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Participatory values-based risk management for the water sector

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Abstract

Water planning and management are faced with increasing levels of uncertainty, complexity and conflict. Multiple decision makers and managers, legislative requirements, competing interests, scarcity of resources, deskilling of management agencies and large uncertainties about the future in a more connected and rapidly changing world, are all drivers for the need to develop improved approaches to aid decision making in the water sector. This paper proposes a "participatory values-based risk management approach", designed to help to make uncertainties explicit, structure complexity in more understandable forms, increase collaboration and manage conflict. The approach will be explained through a case study example: the creation of the Lower Hawkesbury Estuary Management Plan in NSW, Australia. This process, driven by local government, included three interactive stakeholder workshops based on stages of a generalised "participatory modelling process to aid decision making" and the Australian and New Zealand Standard for Risk Management (AS/NZS 4360:2004), as well as an external scientific and legislative review. A range of stakeholders from state and local governments, the water authority, local industries, community associations and residents took part in the process stages of: "initial context establishment" including the definition of estuarine values, issues and current management practices; "risk assessment" based on the stakeholder defined values (assets) and issues (risks); and "strategy formulation" to treat the highly prioritised risks as input to the estuary management action (or "risk response" plan). As the plan has not been finalised or implemented, the external process effectiveness can not yet be properly gauged. However, preliminary evaluation results appear to demonstrate that the process is efficient from time and budgetary perspectives and has a number of other potential benefits which will be outlined in this paper. Other lessons learnt and possible suggestions for best-practice when using such an approach in future water sector applications will also be highlighted.

1. INTRODUCTION

Current water management and planning, including their associated decision making processes, are commonly characterised by interconnecting and complex problems that exhibit high levels of conflict and uncertainty. Increasing worldwide use of water for a variety of activities, largely driven by population growth and affluence, has amplified the problem of water "scarcity" and the conflicts between competing water uses (potable water, sanitation, food production, industrial, energy production and many others, such as social, recreational and spiritual uses). Uncertainties including political decisions, climate variability and change, human behaviour and knowledge (i.e. technological innovation and scientific understanding), have also fuelled the debate on how to cope with increasing water scarcity. This concept of "scarcity", a highly debated and socially constructed one based largely on cultural norms and perceptions, has multiple definitions that predominately equate to a difficulty in supplying water users' needs or demands (Rijsberman, 2004). Under these conditions of complexity, conflict and uncertainty, it has been shown that "traditional" methods of water management and planning are usually insufficient (Gleick, 2000), as are traditional or "objective" forms of risk assessment (Klinke and Renn, 2002). For example, the pertinence of expert-created integrated water models and the legitimacy of these experts to make values-based decisions in representing a variety of world-views and interests are now being questioned (Daniell and Daniell, 2006). In such water management and planning contexts, it is unusual that one institution possesses all of the relevant knowledge and is in control of all the resources required to successfully implement its own decisions. This means that water managers are increasingly obliged to work with other institutions, stakeholders, experts and the general public to create more acceptable models and plans and to implement management solutions (Loucks, 1998). However, exactly how such work in multi-stakeholder or inter-institutional decision making processes can be aided, so that effective treatment of these complex problems can be achieved, is less well understood. This paper proposes one possible approach for aiding multi-stakeholder decision processes in water planning and management: a participatory values-based risk management process.

2. METHODOLOGY FOR AIDING MULTI-STAKEHOLDER DECISION-MAKING IN WATER PLANNING: A PARTICIPATORY VALUES-BASED RISK APPROACH

In order to aid multi-stakeholder or inter-institutional decision-making in the water sector, Daniell et al. (2006) proposed a methodological framework based on the concept of "participatory modelling" and stages of a generalised decision aiding process from the domain of operational research (Tsoukiàs, 2007; Ostanello and Tsoukiàs, 1993). This general methodology, which was first developed and pre-tested for the European Integrated Project, "AquaStress" (Daniell and Ferrand, 2006), has been designed to allow a broad range of stakeholders to explicitly participate throughout the various stages of the decision making processes, as outlined in Figure 1: from defining and constructing the situation to be studied and formulating the problems requiring management, to developing and using an evaluation model to assess potential management alternatives before finally choosing and recommending the most desired courses of action to be implemented.

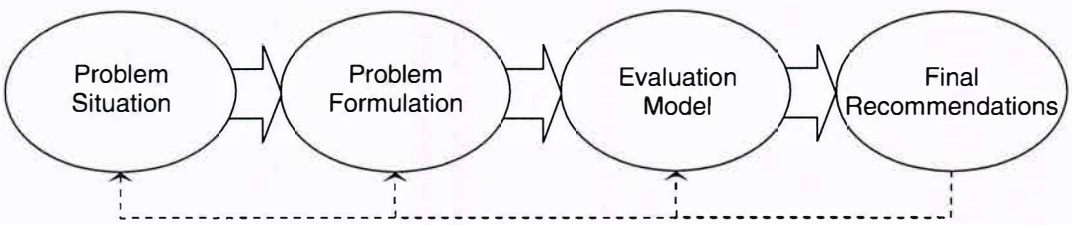

Figure 1. Generalised decision aiding process stages (adapted from Tsoukiàs, 2007)

Throughout the first two stages of the process in Figure 1, it is proposed that stakeholders' values and stakes can be made explicit and used as a base for finding, evaluating and recommending more desirable management options in the later stages of the decision aiding process. The stakeholders' "values" referred to here can take one of two following definitions: firstly, the type of values that are "held" (i.e. principles, morals, beliefs or other ideas that serve as guides to action (individual and

collective)); and secondly, the type of values that are "assigned" (i.e. in reference to the qualities and characteristics seen in objects or people, especially positive characteristics (actual and potential) or those that are considered worthwhile or desirable (Mason, 2002)). The "stakes" referred to include the stakeholders' interests or those issues or problems with which they are concerned. This process can therefore be considered as "values-based" and similar to the improved strategic decision processes proposed by Keeney (1992) that are believed to be superior to traditional "alternative-based" approaches to decision-making (Keeney, 1992). The methodology, as outlined in Daniell et al. (2006), is also "participatory" due to the inclusion of multiple stakeholders and institutions involved throughout the process. It also encourages uncertainties (i.e. related to knowledge, risks, behaviour) to be made explicit and the complexity of the situations studied to be structured into a number of specific categories in order to allow easier investigation and understanding from the stakeholders' points of view.

One of the particular aspects of the methodology proposed in Daniell et al. (2006) is that it is a conceptual framework that can not be directly applied without first considering the specific context where it is to be implemented. Different water planning and management contexts have their own particular aspects and needs which should influence the selection of methods to be used in the process of considering the required methodological elements. To demonstrate one application of how the methodology can be used and adapted to a specific context and to needs, the example of the production of a regional estuary management plan in the Lower Hawkesbury River on the northern boundary of the Sydney metropolitan area in Australia will be used.

2.1. Methodological Adaptation for the Lower Hawkesbury Estuary Management Plan Context

The proposed Lower Hawkesbury Estuary Management Plan (LHEMP) is one of the first broader scale estuary management plans (EMPs) of its type to be implemented in Australia. This initiative follows recommendations from the Hawkesbury Nepean River Estuary Scoping Study Report (Kimmerikong, 2005) that to improve effectiveness, estuaries should be managed relative to catchment boundaries or by a "whole-of-estuary" approach rather than management based on administrative local council area boundaries. It was considered that developing such an approach would "*be more strategic, would facilitate an understanding of the links between issues, allow priorities to be identified, and enable more effective and efficient management of issues by improving exchange of information and coordination of activities*" (Kimmerikong, 2005). Currently on the Lower Hawkesbury River, only around fifty percent of the estuary and tributary creeks are covered by EMPs based on the NSW Estuary Management Program Guidelines (NSW Government, 1992). In order to include the other parts of the estuary in the Lower Hawkesbury River currently not encompassed by an existing plan of management, the Hornsby Shire Council is funding the enlargement process.

The LHEMP project has been designed to be participatory in nature, conducted in close cooperation with the Gosford City Council that also has jurisdiction over a large part of the proposed plan area, as well as with a large range of stakeholders (service agency, industry, commercial, community association and residential representatives) and State Government representatives, who are also responsible for certain domains of estuarine management. BMT WBM and SJB Planning were selected as consultants through a public tender process to run the project in collaboration with the Hornsby Shire Council and researchers from the Australian National University (ANU); these collaborators will be hereafter referred to in this paper as the "project team". The process for the plan creation outlined in the tender (HSC, 2006) was largely based on the methodology outlined in Daniell et al. (2006) and Daniell and Ferrand (2006), as described in the first part of this Section, and was to include a series of stakeholder workshops and an external document review. This proposal was then redefined and negotiated within the project team, before and throughout the implementation. The final implemented process included three interactive stakeholder workshops based on stages of a generalised "participatory modelling process to aid decision making" (Daniell et al., 2006) and the Australian and New Zealand Standard for Risk Management (AS/NZS 4360:2004), as well as an external scientific and legislative review. The principle elements of the process are outlined in Figure 2.

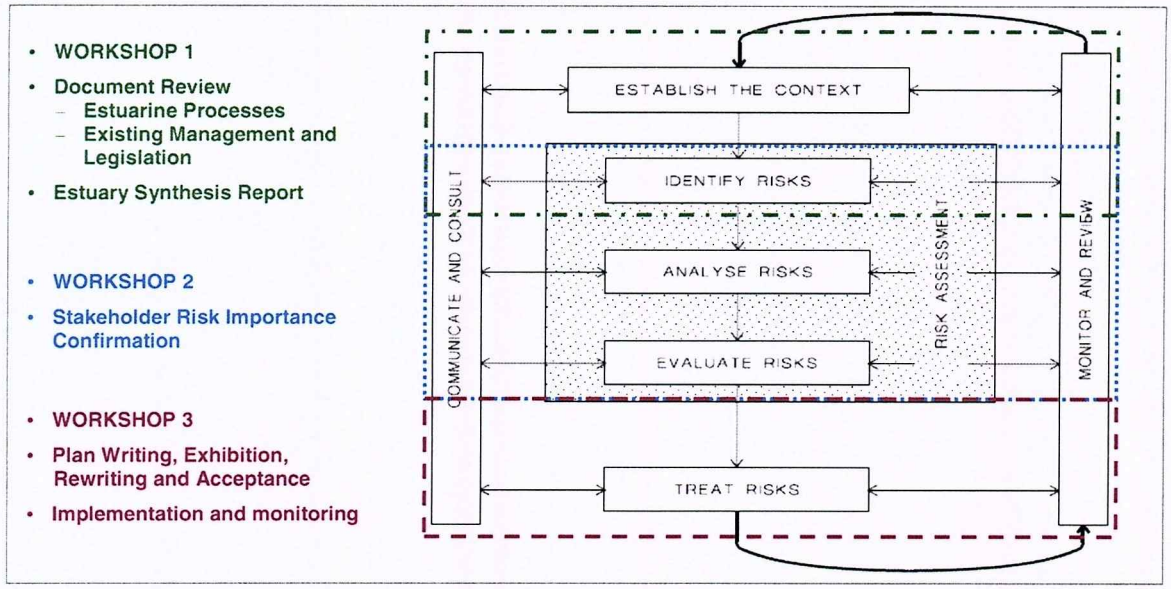

Figure 2. LHEMP Participatory Risk Management Process (based on AS/NZS 4360:2004)

The project team's objectives in using this process, rather than the NSW Estuary Management Planning Guidelines (NSW Government, 1992), included: to capitalise on existing stakeholder and documented knowledge including previous estuary studies and management plans; to encourage increased understanding, knowledge sharing and learning between stakeholders to enhance future collaborations and the capacity to manage the estuary effectively into the future; and to keep the estuary management plan enlargement process as efficient and effective as possible, considering the resource constraints. The methods used in each of the workshops were then selected to help meet these contextual objectives and a number of other project team goals including managing a couple of known key conflicts in the region. A brief description of the methods used throughout the LHEMP process is presented in the following Section. Evaluation results showing to what degree these stated objectives were achieved are given in Section 3 and discussed in Section 4. Further information on the process can be found in BMT WBM (2007), Daniell (2007b) and Coad et al. (2007).

2.2. LHEMP Process Description

The estuary management planning process commenced in October 2006 with a kick-off meeting for the extended project team members. This was followed by another organisational meeting with the key project management team members to define and debate the methods and desired content of the three participatory workshops, as well as to discuss the stakeholders to be invited. Based on the theoretical and practical knowledge of the project team members in facilitating participatory processes to aid decision making, a "values-based", rather than an "alternatives-based" approach to decision making (Keeney, 1992) was adopted. Such an approach appeared particularly relevant due to the strategic objectives of the estuary management plan enlargement process (Kimmerikong, 2005) which would require the input and consideration of many of the regional stakeholders' perspectives. This approach, used within the framework of the Australian and New Zealand Standard for Risk Management (Figure 2), had the intention of first eliciting stakeholder values and common goals for estuary management that could be used as a base for reflection to later define improved alternative actions for estuarine management, as well as be used as the evaluation criteria for the risk assessment part of the process. It is interesting to note that the AS/NZS 4360:2004 framework has also been designed and explained with a "values-based" approach to decision-making implied, so it created a good fit with the participatory decision aiding process (Figure 1) and methodology outlined in Daniell et al. (2006).

The first stakeholder workshop (attended by 30 participants from a wide range of stakeholder groups and state and local government departments) was held in November 2006 and used to "establish the context" (Figure 2) of the estuary by eliciting participants' values (assets), goals and issues (risks)

related to the estuary, as well as to define the estuarine stakeholders and which resources they possessed or required to have an impact on management of the estuary. A variety of individual and group activities were used to elicit and synthesise this information including: individual oral presentations; individual brain storming; group card categorisation; spatial mapping; issues/values cross-impact matrices; group issue and value questionnaires; and a large group discussion to assemble a list of overall stakeholder values and general visions or goals for estuarine management.

Prior to the second workshop, the outcomes of the first stakeholder workshop were further analysed and then synthesised into a report by the ANU (Daniell, 2007a), and BMT WBM and SJB Planning carried out and produced a thorough document review of the current knowledge of estuarine processes, risks and management and planning legislation impacting the new estuarine management plan area (BMT WBM, 2007). The final list of nine estuarine values (assets), eight directly from Workshop 1 and one more from the document review process* (as shown in Table 1), were then used by the ANU to produce the "Risk Consequence Tables" to be used in the next workshop based on examples from HB 436:2004 (Standards Australia, 2004) and a variety of other references (refer to Daniell (2007b) for more details and the full lists of estuarine assets and risks). Tables for "Likelihoods", "Risk Levels" (based on a combination of Consequences and Likelihoods (Wild River and Healy, 2006)), "Knowledge Uncertainties" and "Management Effectiveness" were also produced. This collection of "Risk Tables", document review and Workshop 1 outcomes were then distributed to stakeholders as the Synthesis Report (BMT WBM, 2007) for their consideration.

The second workshop, held in February 2007 and attended by 19 participants, was used to: obtain "agency" (government department, industry and commercial representatives) support for the stakeholder-defined values (assets); further identify the risks elicited in the first workshop and an external document review; and then perform a "risk assessment" in order to prioritise the estuarine risks for subsequent treatment (Figure 2).

Table 1. LHEMP Asset List

Lower Hawkesbury Estuary Assets (Stakeholder Values)		
Scenic amenity and national significance	Sustainable economic industries	Improving water quality that supports multiple uses
Functional and sustainable ecosystems (including biodiversity)	Community value	Recreational opportunities
Largely undeveloped natural catchments and surrounding lands	Culture and heritage	Effective governance*

Sixteen risks (Table 2) were discussed and assessed through facilitated large and small group sessions using the specifically developed Risk Tables.

Table 2. LHEMP Risk List

Lower Hawkesbury Estuary Risks (Adapted Stakeholder Issues)		
Water quality and sediment quality not meeting relevant environmental and human health standards	Climate change	Residents and users lacking passion, awareness and appreciation of the estuary
Inappropriate land management practices	Excessive sedimentation	Regulated freshwater inflows
Inappropriate or unsustainable development	Over-exploiting the estuary's assets	Inappropriate or excessive foreshore access and activities
Inappropriate or excessive waterway access and activities	Introduced pests, weeds and disease	Inadequate monitoring to measure effectiveness of the EMP
Inadequate facilities to support foreshore and waterway access and activities	Insufficient research	Not meeting EMP objectives within designated timeframes
Inadequate or dysfunctional management mechanisms		

These tables, as previously outlined, were used to help the participants to identify the Consequences and Likelihoods of risk impacts on nine previously defined estuarine assets, as well as an associated Risk Level, the Knowledge Uncertainties related to these classifications, and the level of current

Management Effectiveness of the risk related to each asset. From this information, the priority of the risks: acceptable; tolerable; or intolerable was computed and presented, and the participants given some time to discuss the results. From this assessment, all risks were classified as requiring treatment (tolerable or intolerable). These risk priorities were also reviewed at a later date through a stakeholder email survey, sensitivity analysis and alternative calculations (Daniell 2007b; Coad et al., 2007).

The third workshop was then held soon after in March 2007 and attended by 17 participants representing a similar wide range of stakeholders to Workshop 1. This workshop was used to develop strategies and actions for the treatment all 16 risks, as well as to identify monitoring needs, stakeholder responsibilities and stakeholder preferences related to the proposed strategies and actions. Individual brainstorming on cards of strategies and actions preceded the collective visual "strategy mapping" exercise for each risk (similar to Ackermann and Eden's Oval Mapping Technique (2001)) and preference distribution. Throughout this workshop over 900 elements were built into the 16 strategy maps. After the workshop, this information was then computerised using the Decision Explorer® software (Figure 3) and exported to Excel to produce a preliminary Stakeholder-Based Action Table (Daniell, 2007b). This preliminary table was then considered and compared to existing management plans and regional strategies by BMT WBM, and a final table of "risk-response" actions created. The final planned actions underwent a secondary risk assessment based on the same stakeholder value (asset) list to determine their potential efficacy for treating the estuarine risks (Coad et al. 2007).

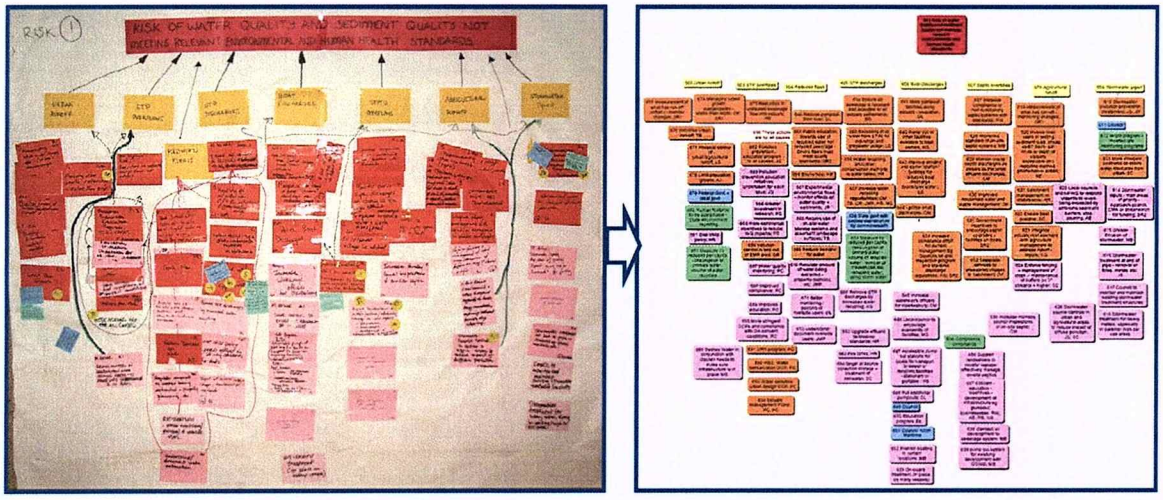

Figure 3. Example paper to electronic strategy map conversion

As part of the participatory process, participant evaluation questionnaires consisting of approximately 15 open and closed questions were completed at the end of each workshop (50-70% response rate), and related to a variety of areas including: whether objectives were met; learning outcomes; what was useful; and what could be improved for future workshops or similar processes. External evaluations to further examine the context, objectives, process and results of the project were also carried out in person by researchers from the ANU in collaboration with the project team, as well as with the aid of audio and video recordings of the workshops.

3. EVALUATION RESULTS

As the plan is still in the draft stage, only evaluation results from a methodological viewpoint will be presented, rather than an evaluation of physical results and external impacts of the approach.

Firstly, to gauge the effectiveness of whether the process was able to allow participants to express their values and combine them into a common set, upon which the next stages of the process could be based, responses from the participant questionnaires were examined. The majority of participants in Workshop 1 asserted that this objective had been achieved, although responses from a couple of the Local Government representatives were a little more mitigated, including: "*Yes – however there*

are lots of differing opinions on what is important"; "*There is a complacency within the community that seems keen to portray the ecosystem as healthy despite evidence to the contrary*"; and "*Some issues and values were difficult to confine going from an individual to group situation*". These responses demonstrate that there does appear to be some normative (values-based) or potentially cognitive (beliefs and world-view) conflicts between the participants and introduce the challenge of defining "collective" rather than "individual" values. These issues will be further discussed in Section 4.

Secondly, when examining the objective of whether the process had succeeded in "capitalising on existing stakeholder and documented knowledge including previous estuary studies and management plans", a number of preliminary conclusions can be drawn from the participant evaluations including: that the workshop process "*Established a range of expertise and views of other government stakeholders*" (WS2: State Govt Rep.); that "*It [the workshop] attracted a range of people with different interests and skills*" (WS3: Community Rep.); and that through the workshop process "*Good supplementary information was generated that could add value to a comprehensive strategy review*" (WS3: Management Agency Rep). On the other hand, the same Management Agency Rep. from Workshop 3 also noted that: "*It is extremely difficult to tap local "expert" knowledge in a way that is useful and where the data collected can be retrieved*". However, upon a further ex-post evaluation interview of the effectiveness of the participatory workshop process, it was highlighted that the stakeholder community coverage of issues had been better than expected, to the extent that very few actions or important documents covered in the subsequent consultant management literature review had been left out of participant comments (Coad, 2007). This corroboration of management perspectives helped to highlight that, to a reasonable extent, this objective of "capitalising on existing stakeholder and documented knowledge" had been achieved through the process.

Thirdly, to determine the extent to which the process was able to "encourage increased understanding, knowledge sharing and learning between stakeholders to enhance future collaborations and the capacity to manage the estuary effectively into the future", a number of participant responses to both closed and open questions at the end of each workshop can be examined. The collective participant responses to the closed questions looking at the comparative effects of Workshop 1 (WS1), Workshop 2 (WS2) and Workshop 3 (WS3) on participants, and the depth of learning they perceived themselves to have undergone, are outlined in Figure 4 and Figure 5.

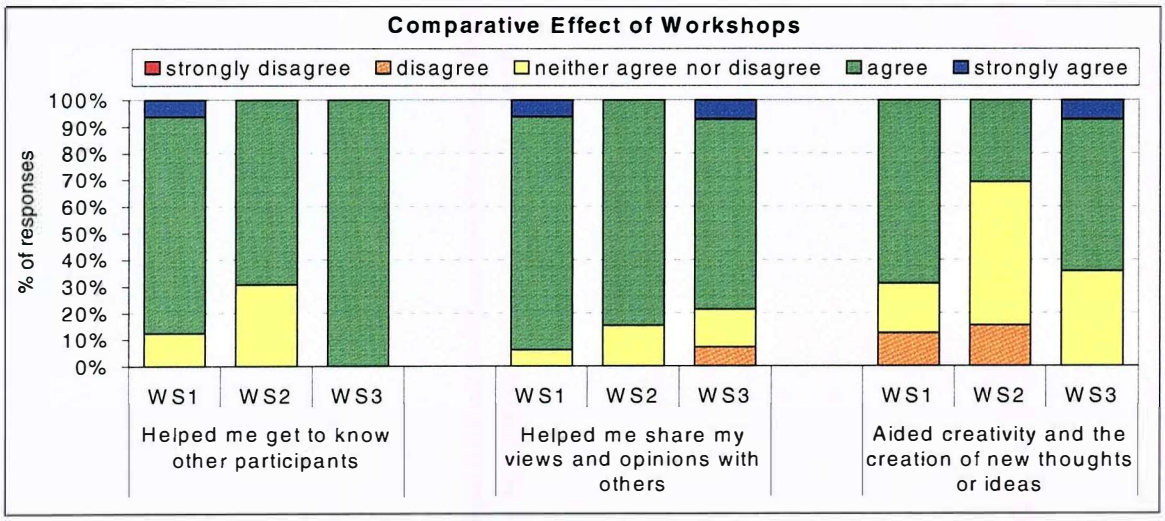

Figure 4. Participant perceived effects of the three workshops

From Figure 4, apart from Workshop 2 aiding creativity and the creation of new thoughts and ideas, participants tended to be in agreement that the workshops helped them to get to know others, share their views and opinions with others and to a slightly lesser extent aided creativity and the creation of new thoughts and ideas. These quantitative results were further supported by participant comments including: "*I was able to listen to and consider other opinions and also had the opportunity to build on other people's basic ideas*" (WS3: Local Govt Rep.); "*It [the approach] gives everyone a feeling of "being heard" and ownership*" (WS3: Community Rep.); and that the workshop process "*Provided a good ground for cross pollination of ideas and perspectives*" (WS3: Community Rep.).

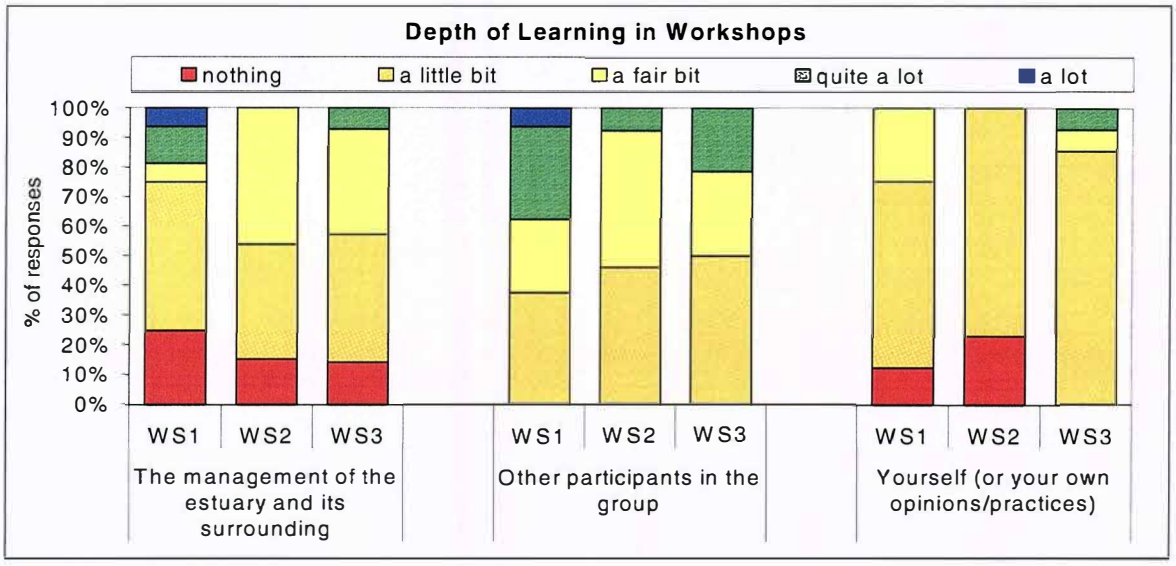

Figure 5. Participant perceived depth of learning over the three workshops

From Figure 5, it appears that the more heavily structured risk assessment process in the second workshop did not seem quite as conducive to learning about any of the three areas: management of the estuary and its surrounding environment; other participants in the group; or themselves (or their opinions and practices). However, a number of participants noted in their evaluation forms that they had learnt the most in that workshop about the actual "*Risk assessment process*" (Env. Agency Rep.) and through using it that "*There are many, many, interrelated issues impacting on estuary, regulated (or not regulated) in many ways*" (WS2: State Govt Rep.). Looking again at Figure 5, the first workshop appeared to produce the largest learning outcomes related to the other participants in the group and the third workshop's activities seemed conducive to the participants' greater learning about themselves and their own opinions or practices. At the end of Workshop 3, one local government representative stated having learnt that: "*There is no one right way to address identified risks. Collaboration is essential*". The majority of these quantitative and qualitative results appear to support the hypothesis that the designed participatory values-based risk management process has helped to "encourage increased understanding, knowledge sharing and learning between stakeholders to enhance future collaborations and the capacity to manage the estuary effectively into the future", at least from a preliminary procedural perspective.

Finally, a few initial comments on to what extent the LHEMP process was able to "keep the estuary management plan enlargement process as efficient and effective as possible, considering the resource constraints" can be made based on comments from the participant evaluations and a number of external sources. On whether or not the proposed LHEMP process was efficient in its implementation and results, the answers rely strongly on the metrics used. When efficiency is looked at as total time, the LHEMP process has so far taken about a year to arrive at a draft plan proposal for public comment, which is short by comparison to the Brooklyn Estuary Management Planning process (a sub-section of the LHEMP area) based on the NSW Estuary Management process (NSW Government, 1992) which took almost 5 years from the start of the Estuary Processes Study to the Draft Estuary Management Plan that was made available to public comment (Coad, 2007). Although the scales and intricacy of assessment are different in these two processes, the final outcome of having a draft action plan is similar, making this an interesting efficiency comparison. Similarly, total project costs (from a Local Government point of view) appear favourable compared to other similar scale planning processes (Coad, 2007; White, 2007).

As to whether the general process effectiveness can be gauged, it appears that the process effectively "*Focused participants to common criteria/objectives*" (WS1: State Govt Rep;), which was a major aim of the "participatory values-based" part of the risk management approach. In terms of managing the known key conflicts in the region, one of the management agency representatives in Workshop 1 stated that it had been "*not too confrontational*". One of the external evaluators commented on the improvements in body language between participants from the first workshop, to the second and third ones, where participants appeared "more relaxed, less defensive and more open to contribute to the

process" (White, 2007). It was also noted "*That you have a process that you are working to reach a conclusion amicable to all participants and the community*" (WS1: Commercial Rep.) and that the LHEMP process is a "*Very ambitious project but clearly [there are] many stakeholders on board, improving likelihood of success*" (WS2: State Govt representative); comments that suggest at least a reasonable level of current process effectiveness. However, one community representative in Workshop 3 also noted that: "*Broad input was achieved but truly effective solutions are elusive because underlying pressures can't be addressed*"; referring potentially to the difficulty of working and planning at a regional scale for treating issues such as population growth and climate change causes and effects, where there is a need to work with higher levels of government and international policy makers.

A number of comments on the effectiveness of the values-based participatory risk management approach were also gathered, including that the approach "*Supported the understanding that the community is made up of people with different values and perspectives – each needs to be considered and valued.*" (WS1: Community Rep.); that risk assessment *"can be subjective and outcomes would be very different given stakeholder [community representatives'] participation*"; and that *"Prioritisation of objectives [for estuary management] will be achieved, - whether or not this is a true indication of priorities is another matter"*. These comments highlight some of the difficult choices and trade-offs that need to be made within the constraints (i.e. time, budget, existing knowledge and available methods) of the LHEMP planning process. Each spatial and risk scale chosen has its advantages and disadvantages, as do the methods used. For example, as highlighted by one of the participants, participatory risk analysis is often a fundamentally subjective process and thus who participates and how can have an important impact on the outcomes. This can be viewed positively or negatively, as the risk analysis process can be time and cost effective, especially in cases of extreme uncertainty and complexity where other more scientific or "objective" methods of analysis may not be possible. This issue is expanded upon in the following discussion session.

4. DISCUSSION

Considering the results of the participant evaluations and other observations of the LHEMP process and preliminary outcomes, there are a number of key themes that have arisen and that merit further discussion, just three of which will be outlined in this paper: the advantages and disadvantages of the risk assessment approach; complexity and its impacts on synthesis and integration in projects such as the LHEMP; and general comments on participatory process implementation.

4.1. Advantages and disadvantages of a participatory values-based risk management approach

As outlined in Section 2, the LHEMP process was specially crafted to meet the needs of the local context and the stakeholders' objectives: in particular, a direct linkage was created between the stakeholders' list of values in the first workshop and the assessment process of Workshop 2, where the values became the "assets" upon which the risks were evaluated. The approach developed for this process can thus be thought of as "values-based participatory risk management". This section will discuss a number of advantages, disadvantages and lessons which have been learnt and which may help to improve the repeat of such a project in a different context.

Firstly, as previously outlined in Coad et al. (2007), participatory risk assessment is an inherently subjective process (especially in this broad estuary management context), even if it attempts to explicit knowledge uncertainties related to the risk assessments. One of the principle advantages in using such an approach is to aid stakeholders to better understand the nature of risks though developing a common (values-based) assessment of them and to then use this method as a basis for determining priorities for risk treatment. An approach of a participatory nature is also suggested by Klinke and Renn (2002) when there is a potential normative conflict (i.e. related to values) amongst the stakeholders due to ambiguity in the definition of the problem situation and a need for trade-off analysis of the risks and deliberation. As this type of risk assessment can be particularly subjective, it is thought that in many contexts, such as the LHEMP, all stakeholders have just as much potential to contribute to it (especially as some of the assets for which the risks were to be assessed, such as "scenic amenity", were not particularly technical). In particular, it was thought that many of the

"community" representatives in the LHEMP process appeared to possess more in-depth knowledge and/or scientific expertise on the estuarine system, industries and community values than some of the agency staff external to the estuary. For this LHEMP process, the exclusion in the risk assessment exercise of Workshop 2 of community members not specifically possessing management roles in the estuarine region therefore had a number of ramifications, both negative and positive. The negative results included that some competent local experts could not input their knowledge into the risk assessment process, potentially reducing its effectiveness in terms of scientific basis (for risks where consequences and likelihoods could be more objectively calculated) and overall community legitimacy; and the positive results being the improved relations between management staff in the region, more open and frank debates about management effectiveness (which sometimes do not occur in the presence of critical community members) and improved support of the LHEMP process from some key management stakeholders who have previously been absent from regional management discussions.

One of the lessons to be learnt from this experience is that risk assessment exercises of this nature will always be biased by who participates and the extent of their knowledge (this includes all types of knowledge such as local, technical, legal, managerial or political), so it is important to include the most capable and knowledgeable people, as well as those required to support and legitimise the outcomes of the assessment. Great care and attention should therefore be taken when organising such a process so that the most relevant participants are able to take part to ensure the success of the assessment results, both in terms of stakeholder legitimisation and scientific validation. However, independent of which group of stakeholders (or even external experts) carry out the "risk assessment" part of the risk management process, it is thought that the first steps used in the LHEMP process of how to carry out the initial context establishment and definition of values or "assets" could provide a number of advantages for quality stakeholder participation where the participants have the opportunity to influence the future direction and focus of the planning process. The influence is easy to trace, as the risk analysis subsequent to the initial context establishment is based entirely on impacts to "stakeholder community" agreed values. This means that the risk impacts examined will be analysed against what values are the most important for the stakeholders.

As this approach (and its application to the complex and ambiguous water sector problems) is still in its infancy, it is believed that further investigation into the theoretical and practical benefits and constraints of the approach is warranted. Potential questions for future research could include:

- How does participation and negotiation during the workshop process shape the final set of community-defined values and to what extent do the participants really share them (i.e. co-construction of "utilities" as used in some forms of economic and decision theory)?
- To what extent do community and shared risk assessment and acceptance differ from individual assessment and acceptance? – For example, there may be only a partial agreement on the values (criteria) and assessment if there are varying views on outcomes (likelihoods, consequences etc.).
- What effects could changing the order of decision steps in the approach have on outcomes (i.e. defining risks first and criteria for their assessment (potentially values) afterwards)?
- What are the dependencies within the decision process stages and to what extent can causal links between factors be mapped within them or in the real-life contextual situation (i.e. to aid the construction of integrated water decision-aiding models or decision support systems)?

4.2. Complexity and its effects on synthesis and integration

Estuary management, like many other management situations in the water sector, is a process characterised by interconnecting and complex problems which exhibit high levels of conflict and uncertainty, as outlined in Section 1. Processes such as that of the LHEMP attempt to embrace and to work in order to structure and understand the complexity of estuarine processes and the effects of management regimes on them. In order to achieve this goal, there is a need to gather and facilitate the integration or synthesis of many types of knowledge: scientific or technical knowledge and expertise; local community and stakeholder knowledge; as well as managerial, political or legal knowledge. Many different methods may be employed to facilitate the gathering and integration of these knowledge bodies. However, each choice of method will possess its own advantages, disadvantages and introduce a variety of trade-offs, especially related to over-simplification or challenges due to too much complexity. In the former case, oversimplification may lead to a loss of legitimacy from many stakeholders' points of view if their visions are not seen to be taken into account. In the latter case, embracing the "full" complexity of the estuarine system and its management regimes

presents major challenges for integration and synthesis of understanding and information.
In the LHEMP process, a number of challenges related to embracing the "full" complexity of the estuarine system were encountered. Within the process, two principal knowledge collection and integration or synthesis methods were used: the participatory stakeholder workshops; and the external scientific and legislative literature review carried out by the consultants (BMT WBM and SJB Planning). In the case of the participatory stakeholder workshops, an extraordinarily large amount of information was collected and knowledge exchanged in the short time allocated. However, the time constraints, and potentially the methodological constraints, meant that often the full expertise and knowledge bodies of the participants were difficult to tap. To reduce this problem, it was common for the participants to refer to scientific reports or existing studies that should be considered by the consultant team. Nevertheless, the capacity (especially from a time and budgetary perspective) for the consultant team to carry out an in-depth study of all of the cited documents and to synthesise the perspectives and information in a "complete" fashion remained somewhat limited within the timeframe of the participatory part of the process. Developing improved methods of quickly tapping existing bodies of tacit and already documented knowledge therefore appears to be a topic worthy of research.

4.3. General Comments on Participatory Process Implementation

There are also a small number of more general suggestions about the use of participatory processes that could help to improve general understanding and future management and planning projects. Firstly, honesty about the potential positive and negative outcomes of participatory processes is required. This is especially important for the project implementers to acknowledge to the managing institutions and participants. All participatory processes, and the choice of the methods used within them, will require many choices and potential trade-offs that will have a variety of impacts on the management or process situations including: the possibility of: changed power structures between participants (and non-participants); relationships changes and conflicts; and trade-offs between stakeholder process legitimacy and "scientific" or "methodological" validity from an external point of view. As participatory processes are real-world processes, they will also be carried out under real-world constraints which will often include time and budgetary constraints. This means that decisions underpinning their design and implementation can not always be made in collaboration with everyone who would like to be involved or to an "ideal" methodological standard, due to a lack of time and other resources. Last minute changes or unforeseen contextual constraints are also more than likely to impact the process at some stage of its implementation, but negative impacts may be able to be minimised by flexible and experienced process managers or facilitators. It is also acknowledged that many questions remain about the best ways of treating complexity and managing uncertainty and conflicts, thus highlighting the need for more research and innovative practical trials like this LHEMP process to be able to push sustainable management processes forward and lead to continual improvement in these processes.

5. CONCLUSION

From the authors' knowledge, the use of the Australian Risk Management Standard (AS/NZS 4360:2004 and HB 436:2004) and the associated Environmental Risk Management Guide (HB 203:2006) for broad or regional scale estuary management has not previously been attempted; especially as it has been used in this "participatory values-based risk management" approach to:

- Develop a common set of estuarine values (assets) and a collection of issues (risks) considered to be the most important to stakeholders, upon which all subsequent analyses were performed;
- Acknowledge and analyse uncertainties that may impact on the effectiveness of estuarine management including: looking at the likelihood of risk impacts; estimating the level of knowledge uncertainty related to risk level predictions; and a risk prioritisation model sensitivity analysis; and
- Attempt to structure the estuarine system's natural complexity (and its management) through the "multi-asset" risk analysis; and by creating the strategy maps to structure the relations between the actions, strategies and risk effects and causes (plus the monitoring needs and responsibilities).

From preliminary analyses, it can be seen that the approach produced reasonably positive outcomes relative to the stated objectives including:

- Eliciting stakeholder values upon which the following stages of the risk management approach could be based;
- Capitalising on existing stakeholder and documented knowledge in the LHEMP region;
- Learning, mutual understanding and relationship building between all stakeholders (and project team members, including the consultants and researchers);
- A comparatively efficient process in terms of total time and local government budget dedicated; and
- Workshop process effectiveness, including management of conflicts.

However, the effectiveness of the approach in improving the estuarine management and preservation of assets will have to wait until the plan is enacted to be properly assessed.

Based on these preliminary evaluations, this paper has presented discussion on the participatory approach used in the LHEMP process, as well as a number of recommendations for future practice and research areas which warrant further study. It is hoped that the lessons learnt during this process may aid the later phases of the LHEMP implementation and allow others to undertake similar processes to improve water management and regional sustainability in other areas.

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