelling tools can be displayed visually and many international examples have been described (Bohnet et al., 2011; Bowron and Davidson, 2012; Cohen et al., 2006; Meyer et al., 2015; Robinson et al., 2011; Salter et al., 2009; Sheppard et al., 2011; Voinov and Gaddis, 2008).

With increasing recognition of the need for community engagement in the development of future scenarios and hence consideration of adaptation options, the role of EDSS has become more than simply including and providing science based information alone. The sustainability science literature (Bizikova, 2009; Bowron and Davidson, 2012; Pettit et al., 2011; Salter, et al., 2009) describes projects that increasingly include social elements of economics, demographics and community preferences. In particular, the scenario planning element in EDSS has been reported as having value as an adaptive, shared learning approach that enables participants to develop a better understanding of how NRM decisions are made (Tompkins et al., 2008). This element has been asserted to have value in empowering stakeholders through their involvement in and contribution to local planning processes (Ernst and van Riemsdijk, 2013; Reed et al., 2013). Further, scenario planning has been recognized as having value in that the use of scientific data integrated into the scenario development increased participants' understanding of the real physical and social threats and effects of climate change (Pert et al., 2010).

As valuable as EDSS are deemed, it is increasingly evident that they lack application beyond their initial development phase (Dilling and Lemos, 2011; Hochman and Carberry, 2011; Lemos et al., 2012; McIntosh, et al., 2011; Meyer, et al., 2015). One challenge identified in sustainability literature is that EDSS may be designed with too much focus on the technology rather than the needs of the end user (Hochman and Carberry, 2011). Additional challenges identified include insufficient funding and inadequate funding cycles to support the application of the EDSS and the adaptive learning processes needed (Campbell et al., 2015; Lemos, et al., 2012; Meyer, et al., 2015; Roux et al., 2010; Talwar et al., 2011; Voinov and Bousquet, 2010). Further, while the literature advances participatory processes in natural resource management, it lacks acknowledgement of the institutional and organizational requirements needed to support this participatory work (Meyer, et al., 2015; Reed, 2008).

It is evident from the discussion above that the development of EDSS as a science informed tool is well advanced but its continued use beyond the development project is limited. This situation points to a lack of commitment from potential end users and possibly a failure of researchers to fully understand the needs and requirements of end users. While the perspectives of the researchers who have designed an EDSS tool have been recorded, there is a paucity of literature documenting the perceptions of the end users of these tools. To best understand why the stakeholders, as end users of the tool, are not using it after the project's end, we have asked end users in the EFL project to share their experiences with the EDSS. Twenty-nine stakeholders who had used the EDSS from the project in South Australia were interviewed.

This paper reports on the perspectives of these twenty-nine respondents regarding the effectiveness of the EDSS in the context of its ongoing application in regional NRM planning. The objective of the study was to identify structures and processes that support or inhibit the ongoing use of the EDSS and the legacy of learning contained within it. Data gathered through semi-structured interviews with end users of the EDSS is used to better understand how to design a more effective EDSS that may be used beyond the research and development phase of a similar project.

2. Methods

2.1. The EDSS used in the envisioning future Landscapes (EFL) initiative

Researchers from the University of Adelaide's EFL initiative designed an EDSS to assist in the development of regional NRM plans in the Eyre Peninsula and South Australian Murray-Darling Basin NRM regions in the state of South Australia. This EDSS combined community engagement in the development of future scenarios with computer based land use planning and modelling tools. The research team developed and tested an approach to stakeholder engagement with an EDSS tool designed to encourage the long term use of the EDSS to support stakeholders in taking meaningful action on climate change. They added an element that also allowed stakeholders to create values-rich narratives through a participatory 'envisioning' process (Meyer et al., 2013; Meyer, et al., 2015; Moretti et al., 2009; Wells and McLean, 2013). This approach was developed to strengthen stakeholders' personal engagement in the process and increase the long term use of the EDSS by end users.

The EFL team developed the 'envisioning' approach to stakeholder engagement to explore and develop shared values and bring people together as they engage in the NRM planning process (Meyer, et al., 2013; Meyer, et al., 2015; Moretti, et al., 2009; Wells and McLean, 2013). The process began with a discussion about 'how we really want to experience the landscape' which placed stakeholders, along with their values, at the core of the discussion and enabled them to exercise personal choice and leadership. They explored central themes, worked to develop a shared vision, then developed identifiable indicators of progress which would illustrate if the process was working or not, and engaged in action learning in the development of participatory scenarios and engagement with the geographical information system (GIS) visual element of the EDSS. Finally, the research team sought to ensure that planning would be understood as part of an integrated process, directed to action, as opposed to an end in itself (Meyer, et al., 2013).

The EFL initiative incorporated four stages, beginning with a review by the research team of past planning processes in the region. They then held envisioning workshops with local stakeholders to ascertain key design elements of their EDSS. Next, researchers developed a GIS visual tool, the Landscape Futures Analysis Tool (LFAT) and delivered it to stakeholders; and finally, in the fourth stage, they evaluated the success of the process through training sessions and semi-structured interviews with stakeholders (Meyer, et al., 2015).

The EFL team worked within an action research framework and collaborated with staff from the NRM Boards in these regions from 2011-2013 to design and implement a process to support climate change adaptation planning in the development of their next 2014–2019 NRM plan. The majority of workshops with NRM Boards and stakeholders took place in 2012 (Meyer, et al., 2013).

2.2. Case study

The methods used in this study consisted of a document analysis of literature related to the EFL project and hour long semi-structured interviews, in person or on the telephone with stakeholders, those who attended any of a series of EDSS workshops in the project during 2012. The same set of forty-nine interview questions was used in each case, and was also made available in an online format. Out of twenty-nine respondents, twenty-four participated in oral interviews and five people answered the same questions online. The questions were used to ensure that respondents had substantial opportunities to share their experiences with all aspects of this EDSS. Twenty-nine interviews were conducted in March and April 2016. Stakeholders who had participated in any of the 2012 workshops were e-mailed and invited to engage in this research study.

The twenty-nine respondents provided a representative cross section of the regional stakeholders; fifteen were NRM staff or board members, ten were government employees, two non-governmental organization (NGO) employees, one city employee and one who reported their affiliation as 'other'. The majority of respondents, twelve people, thought they had attended two to three workshops, seven people thought they attended three to five workshops and six people thought they attended more than five workshops. The interviews were transcribed confidentially, analysed to identify the perceptions of the end users of the EDSS, coded and then further analysed using Nvivo qualitative data management software.

3. Results

Quotations from the transcribed interviews are used extensively in presenting the findings as they comprise the data of the study. We have slightly edited the quotations for grammar and clarity and present any modifications made within brackets. Although quotations represent the best source of data regarding the end users experiences with the EDSS, we cannot present all of the data collected here due to space limitations. We have therefore selected representative quotations, which we feel add valuable, first hand perspectives of the end users of the tool.

3.1. The end users found the EDSS to have overall value

Data analysis showed that the majority of respondents reported that they felt the EDSS was valuable overall. Eighty-three percent of respondents said that they felt the EFL was useful or very useful for the region's NRM planning for climate change adaptation planning. Data collected from the use of a five-point Likert scale showed that respondents recorded an overall increase in both awareness of and concern about the potential effect of climate change on their region after the project. When asked if, as a result of the project, they had made any changes in their behaviour relating to climate change, 76% responded that they had not, many saying that they already were well aware of climate change. However, when asked if, as a result of the project, they had made any changes in

Table 1
A summary of questions and responses related to the individual elements of the EFL.

Question	Response	
Did developing local scenarios help you to make decisions about climate change adaptation?	88%	Yes
Did the visual display of the scenarios, and other climate change information such as the Landscapes Future Analysis Tool (LFAT), help you to make decisions about climate change adaptation?	76%	Yes
Did the envisioning process help you to make decisions about climate change adaptation?	64%	Yes
Did adding local perspectives help you to make decisions about climate change adaptation?	86%	Yes
Did the involvement of experts on climate change help you to make decisions about climate change adaptation?	90%	Yes
Did the processes used in this project sufficiently explain climate change science to participants who were not climate change experts?	83%	Yes
Do you feel that the project identified priority risks and sensitivities for further investigation by experts and local stakeholders?	69%	Yes

their work relating to climate change, just over half (52%) of respondents, said that they had. When we later invited respondents to share any other comments regarding the EFL, again, the majority of comments were positive. As the majority of comments were positive. We present a sample of them below: This [EFL] project is best practice now… I believe this was an excellent project to help us [NRM] move forward if applied well in landscape adaptation planning and prioritising investment in landscape planning;

> Here, in South Australia, it was probably one of the first attempts to do the visioning systematically, so this is a novel approach in this area and had merit in that it directly involved the stakeholders and not just the researchers…. [The EFL] project moved their [NRM] work forward, I suspect we were moved ahead, it was a bit of a quantum leap for them [NRM]. I would use it now if it was available state-wide;

> It's [the EFL] leading edge, one of the first times they tried to tackle this issue. It used innovative processes and involved a wide range of people and involved both technical information and tried to speak to people's values… the project was very well done… the innovative approaches used here were excellent… [an] excellent project!

The individual elements of the EDSS itself were all deemed valuable; the community engagement in the 'envisioning' process, development of future scenarios, and computer based land use planning and modelling tools that provided a visual element. The majority of respondents stated that each element helped them make decisions about climate change adaptation. Further, no one element stood out as being much stronger than any other, nor had been used significantly more than any other element after the project ended. A summary of questions and responses related to the individual elements of the EFL is presented in Table 1.

3.2. The EDSS was not used after the Project, Although many people supported its use

The data presented above suggests that the end users of the EDSS felt that the overall process was valuable to them in their decision making for climate change adaptation planning and natural resource management. However, the findings of this research show that the great majority of the end users of the EDSS did not use the tool in entirety, nor any of its individual components, after the project ended. A summary of questions and responses related to the ongoing application of the individual elements of the EFL is presented in Table 2.

When asked why they did not use the various elements after the project ended, 88% of respondents said the scenario development process was not needed in their work, 48% said the LFAT tool was not needed in their jobs, and 55% stated that the envisioning process was not needed in their employment. Almost half (48%) of respondents commented throughout the interviews that the tool was not used after the project ended and just over half (55%) of the respondents commented throughout the interviews that they wished it had been used; comments saying that it has not been used include:

> It [the EDSS] was useful but it was not implemented into our NRM plan, although it did influence our climate change adaptation plan and other climate change publications we developed. The EFL was the catalyst for this work;

> …there were significant barriers to enabling staff to use the product [the EDSS] after the process was conducted, so it wasn't used at all after engagement on the project ceased; I recently spent time with planners in NRM and they made no use of this [EFL] work… it has highlighted how difficult it is to engage with NRM planning in this work;…it [the EFL] didn't get off the ground and did not get implemented due to the funding running out.

Comments suggesting that the EDSS should have been used after the project ended include:

> …my role changed and I got distracted in the planning but in hindsight we should have looked at it [the EDSS] for our second strategic plan and it could have been useful;

Table 2
A summary of questions and responses related to the ongoing application of the EDSS.

Question	Response	
Have you used the scenario development process since the workshops?	79%	No
The Landscape Futures Analysis Tool (LFAT) used in the project was made available for public use after the project, have you used it?	78%	No
Have you used the envisioning process tool since the workshops?	72%	No

This [the EFL] was an important project and I should have been more proactive to see results and it [the EDSS] could have been and should have been used in the next strategic plan. They [NRM] get trained and see a new way of learning and know that it is a good thing to do but then get bogged down with daily work and expectations and don't use it. Also external influences on staff and management such as political or funding, some not convinced or not buying in, and they control what actions we take ultimately. There are lots of externals regionally, staff changes and new priorities. It takes time and work to do things differently and it's uncomfortable for people to change. Maybe we need to consider changing management processes and succession planning. These projects introduce change;

It ended as a lost opportunity for the region. The use of the tool has not happened, which is a shame;

and:
I would like to see it [the EDSS] picked up and further developed if at all possible, it was valuable work but it would need ongoing funding from the Australian government.

3.3. Stakeholder engagement, values and envisioning

The EFL team employed an 'envisioning' approach within their stakeholder engagement process to develop values-rich narratives in an attempt to strengthen end user engagement in the NRM planning process. Our data illustrates that end users clearly value stakeholder engagement and support a process which connects the actions needed to adapt to climate change to their individual values and priorities. A summary of this data is presented in Table 3.

Further research is warranted to ascertain what type of stakeholder engagement would be most effective, under what circumstances, and at what stage of the process. Respondents did elaborate on the importance of developing an EDSS tool that is connected to the values of the end user community, comments included: [This is] very important, actions by the community are informed by their needs and values, but you have to have good science and develop the science for the science's sake and then add to it based on the needs of the customer. You might not know what science is needed until you actually speak to the people; [This is] very important, for buy in you need to connect it to people otherwise it's an academic exercise only; and: [This is] very important, this is the crux of climate change adaptation planning; getting people to act.

The envisioning process was an attempt to develop an EDSS tool that would have a connection to the end user's values and that may influence engagement with, and ongoing application of the tool. When asked if that process helped them to make decisions about climate change adaptation, comments included:

Yes, I think it [the envisioning process] was about sharing values and it started good conversations and robust discussions and helped us to better understand the other peoples' perspectives;

Yes, this was useful to get a perspective beyond raw data science. Uptake and actions are based on community action and values.

Finally, one person was a passionate advocate for this process, exclaiming:
Yes, [the EFL] presented the best workshop I have ever seen in my life! Pick an asset and they are usually top of mind but visions are deep and core and can take a long time to come to the surface. [The envisioning process team] wanted to find one value and one asset and it took all day, and that's what it takes to work! That's what needs to happen! After that workshop everyone, stakeholders and managers said they'd leave, if it happened again they would not attend as it was too hard and too confronting. It was too sophisticated. I think decision makers need to grow up and embrace sophistication such as this to make any real impact.

3.4. Processes, policies and structures identified to support the EDSS

Interviewees were asked questions regarding the types of processes, policies and structures that might support both the ongoing

Table 3
A summary of questions and responses related to stakeholder engagement.

Question	Response	
How important is stakeholder engagement to the success of local and regional climate change adaptation projects?	100%	Responded important or very important
How important do you feel it is to have broad stakeholder engagement in regional and community climate change adaptation projects such as this?	97%	Responded important or very important
How important do you feel it is to have limited, strategic stakeholder engagement in regional and community climate change adaptation projects such as this?	90%	Responded important or very important
How important do you think it is for an EDSS tool to be informed by connecting the actions needed to adapt to climate change to the regular needs, priorities and values of individuals within a region?	100%	Responded important or very important
Did you feel you were able to express your opinions in the workshops you attended?	93%	Yes
Did the project give you contacts that you still keep in touch with?	62%	Yes
After the project, were you aware that any networks were formed?	55%	No
How satisfied were you in regard to your involvement in the project?	45%	Responded satisfied

Table 4
A summary of questions and responses related to processes, policies and structures to support the ongoing application of the EDSS.

Question	Response	
How useful would it be for researchers, funders and stakeholders to collaborate more closely together to support projects such as the EFL?	100%	Responded useful, or very useful
How important do you think is to manage data and information related to the EDSS beyond the project end to ensure a knowledge 'legacy' is carried forth from concluding projects such as this?	100%	Responded important, or very important
How useful do you think it would be for the region to establish a permanent coordinator position to facilitate further and ongoing climate change adaptation initiatives?	93%	Responded either useful, or very useful
How useful would it be for climate change adaptation projects such as this to be funded for a longer time period, perhaps 5–8 years?	93%	Responded useful, or very useful
How important is it that planning to sustain the ongoing use of the EDSS beyond the duration of the pilot project is included from the earliest stages of project planning?	86%	Responded important, or very important
What would help you implement what you learned in that/those workshops? The top 3 responses were, number 1:	52%	Responded ongoing communication, a refresher course and more training
Number 2:	17%	Requested more access to, more training on, and further development of the tools
Number 3:	12%	Suggested more support from their organization

use of the EDSS and the legacy of learning embodied within it. A summary of this data is presented in Table 4.

All respondents agreed on the importance of managing data and information related to the EDSS beyond the project's completion to ensure a knowledge 'legacy' is carried forth from concluding projects such as the EFL; a sample of their comments are:

…it's good to see trends, [but] new management changes focus all the time and so much good data and tools are continuously lost; This idea of how you build longevity into this stuff to keep a knowledge legacy is very important and climate change research may have suffered this problem and suffered from it. There's a pecking order, climate change science information is lasting and solid but the action oriented, on the ground work [is not];

[This is] very important, [it is] too much work to lose, if funded longer then the processes and practise become part of normal business and data management will as well;

[This is] very important, critical, this gives you your outcomes and otherwise [it is] a waste of a valuable resource. It's adaptation pathways to decide and check back and review and move forward again;

It is very sad if projects like this do not get followed up and used beyond the development life. There are current uses for this information but due to the difficulty in its access and use, it doesn't get used…There doesn't really seem to be an 'owner' for these tools to provide further use;

Organizational policies restrict the implementation of these great innovative ideas, legislation hinders it and stops it. A desktop analysis needs to be done, what is out there and what has been done already and pull it all together;

and finally:
[This is] very important, in this project and others, [for events] such as the major drought, people simply forget, [if we had data] such as the key indicators for another drought, we [would be able] to forecast events and be able to forecast the crisis so we can deal with it before it hits; like the bushfire system [where we can say we have] extreme risk, moderate risk or low risk.

When asked how useful would it be for the region to establish a permanent coordinator position to facilitate further and ongoing climate change adaptation initiatives, 24% of respondents commented that it would be better to add such work into existing job descriptions and collaborate to share knowledge, expense and networks. Considering funding climate change adaptation projects such as this for a longer time period, a few people commented on the adaptive nature of this work and the time needed to influence behavior and develop structural and institutional support for sophisticated decision making processes to develop and mature; four comments were:

[This would be] very useful, as long as it is moved to the practical. This is leading edge and innovative and it needs time to be adopted and be successful;

[This would be] useful, short term funding is a problem. This is about progress of work rather than individual projects;

…Climate change is a long-term issue so we need the information to be ongoing so we are able to track changes and be supported;

and:
[This would be] very useful, it really reflects our funding model, especially government funded ones. This is long term work, but also, projects need an end date. Projects end when there is more to do, but who will pay for it, the succession of the project? We should be continuously asked to show results and be evaluated and cycle through the process. This is adaptive work.

When asked what would help them implement what they learned in the workshops, comments included:
The LFAT was excellent but it needed more/ongoing training. The scenario planning is helped by the LFAT. It needed ongoing

advising by the experts. Local industry could get involved and stay on as local trainers. LFAT has a *huge* potential but it needs good funding to support the ongoing training;

Resources/funding to support on the ground implementation is critical. A program planning system that adopted best practise. Organizational change. This project is best practise now;

We need to ensure that the information/work gets into the regional NRM plan and then it will be used. It has to start at the top and trickle down into use by the NRM and stakeholders;

There wasn't a person with capacity to help maintain access [to the EDSS], nor were there sufficient documents to help guide it's use. You either did the training and remembered it or you won't be able to use it;

and:
Governance needs to support and fund these initiatives. Scotland is doing this great, they've legislated climate change into every part of government. Governance needs to get on board and regulate it and mandate it to make people take it seriously. This is hard work, [the EFL's] envisioning process, it's new and very sophisticated thinking and most people are immature in the decision making process. Something game changing and revolutionary is needed.

When asked what actions were taken in the region as a result of the project, 59% of respondents were unsure, yet, in another question, 79% of respondents said they were aware of other climate change adaptation projects in the community since 2012 and were able to provide a list of varied projects. A challenge identified in this research design was the difficulty in attributing effect to direct cause. Changes to a person's beliefs, attitudes, and behaviours is not easy to relate to a clear cause (Adger, 2003; Dahl, 2012; McIntosh, et al., 2011; Miller et al., 2014). Further, the EDSS process itself is neither stable or inert, and the processes and participants involved are not directly controlled (McIntosh, et al., 2011). A few respondents mentioned this challenge directly when responding to interview questions regarding the effect the EDSS might have had on their beliefs, attitudes, and behaviour and how it might have influenced, or not, further climate change adaption work in their organizations and in the region.

The data presented above illustrates the types of processes, policies and structures that end users of the EDSS expressed would support both the ongoing use of the EDSS and its educational legacy. A significant finding was that end users of the EDSS would like to have access to resource people and ongoing communication and training.

4. Discussion: We may be more 'roughly right rather than precisely wrong'

The opinions of end users on their experiences with the EFL project and the EDSS developed within it, provided valuable insight for similar future projects. In the early stages of the EFL, the research team reviewed the NRM planning processes and found that the NRM plans were often not consulted after their development; the plan was developed more to meet a regulatory requirement than to guide the ongoing NRM process (Meyer, et al., 2013). The EFL research team attempted to meet this challenge through the use of envisioning as the means to develop a better connection to end user's values. While there was a mixed reaction to the envisioning process there seemed to be an appreciation that this engagement process was new and important. There is good evidence that the combination of envisioning, scenario planning workshops and involvement with EDSS development successfully engaged end users. However, despite this project engagement the EDSS lacked sustained application. This strongly suggests that factors beyond the project engagement processes are limiting.

The results of this study showed that the majority (90%) of the end users of the EDSS commented positively about the process and felt that it had value, and that almost half (48%) of all respondents stated that the EDSS was not used after the project ended. Yet, just over half (55%) of the respondents stated that they wished it had been used. Further, just over half (52%) of respondents said that, as a result of the project, they had made changes in their work relating to climate change, illustrating that there is value in the legacy of learning embedded in the EDSS.

End users identified a lack of follow up, support, ongoing training and internal and external promotion as contributing to the failure to use the EDSS after the project ended. End users readily recognised that organizational support is needed to build capacity for EDSS use and to promote the tool. Even though they felt there was value in the EDSS, once the EFL project ended, the organizations that had agreed to work with the tool in its research and development phase failed to provide support to promote the tool into onging use. Tasked with meeting the demands of their office, natural resource managers apparently continued in their day to day work and did not take the opportunity to adopt the decision making tool into sustained application; conducting 'business as usual' was less taxing and time consuming than introducing new tools which require organizational support and promotion. End users identified that organizational change was required for the EDSS to enter into management practise. While researchers in the EFL project collaborated with NRM end users to develop an EDSS, they had no role nor apparent influence in bringing about organisation change. Individuals and organizations take time to adjust to new ways of thinking and practise. One respondent noted the complexity of planning for climate change adaptation and the time it took for their personal growth regarding the issue to occur:

Some of the stuff that [the EFL research team] is doing is excellent but it needs to be institutionalized, funded and implemented/used by people to have impact. I've moved out of the position of influence and now I've come around to the thinking, it's taken me ten years to get here.

The experiences described in this study illustrate that there is a need for a champion to promote the EDSS and encourage its adaptation into NRM practise. One person suggested that it would be helpful to promote the end of the research and development phase of the project and the launch of the EDSS into organizational practise; stating:

There was a need to 'launch' the LFAT at the end of the project, there was no launch and we weren't told the project was over.

Another respondent appreciated that the team for this study was consulting end users as to their experience with the EDSS and suggested that it is important to understand the needs of the end user when designing these tools:

> The work you [this study team] are doing is rare and very important. The challenge is of the implementation of these things. You should ask why the South Australia Murray Darling Basin did not include the EFL/use it in the next plan. Why was this EDSS not used in the end? We misidentify the problem. We're roughly right rather than precisely wrong. We think it's a capacity problem but it could be the information we offer is not really answering the right question.

Many of the experiences and limitations associated with adaptation planning processes embodied in EDSS applications have been described in international literature (McIntosh, et al., 2011; Salter, et al., 2009; Voinov and Gaddis, 2008). However as noted earlier, these descriptions come from the researchers' perspective and almost inevitably present a scientific and technical interpretation. The end user information from this study acknowledges the importance of the scientific and technical elements. But it highlights that communication about the consequences of the end of EDSS development is important, that the time needed for learning is underestimated, that supportive organisational change is needed and that additional promotion and ongoing support is needed to realise better outcomes from EDSS.

5. Conclusions

Sustainability science literature advances the importance of including stakeholders in the research process and that doing so may lead to an increase in the uptake and application of the associated EDSS (Miller, et al., 2014; Reed, 2008). Our research supports this general observation but it also clearly indicates that much more involvement with end users and their supporting institutions is needed after the EDSS development phase if it is to have continued use.

Interview responses suggest that the obstacles to the use of the EDSS were more organizational and institutional (lack of promotion, continuity of staff and funding) than technical (problems with the tool itself.) A lack of follow up from the research team, lack of ongoing communication and training opportunities after the funding ended and having the development project conclude without a champion to carry it forward were identified as major obstacles to ongoing use.

We contend that EDSS almost always represent a contemporary understanding of the ecological system they have been designed for and hence embody a substantive knowledge base. It follows then that on-going use of the EDSS should be of value in future planning and or checking estimated responses against observed responses to adaptation actions. We further contend that effective adaptation requires buy-in from responsible organisation management to direct resources to EDSS application to realise the knowledge legacy of the EDSS. The responses of people interviewed in this study suggests that organizational and institutional changes are needed to provide the necessary support and incentive for the longevity of use of these tools. Quality, science informed EDSS that are designed to connect the end users of the tool personally, through their values and interests, to influence behaviour and help them make complex decisions about NRM planning, need to be supported by regional planners, and their organizations through willingness, capacity and commitment (Meyer, et al., 2013). This case study demonstrates that the primary barriers to the continued use of the EDSS was the lack of continuity in maintaining the tool as an active agent in the decision making process.

When NRM managers agree to collaborate with a research team designing an EDSS to aid them in their decision making, there needs to be meaningful organizational commitment to support the ongoing application of the tool, once they are convinced of its utility. Further, the organization needs to acknowledge the time commitment and support needed to introduce organizational change in decision making and planning processes, and to proactively develop the policies and structures needed to facilitate sustained application of the newly introduced tool. Until agencies commit to changing policies, procedures and practices in order to support ongoing use of the tool, the legacy value of the EDSS will remain limited.

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