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Stakeholder engagement with environmental decision support systems: The perspective of end users

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Key Messages

- Environmental decision support systems (EDSS) assist natural resource managers to assess problems and select options for change.
- EDSS are proven useful, yet are often not used after the research and development phase.
- The end users of EDSS suggest that ongoing engagement and communication with them beyond the pilot project stage would support ongoing use of the tool.

Environmental decision support systems (EDSS) are designed to assist natural resource managers and stakeholders to assess problems and select options for change. EDSS that combine community engagement in developing future scenarios with computer-based land use planning and modelling tools are widely used internationally. However, these EDSS are often not used after the research and development phase. To best understand why the EDSS are not being used in the long term, the end users of the EDSS should be consulted—a perspective that is lacking in the literature. The research reported here presents the perspectives of stakeholders involved in a community climate change adaptation project in western Canada. Evidence from the community suggests that this project was successful in instigating change. However, the EDSS was not used after the project's end. Our findings indicate that, from the end users' perspective, the project could have had much greater and sustained success had there been ongoing engagement and communication with them, particularly in the form of continued support for the use of EDSS after the development project.

Keywords: adaptation de la collectivité aux changements climatiques, utilisateurs réguliers, système de soutien décisionnel enenvironnement, collectivités locales, participation des parties prenantes

Participation des intervenants aux systèmes de soutien décisionnel en environnement : le point de vue des utilisateurs réguliers

Les systèmes de soutien décisionnel en environnement (SSDE) sont conçus pour aider les gestionnaires de ressources naturelles et l'ensemble des parties prenantes à évaluer les problèmes potentiels et à proposer des solutions appropriées. Les SSDE qui combinent la participation des collectivités aux processus décisionnels, à l'aide d'outils informatiques de modélisation, et la planification de l'utilisation du sol sont largement interpellés sur le plan international. Toutefois, il est fréquent que ces SSDE ne soient pas utilisés après la phase de

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développement et de recherche. Afin de mieux comprendre la raison pour laquelle les SSDE ne sont pas mis à contribution à long terme, il faudrait consulter les utilisateurs réguliers des SSDE dont les points de vue sont peu considérés dans le monde de la recherche. Cette étude présente les points de vue d'intervenants qui participent à un projet d'adaptation de la collectivité aux changements climatiques dans l'Ouest canadien. Des témoignages issus de la collectivité suggèrent que ce projet a réussi à susciter des interventions positives. Toutefois, le SSDE n'a pas été utilisé après la fin du projet. Nos conclusions indiquent que du point de vue des utilisateurs réguliers, le projet aurait pu connaître un succès beaucoup plus important et durable s'il y avait eu une mobilisation et une communication continues avec ceux-ci, particulièrement sous la forme d'un soutien permanent pour l'utilisation du SSDE après la phase de développement.

Mots clés : adaptation de la collectivité aux changements climatiques, utilisateurs réguliers, système de soutien décisionnel enenvironnement, collectivités locales, participation des parties prenantes

Introduction

Climate change is a complex problem requiring urgent action at both the global and local scale. Local action is a vital component of meeting the dynamic challenge of climate change, especially through identifying and implementing adaptation actions for protecting natural resources. Natural resource managers are tasked with making decisions that are both effective and responsive to the affected public (Beierle 1998). Consideration of the multiple interests and diversity of values of the public is very challenging. However, natural resource management has been evolving and progressively engaging stakeholders in planning and identifying priority issues for action (Reed 2008; Kalbar et al. 2016; Murdock et al. 2016; Rodela et al. 2017; Zasada et al. 2017; Zulkafli et al. 2017).

This process is encapsulated in "sustainability science," which aims to translate scientific knowledge into useable science (Ford et al. 2013; Rodela et al. 2017) and links knowledge and action (Miller et al. 2014). Policy development should be an outcome of this link, yet these connections are often tenuous. Linking useable science to policymaking in a meaningful way remains a challenge. Current literature asserts that decision makers continue to rely on experiential knowledge more than evidence-based science, which may limit the success of relevant policy development (Cvitanovic and Hobday 2018). While computer-based decision support systems have been rapidly developing, their use and hence assessment for generating possible solutions, informing policy development, and aiding community decision-making appears to be lagging.

Environmental decision support systems (EDSS) have been developed to assist natural resource managers and stakeholders to assess problems and choose appropriate responses. Current literature has established that despite substantial research data and EDSS availability, there is a gap between these knowledge tools and their use by stakeholders (Betsill and Bulkeley 2007; McIntosh et al. 2011; Lemos et al. 2012; Karpouzoglou et al. 2016; Rodela et al. 2017; Zasada et al. 2017; Zulkafli et al. 2017). Improved stakeholder engagement is needed to increase the influence of research in environmental management and policy. Recent literature has also revealed that there is significant opportunity and value in engaging in action- or community-based forms of research in which academic and environmental researchers partner with local stakeholders to identify research needs which reflect local concerns (Betsill and Bulkeley 2007; Miller et al. 2014; Meyer et al. 2015; Lindblom et al. 2017). Such collaborative research projects provide opportunities for mutual learning with local practitioners and experts and hence should enable the development of well-informed and fit-for-purpose EDSS that have ongoing use (Miller et al. 2014; Lindblom et al. 2017). Through this paper, we add to this discussion by presenting the perspectives of 12 stakeholders who used an EDSS in a community climate adaptation project in western Canada. The aims of this paper are to (1) improve EDSS development practice through the analysis of the perceptions of end users of the tool, and (2) to identify processes and structures that can be used in an EDSS application to support its ongoing use and the legacy of learning that is embodied within it.

Environmental decision support systems

EDSS developed for use in environmental domains have advanced from their origins as computer-based systems to support the current practice of incorporating stakeholder engagement in a participatory decision framework (Rizzoli and Young

1997; Matthies et al. 2007; Kalbar et al. 2016; Murdock et al 2016; Zulkafli et al. 2017). This advancement recognizes that the analysis of complex problems can benefit from the inclusion of non-scientific perspectives. EDSS that combine community engagement in the development of future scenarios, with computer-based land-use planning and modelling tools that provide a visual element, have been used internationally and documented in the sustainability science literature (Cohen et al. 2006; Voinov and Gaddis 2008; Salter et al. 2009; Bohnet et al. 2011; Robinson et al. 2011; Sheppard et al. 2011; Bowron and Davidson 2012; Meyer et al. 2015). Commonly, these systems provide a visual element that illustrates modelled scenario outputs in graphical and sometimes simulated landscape settings. It has been argued that this form of EDSS may be an effective way to translate complex scientific data to non-scientist end users (Shaw et al. 2009; Sheppard et al. 2011; Rodela et al. 2017).

The visual element in this type of EDSS may also increase user awareness and understanding of local climate change adaptation and mitigation options (Schroth et al. 2009; Sheppard et al. 2011; Bowron and Davidson 2012; Sheppard et al. 2013; Schroth et al. 2015). Further, presenting information visually allows information to be illustrated at a local scale which participants may more closely identify with, and may then have greater effect than information presented in text (Shaw et al. 2009; Lieske 2012; Sheppard et al. 2013). The strengths of the participatory scenario development component of this type of EDSS are also well-documented and build upon the strengths of the visual element. The use of scenarios enables participants to recognize variable futures that diverge from the current planning path (Robinson et al. 2011) and enables participants to develop shared visions of the future that embody local priorities, concerns, and values (Bizikova and Hatcher 2010; Pert et al. 2010; Robinson et al. 2011; Beach and Clark 2015). Scenario planning also allows opportunities for advanced learning at the individual and community level (Robinson et al. 2011; Vergragt and Quist 2011; Cairns et al. 2013), and a way to identify actions a community has some control over within the highly complex and uncertain domains of natural resource management and climate change adaptation planning (Schmitt Olabisi et al. 2010). Further, scenario planning allows participants to contribute local knowledge to advanced scientific climate change information and projections for regional and local use (Palacios-Agundez et al. 2013; Beach and Clark 2015).

As much as the literature acknowledges the valuable contributions of such EDSS, it is also asserted that these tools are often not used beyond the development and pilot project phase (Dilling and Lemos 2011; McIntosh et al. 2011; Lemos et al. 2012; Meyer et al. 2015; Moeseneder et al. 2015; Sandink et al. 2016; Merritt et al. 2017; Rodela et al. 2017; Zasada et al. 2017; Zulkafli et al. 2017). It has been suggested that a lack of continuity of staff may be detrimental to long-term relationship building and also results in a lack of in-depth subject knowledge that would support the ongoing use of the EDSS (Campbell et al. 2015; Meyer et al. 2015). Sustainability science literature has identified the need to manage data and information related to EDSS beyond the project end and to ensure that a knowledge "legacy" is carried forth from concluding projects (Roux et al. 2010; Voinov and Bousquet 2010; Campbell et al. 2015; Meyer et al. 2015). Insufficient stakeholder engagement with EDSS has also been identified as a challenge to the ongoing application of the tool (McIntosh et al. 2011; Rodela et al. 2017; Zasada et al. 2017).

Stakeholder engagement in natural resource management

Sustainability science literature asserts the need to frame global climate change as a local issue by linking it to current local challenges (Betsill and Bulkeley 2007; Lindblom et al. 2017; Zulkafli et al. 2017). There is substantial literature in support of the value of broad stakeholder participation in empowering communities to act on regional and community climate change adaptation planning (Milligan et al. 2004; Ernst and van Riemsdijk 2013; Rodela et al. 2017; Zulkafli et al. 2017). This literature suggests that there is a need, from the initial stage of the project onwards, to encourage personal buy-in from the widest community possible. If the community understands the value of EDSS, they may adjust their own behaviours and that of the organizations they are involved in to reflect on the use of and ongoing need for EDSS.

Yet, it appears that climate change adaptation plans are often not adequately consulted after their

completion, and that once the research and development phase ends, the valuable project outcomes are often not considered for future use (Koontz 2005; Meyer et al. 2015; Sandink et al. 2016; Merritt et al. 2017; Zasada et al. 2017; Zulkafli et al. 2017). The literature has noted the value of having an embedded representative in at least one organization involved in the project to serve as a champion for the EDSS being adopted into ongoing actions and plans (Dilling and Lemos 2011; McIntosh et al. 2011; Cairns et al. 2013; Zasada et al. 2017). Investing a project's limited funds to support the efforts of a few carefully selected, skilled, passionate, connected, and highly influential champions to serve as stakeholders and undergo training in the use of the EDSS, from a variety of organizations, may have more effect on project success than a broader approach to stakeholder engagement.

Further, challenges persist in achieving collaborative approaches to decision making that is equitable among stakeholders with differing viewpoints, expertise, and priorities. Sustainability science literature has documented the challenge of using computer-based decision support systems to support decision making to solve complex environmental issues while considering diverse understandings inherent in collaborative processes (Ramsey 2009). Current literature suggests the need to consider the social dimension of EDSS development and use to better support the needs of end users and align within existing organizational structures (Rodela et al. 2017). The politics of knowledge and power relations may be recognized in this approach when considering the balance between the provision of scientific knowledge relevant to the needs of the end user, and the value of the information provided by a collaboration of stakeholders. Stakeholder knowledge from a variety of practitioners can lead to an iterative process in the ongoing development of EDSS that combine scientific data with local expertise to support an EDSS that meets the real needs of the community using the tool, thus allowing for mutual learning opportunities. In this model, the politics of knowledge and power relations become more equitable to all involved in the process. Rodela et al. (2017) assert that current literature favours the reporting of scientific knowledge and the knowledge acquisition of the scientist developers of decision support tools.

The research reported here asked the end users of EDSS to share their perspectives on their experience as stakeholders involved in community climate change adaptation planning. Allowing EDSS end users to share their perspectives will enhance our understanding of their experience with EDSS to help them make decisions about complex natural resource problems. While current literature focuses on the researchers' perspective of EDSS, this study presents the perspectives of EDSS end users, which may contribute to more equitable and meaningful learning by all stakeholders involved.

The project studied and methods

This research analyzed a project undertaken by the University of British Columbia's Collaborative for Advanced Landscape Planning (CALP) and the Columbia Basin Trust (CBT) along with the community of Kimberley, in the province of British Columbia, Canada—the "Kimberley Climate Adaptation Project" (KCAP) (Liepa 2009; Pond et al. 2009; Schroth et al. 2009; Schroth et al. 2015). Kimberley, a former mining community, is located in southeastern British Columbia and had a population of 7,425 according to the 2016 Census (Statistics Canada 2016). The city is listed as an official BC Resort Community by the British Columbia Ministry of Tourism, Arts and Culture (2019), which actively promotes tourism as an economic driver. The local alpine ski resort is an important economic contributor and the area is also well-known for camping, fishing, cycling, hiking, and golfing.

The KCAP, which ran in 2008–2009, developed an EDSS that combined community engagement in the development of future scenarios with computer-based land use planning and modelling tools. The project led to the creation of a community climate change action plan with many recommendations developed and implemented. A literature review suggested that, as evidenced from the outputs of the project, the KCAP may have been a more successful project than others that used similar EDSS in Canada and internationally, and that it was also the most successful of the CBT's Communities Adapting to Climate Change Initiative projects. The apparent high degree of success achieved with the project EDSS suggested that it would provide an informative case study. A case study approach is well-suited to analyze a contemporary, real-life

phenomenon, such as considering the effectiveness of EDSS from the perspective of the end user (Yin 2009). The project was guided by a multi-stakeholder steering committee and had significant involvement of city staff, councillors, and local stakeholders who formed small working groups that explored priority climate change adaptation issues. This resulted in an adaptation plan with over 70 recommendations that were intended to inform Kimberley's Official Community Plan (Liepa 2009; Pond et al. 2009).

The methods used in the present study included a document analysis of literature related to the KCAP case study and semi-structured interviews in person or on the telephone with stakeholders. Stakeholders were defined as those who attended any of a series of EDSS workshops in the project during 2008–2009 in Kimberley, which included approximately 50 people. The same set of 46 interview questions were used in each case, and as some of the participants no longer resided in the community, these exact questions were also made available to be answered in an online format. Stakeholders were invited to participate in this research project through a variety of means, including direct invitation by the original local project coordinator of the KCAP, word of mouth, and local advertisement through community organizations' e-mail list-serves. In May 2016, 12 interviews were conducted in Kimberley, seven years after the project was initiated; one respondent completed the interview questions in the online format. The 12 respondents provided a representative cross-section of the community: 5 city councillors or employees, 3 non-governmental organization employees, 1 private business owner or employee, 1 citizen who participated on his/her own initiative, and 2 who reported their affiliation as "other." The majority of respondents thought they had attended three to five workshops. The interviews were confidentially transcribed and subjected to a content analysis that identified the perceptions of the EDSS end users, which were then coded and analyzed using NVivo qualitative data management software.

Results

In presenting the findings we use quotations from the transcribed interviews as those are the study's data. Quotations have been slightly edited for grammar and clarity. The quotations present the perspectives of the EDSS end users; space limitations prohibit presenting all of the data collected.

End users found the EDSS useful

Data analysis showed that the majority of respondents felt that the EDSS was helpful to them in making informed decisions about climate change adaptation in their community. Through the use of a five-point Likert scale, respondents recorded an overall increase in both awareness of and concern about the potential effects of climate change on their community after the project. The majority of their comments were regarding an increase in climate change knowledge relating specifically to their community. One person said that their behaviour regarding climate change had modified as a result of the project, stating: "…[I now practise] water conservation and the use of low flow devices and use less water in my gardens, [it influenced] how I heat my house and do renovations, and we put in low flow devices, etc."

The majority of respondents were very satisfied with their involvement in the project and all felt that they were able to express their opinions in the workshops they attended. The majority interviewed felt that the KCAP was very useful for the community in planning for climate change adaptation, and they provided comments such as:

> We weren't doing anything to deal with climate change before and this triggered the whole process for us and we examined our operations and reduced our impact.

> It helped to increase the level of understanding and awareness and recommended a number of actions and responses to consider and built support for the actions needed and funding required to get passed.

Regarding the individual elements of the EDSS itself, each element was considered useful with no one element—community engagement in the development of future scenarios or computer-based land use planning, modelling tools that provide a visual element—standing out as having much more influence than the other. All respondents stated that the processes used in the project had sufficiently explained climate change science to participants. The majority felt that the involvement of experts on climate change had helped them to

make decisions about climate change adaptation; comments included:

> Yes; absolutely, we need outside experts, especially in small communities; for example, your mom can tell you something fifty times and you ignore it but then an outside expert tells you and you finally hear it.

> [It is] important; opportunity for interaction helps learning on all sides, we were fortunate to have experts but I'm sure we needed community member input to provide community expertise. Mixing and interaction of both experts and locals was helpful for buy-in and moving forward with recommendations and funding, etc.

The majority of respondents recalled developing local scenarios as part of the workshops and asserted that the scenario development exercise was helpful to them in making decisions about climate change adaptation. One stated "… I found the scenarios extremely helpful to us. For example, the scenarios showing two different ways to develop housing was an excellent resource and tool. The scenario development exercise was very effective." Ten respondents said they had not used the scenario development process since the project ended, with eight of those ten saying that it was not needed in their jobs. The majority of respondents felt that adding local perspectives was helpful to them in making decisions about climate change adaptation, one noting "Yes; this is one of the most key things, talking to people about what they saw and felt and sharing information with the community shifted the conversation."

The majority of those interviewed said that they felt that the visual display of the scenarios, and other climate change information such as the 3D Virtual Globe Google Earth, had helped them to make decisions about climate change adaptation. One person stated, "Yes; the visuals really showed what could happen in our community." All participants recalled the 3D Virtual Globe Google Earth tool but only two had used this tool after the project ended; almost all respondents said they did not have any need to use it in their job. Eleven people said that they did not know how and where to access this tool, yet 6 of those 11 noted that they could find it if they wished to.

The majority of respondents felt that the project identified priority risks and sensitivities for further investigation by experts and local stakeholders. When asked if they were aware of any other climate change adaptation projects in the community since 2009, there were affirmative responses:

> Yes; all of our buildings have had energy audits on them and the City Council brought in further experts to advise on climate change adaptation.

> Yes; water and fire plans and actions definitely came from the Kimberley Climate Adaptation Project, it prioritized these issues and helped us find funding for the work.

In answers to another question, 8 of the 12 respondents were able to list other climate change adaptation projects in the community since 2009; comments included:

> The acceptance of the fuels management program and we still use the posters from the project today and find them invaluable.

> The water flume for flooding; the fire interface for wildfire; the water conservation bylaw; the flood works.

> The city sponsored low flow toilets and solar installations, offered hot water heating rebates and did energy audits on the buildings and the city uses vehicles that are the most energy efficient.

When asked to describe the KCAP, the majority of responses were positive, including the following:

> The way it personally affected me is that it built my personal awareness of the potential impacts of climate change on this community and region and opened my eyes and got me thinking about it on a practical level rather than as a concept.

> The project helped the community to establish benchmarks on our situation and then helped us plan to reduce the impact of climate change.

The data just presented suggest that the end users of the EDSS felt that the overall process was beneficial to them in making decisions about complex natural resource problems.

The challenge of attribution

A challenge in this research design is the difficulty in attribution of effect to direct cause. Behavioural change, such as action on climate change adaptation, changes to beliefs and attitudes, are very hard to attribute (Adger 2003; McIntosh et al. 2011; Dahl 2012; Miller et al. 2014). The EDSS process itself is not a static process and even if outcomes of EDSS use are deemed to be a success, it is hard to attribute this success to the use of the EDSS; people and processes are unable to be directly controlled or replicated (McIntosh et al. 2011). In this study, without being asked to address this subject specifically, the respondents brought up the challenge of attribution in response to various questions. Statements illustrating the challenge of attributing actions as resulting directly from the KCAP project include:

> Yes; but climate change is slow moving and lots of projects are coming along as well that had to be done anyway. But, a couple of projects were definitely related to the Kimberley Climate Adaptation Project, for extreme weather events, etc.

> Quite a few [adaptation initiatives after the KCAP], a major Mark Creek rehabilitation project, a risk was identified through the project and acted on. Other flood mitigation projects from the project learnings and recommendations. Wildfire mitigation, [the] solar mine on reclaimed land. The Kimberley Climate Adaptation Project built more support for these initiatives but it is hard to directly attribute some of the work to that project.

Stakeholder engagement

The majority of the community members interviewed stated that stakeholder engagement is very important to the success of community climate change adaptation projects. One person noted that, "[It is] important; some things will happen without this engagement but more would happen with more engagement." The majority also suggested that both broad stakeholder engagement and a more limited, focused form of stakeholder engagement are necessary for effective use of EDSS; comments included:

> [It is] very important; you need both limited and broad engagement; champion stakeholders need to get involved, those with the jobs, knowledge and time and then you need broad engagement from the community to support it and get bylaws passed and funded.

> [It is] very important; I think you need both limited and broad engagement. Engaging community leaders adds legitimacy to the project and we had an invite list of important people and a broad cross section of different groups and values.

In support of limited, focused stakeholder engagement one person said, "[It is] very important; a few strong, real people are needed, local people you can trust, they have built a reputation over the years, they are not in it for the money and are people who are not in it for personal gain."

Statements in support of broad stakeholder engagement included:

> Very important, broad scale is absolutely critical to build the awareness that is needed, share problems, come up with solutions and have the whole community own those solutions.

> Broad stakeholder engagement is a litmus test of where the community is at.

To summarize, seven respondents felt that a combination of both broad and limited stakeholder engagement is the best strategy, three stated that limited, focused stakeholder engagement should take precedent, and two suggested that broad stakeholder engagement is most important.

The need for follow-up and ongoing communication

The need for follow-up and ongoing communication emerged as a clear theme in the study. Without being asked to address this subject specifically, some respondents stated that they did not know what happened after the project ended. Further, when asked what would help them to implement what they learned in the workshops they attended, six people suggested more and ongoing communication, five suggested more and ongoing training, and three suggested more follow-up. One respondent commented that:

> Updates about the project would be helpful as awareness of the project has decreased in the general public. More communication; people only become aware in a crisis so ongoing communication would be helpful. Funding; to keep communication going. Community and organizational culture; to keep communication going, it often gets lost in the day to day work. It is hard to plan for future issues without more constant reminders and ongoing communication of the climate change issue. The knowledge and information was helpful to communicate and discuss the ideas with others, and the tools, the visuals and graphics have been used [after the project's end, and currently].

The majority of those interviewed responded that it was very important 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 the KCAP; comments included:

> [This is] very important. This is the biggest issue, otherwise you risk losing all that we have done, all that good work, so embed it into the organization and community culture to keep it going.

> [This is] very important. The problem in long-term projects is that you lose people, people that were part of that infrastructure leave or retire and lose the information related to the project; too often it becomes a lost file and becomes a waste of hard work and resources.

> [This is] important; if you want to know where you are going you need to benchmark it and have ongoing monitoring.

Structures and processes identified to support the use of EDSS

Questions were asked regarding the types of structures, processes, and policies that would support both the ongoing use of the EDSS and the legacy of learning embodied within it. The majority of respondents said that they thought it was very important for climate change adaptation planning to be included in community planning, and that participation in the project influenced their opinion on this; for example, "[This is] very important; especially when you look at new subdivisions and adding infrastructure such as arenas, libraries, pools and conserving energy and water."

However, one person noted the complexity of natural resource management and climate change adaptation planning among conflicting priorities, stating:

> [This is] important; it is moderately important. Now, after the project, I became a City Councillor and I now see the reality of a wide array of issues to be dealt with and climate change is a slow-moving train wreck and at any given time there are more urgent issue/faster-moving train wrecks to deal with.

The majority of respondents also felt it was important that planning to sustain the ongoing use of the EDSS beyond the duration of the pilot project be included from the earliest stages of project planning; comments included:

> [This is] very important; too often this good work is left on the shelf, it only lasts a short cycle of funding or election and this is long term and ongoing work to change behaviour.

> [This is] important; it is easy for these projects to fall off the table, so plan early to address the need for resources and make it accessible and easy to use.

All respondents said that it would be useful for the community to establish a position for a permanent coordinator to facilitate further and ongoing climate change adaptation initiatives. Five people commented that it would be hard to fund such a position and that it might be better to add such work into existing job descriptions; two comments were:

> [This would be] useful; although it is challenging and unrealistic for smaller communities and it is more useful for more individuals to be kept trained and learning, to keep all sectors informed and trained and they can share their expertise.

> [This would be] useful; with budgets tight it may not be the highest priority, we need to be able to afford it; however, it could be part of one person's, or a few peoples' current job.

The majority interviewed said that it would be useful for climate change adaptation projects such as the KCAP to be funded for a longer time period,

perhaps five to eight years. The majority also said that it would be very useful for researchers, funders, and stakeholders to collaborate more closely together to support projects such as the KCAP; comments included:

> [This would be] very useful; with different expertise shared everybody learns, the more information you can gather and share the better off you will be and all [will] continue learning.

> [This would be] very useful; having more people help each other from different silos, sharing learning and perspectives can go a long way to find efficiency and cost savings.

The data outlined above presents the types of structures, processes, and policies that EDSS end users feel would support both the ongoing use of the project EDSS and its educational legacy.

The importance of local champions

A primary finding was that of the importance of the longevity of key stakeholders in the community. Similar to other studies, the importance of such local champions was illustrated first-hand and was shown to be key to the overall success of the EDSS. For example, the local project coordinator of the KCAP was well-established and well-connected and was able to convene a team of committed, passionate, environmental, and climate change minded professionals in the community to participate in the project; many of these stakeholders have continued to reside in the community.

Discussion

The findings of this study complement the sustainability science literature supporting the value of this type of EDSS (Cohen et al. 2006; Voinov and Gaddis 2008; Salter et al. 2009; Bohnet et al. 2011; Robinson et al. 2011; Sheppard et al. 2011; Bowron and Davidson 2012; Meyer et al. 2015; Rodela et al. 2017; Zasada et al. 2017). While the literature reports overall value in EDSS, there has been a need identified for further research to better understand the perspectives of the EDSS end users (Talwar et al. 2011; Meyer et al. 2015; Lindblom et al. 2017). Sustainability literature offers the researchers' perspective that the EDSS tool is useful. This study found that stakeholders, as end users of the EDSS, also felt that the tool was useful overall. Stakeholders in the project reported satisfaction with all elements of the tool: the participatory scenario planning, the computer-based modelling tool and other visual elements, and the contribution of those with expert knowledge on climate change science. No one element of the EDSS was recorded as significantly more useful than any other.

The EDSS in entirety, however, has not been used since the project's end. The majority of respondents reported that they did not use the EDSS, or any of its components after the project ended as they had no need for it in their jobs. Two professionals do use the KCAP posters in their work to this day. Regarding the structures and processes required to increase the longevity of EDSS use by stakeholders and the legacy of the learning that is embodied, the interviewees were asked to list what might help them implement what they learned in the EDSS workshops. Responses included more support from local government, broad policy change, more community support, more tools, more advice, and more frameworks. The majority of respondents stated a need for more and ongoing communication, funding, and training. Maintenance and renewal of awareness of the process, the tools, and most importantly, the outputs of the project are what end users sought. These findings complement those in other environmental planning literature which assert the need for organizations involved in such projects to acknowledge and implement the institutional policies, procedures, and resources that are needed to support the ongoing use of EDSS (Reed 2008; Meyer et al. 2015).

Our findings support other sustainability science literature which assert that ensuring meaningful stakeholder engagement from the very inception of the project through to its completion is important so that end users of EDSS might develop a degree of ownership in project results, encouraging the ongoing use of EDSS (Campbell et al. 2015; Lindblom et al. 2017; Rodela et al. 2017; Zasada et al. 2017). Meaningful stakeholder engagement throughout climate change adaptation projects may be one way of increasing the usability of such climate change science by stakeholders to aid them in their decision making.

This paper identified that ongoing communication is an important element to increase the longevity of use of EDSS by stakeholders and the legacy of the learning from the tool. Many of the respondents expressed a desire for follow-up and ongoing communication about the project after it ended. The longevity of key stakeholders in the community has emerged in this study as a strong element in the success of this program. Many studies have noted that having at least one person serve as a champion for the EDSS contributes to the tool being used beyond the research and development phase (Dilling and Lemos 2011; McIntosh et al. 2011; Cairns et al. 2013; Zasada et al. 2017). Ensuring continuity of staff and program participant stakeholders builds relationships and trust among players, enabling them to freely engage each other; further, this continuity may also build confidence in funders to support less defined projects to facilitate ongoing adaptive learning opportunities (Roux et al. 2010; Voinov and Bousquet 2010; Campbell et al. 2015). Further research would be of value to explore the ratio of local community experts and champions in community climate adaption projects to the ratio of visiting, outside researchers and experts, as this study suggests that having a core group of local experts and champions may be an important element in the long-term success of such projects.

Current sustainability science research has identified the need to better understand the role that values play in decisions, actions, and social change in individuals and communities (Dahl 2012; Miller et al. 2014; Zulkafli et al. 2017). In this study, the majority of respondents said that it was very important for an EDSS tool to have the capability to connect the actions needed to adapt to climate change to the regular needs, priorities, and values of individuals within a community. It appears that connecting an EDSS more closely to the values and beliefs of stakeholders may be an element of a more successful program. One of the researchers involved with the KCAP noted that the KCAP was a process "with heart" in which they asked people to identify places they love and then to convey how they wanted to see their future and the future of those places. The findings here reinforce the need for more research to gain an understanding of the role that a person's values and beliefs have on their actions and engagement with EDSS.

Limitations of this study include the challenge of effect and attribution, and the sample size of the respondent population. However, the respondent population is valuable in that it is representative of a cross-section of the original KCAP participants. The invitation to interview for this study was open to anyone who participated in any of the KCAP workshops, so it is possible that those who chose to interview were those that are more interested in environmental planning and may be more likely to respond positively to the processes used in the KCAP.

Conclusion

Data gathered from the perceptions of the end users of an EDSS contribute to the current discussion on EDSS development practice for sustained application of the tool. These findings suggest that the EDSS may be considered to have substantial value, even if it is not used again after the project's end, if the learning derived from the EDSS is useful, widespread, and contributes to ongoing action and decision making for climate change adaptation. The EDSS may be considered successful if it builds capacity and educates the community. The data in this study suggest that the project EDSS was a valuable learning tool, increasing both stakeholders' awareness of and concern about the potential impacts of climate change on their community. The findings show that many of the KCAP recommendations have been acted upon and, thus, the final KCAP report and recommendations, along with the use of the posters prepared for the KCAP, may be seen as the legacy of the project having the most impact. However, the end users' perspective suggests that much greater and enduring success would have been possible had there been ongoing communication, training, and funding to advance continued awareness of the EDSS process, tools, and outputs. On-going engagement, inclusion, and further development are needed to support the sustained application of the EDSS. Beyond the context of this particular case study, these findings and recommendations are applicable to projects conducted in similar political and socio-economic situations.

Such complex problems as climate change adaptation require a sustained effort. It was clear from the end users of this study that they believe there is

considerable value in the ongoing use of the EDSS beyond the duration of the development project. Hence, planning to perpetuate this use should be included in early stage project planning. Doing so may help to ensure that widespread capacity building and education, as well as use of the EDSS, will continue beyond the relatively short duration of any such climate change adaptation development project.

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