

## Build collaborative models or capacity? Reflections from two years on.

**J.L. Ticehurst<sup>a</sup> and C. A. Pollino<sup>a</sup>**

<sup>a</sup> *The Fenner School of Environment and Society, Australian National University,  
Canberra, ACT, Australia, 0200,*

[Jennifer.Ticehurst@anu.edu.au](mailto:Jennifer.Ticehurst@anu.edu.au); [Carmel.Pollino@anu.edu.au](mailto:Carmel.Pollino@anu.edu.au)

**Abstract:** In 2007 we undertook ‘*capacity building*’ with six Natural Resource Management (NRM) bodies within Australia, where the aim was to train staff in how to develop Bayesian networks (Bns). Previously, the NRM staff had expressed interest in developing Bns themselves to assist with their target setting, planning and reporting needs, so that investments in on-ground activities can be better targeted to outcomes in resource condition. Concurrently, we were developing generic Bns ‘*collaboratively*’ with the same groups. Six months after completing the initial training, none of the NRM regions had made any significant progress in the development of their own Bns. Follow-up surveys, two and a half years later, found that the development of Bns by the NRM regions themselves had largely been limited to conceptual diagrams and influence diagrams. The NRM regions who had made the most progress were those that had staff complete other external training, and those who had committed additional funding to external projects, rather than just internal management and target setting. The time commitment required to develop the Bns and lack of data resources remained the major limitations. Since the 2007 Bn training exercise, fewer participants believe that it is valuable and feasible for the NRM regions to develop their own Bns, but a greater proportion can see the usefulness of the Bn approach to their work. If completed Bns are the measure of success, then it is best to build collaborative models, but detailed capacity building in the initial stages of this project aided the depth of the collaborative feedback, the building of a working relationship between the researchers and stakeholders, and provided a systems approach to environmental management for the stakeholders. Consequently, we would recommend building both capacity and collaborative models to improve NRM decision making processes and to increase adoption of decision making tools.

**Keywords:** Bayesian networks; Natural resource management, Model development.

### 1. INTRODUCTION

Stakeholder participation in model development has been identified as being important in providing a greater level of ownership of models and decisions, and promoting self reliance and equity in decision making outcomes and processes (Hagmann et. Al., 2002). Models can encourage critical thinking (Standa-Gunda et al., 2003, Pahl-Wostl and Hare, 2004), and through participation, models are more likely to be adopted into decision making (Phillips et. al., 2003), increasing the quality of the subsequent decisions (Videira et al., 2003). However, more participation does not always achieve better outcomes (Lynam et al., 2007), rather well designed and targeted participation is more productive in the model development process. Stakeholder participation can be used to provide information which researcher then use to derive models (e.g. Hare et al., 2003), or it can be utilised more frequently for iterative model review and to identify potential sources of input data (e.g. Ticehurst et al., 2007, Henriksen and Barlebo, 2008). Smith et. al. (2007) used participatory modelling, utilising the Bayesian network (Bn) approach, to represent the collective (corporate) knowledge on the success of a current fire management strategy for the Queensland Parks and Wildlife Service, Australia. Stakeholder questionnaires were used to complete the working model.

Landscape Logic is a collaborative project that aims to assist the Natural Resource Management (NRM) Regions of Australia to better inform investment decisions, communicate decisions to their stakeholders while improving the condition of their natural resources (<http://www.landscapellogic.org.au/>). There are 13 partners within the landscape logic team including research teams and 6 NRM regions, 3 in Victoria and 3 in Tasmania (see acknowledgements for a full list of partners). Prior experience and consensus amongst the project partners, including the focus NRM Regions, led to Bns being selected as the integration approach across the internal projects.

Two issues, the management of native vegetation condition and water quality, were selected by the project partners to focus upon. Initially we proposed that the research group would develop Bns for the focus issues, in collaboration with the NRM Regions and research partners, and at the end of the project the partners would be trained in the use, development and maintenance of such tools. However, following an introduction into the Bn process, the NRM Regions expressed interest in being trained at the start of the project to develop Bns to assist in their planning, implementation, monitoring and reporting requirements. In response, two concurrent approaches to Bn development were carried out in this project, each with different levels of participation from stakeholder groups. The first is building capacity in the NRM Regions so they can construct their own Bns (*Capacity building*). The researchers' trained the NRM regional staff in Bn development and then provided supervision while they built their own models. The second activity was the traditional model building approach, where the researcher develops the model with periodic review and input by the stakeholders (*Collaborative Model Building*).

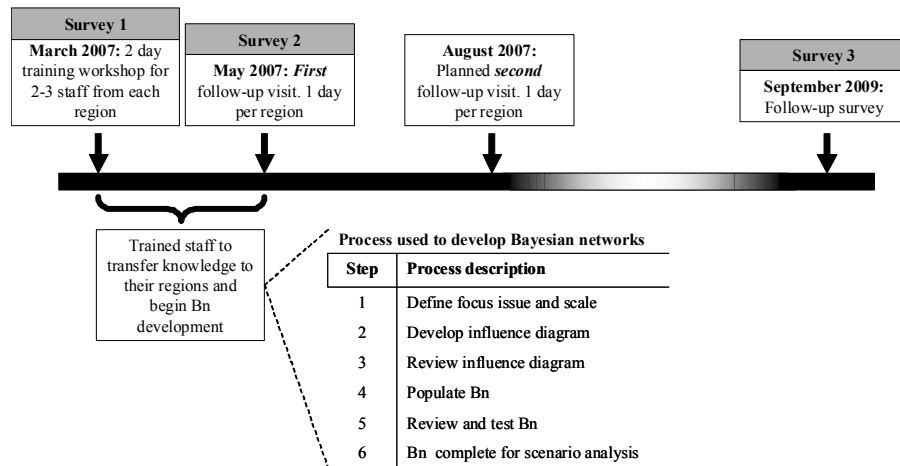
A previous publication (Ticehurst and Pollino, 2007) discussed in detail the progress in the capacity building model development, 6 months after the initial training workshop. It reports on the progress and barriers for the NRM regions to develop their own models. Here, an additional two years on, we revisit the progress and barriers to the capacity building Bns, and consider whether this, or building collaborative models, is the better approach.

## 2. METHODS

This paper contrasts the authors' experience in capacity building and collaborative building of BNs for NRM, which was an opportunity that presented itself during the development of the Landscape Logic project. The same NRM Regions underwent the capacity building and collaborative model building components of the project, so we discuss how the outcomes of one activity impacted upon the other.

The proposed timeline for the capacity building approach used for the NRM Regions to develop their own Bns is shown in Figure 1. The training workshop held in March 2007 stepped through the theory in developing Bns (Steps 1 to 6 in Figure 1), and each step was followed by hands-on experience putting the theory into practice. Two follow-up visits were planned where one day was allocated to each NRM region for each visit in order to assist them with the development of their Bn, and address any problems they may have encountered. In addition to the visits the trained representatives were encouraged to ask for additional assistance via phone and email contact, whenever they required it.

Surveys, or questionnaires, were completed by stakeholders following the March training workshop, the first follow-up visit in May 2007, and then in September 2009. These were designed to gauge the impact and effectiveness of the training, their perceptions of how Bns will assist them in their decision process, whether Bns were meeting their expectations, and what, if any, barriers they were encountering in developing these types of models. The results of the surveys, as well as anecdotal evidence, are discussed with respect to how effective capacity building within the NRM Regions has been, compared to the collaborative modelling approach.



**Figure 1: Proposed timeline and process for the development of the 'Capacity built' models.**

For the *Collaborative Model Building* exercise, the steps used to develop Bns for the focus issues in the exercise were the same as that proposed for the NRM regions to develop their own Bns (Steps 1 to 6 in Figure 1). The project research partners, other experts and the NRM Regions were involved in defining the focus issues (Step 1), developing the influence diagram (Step 2), reviewing the Bn structure (Step 3) as it relates to their current decision making processes and assumptions, and to provide sources of data to inform the Bn model. The researchers' then took the data and input information and populated the Bns (Step 4).

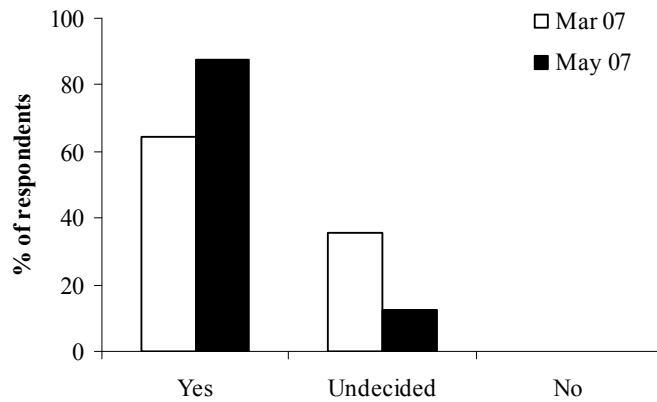
Given that the collaborative models are still not completed, this paper primarily discusses the success of the capacity building modelling, while a true comparison of the two levels of stakeholder participation cannot be done until the collaborative models have been completed.

### 3. RESULTS

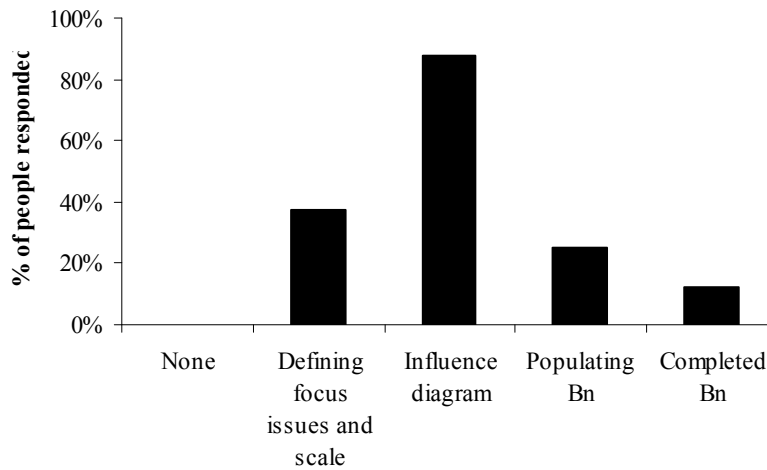
Fourteen NRM regional staff attended the March 2007 training workshop and completed a survey. Twenty participants completed surveys during the May 2007 follow-up visit. A detailed report of the findings from these two surveys is given by Ticehurst and Pollino, (2007). A similar survey was sent out to each NRM region staff contact in September 2009, where the intention was to determine the NRM regional interest in Bns. One NRM region submitted 3 completed surveys, which have all been included assuming that between them they summarise that NRM regions' response. Another NRM region did not respond at all, despite several follow-up emails and phone calls.<sup>1</sup> That NRM regions' response was included in only some of the sections discussed below, following a conversation with the key contact for that NRM region. Note that this is only a small sample to test, so the results are only indicative.

Results indicate that more NRM regional staff believe that Bns are a useful tool for their work, increasing from 62% in March 2007, to 87% in September 2009 (Figure 2). When asked what steps they had found most useful (in the most recent survey), 88% of respondents believed that the development of the influence diagram was of most use (Figure 3), followed by defining the focus issue (38%) (Figure 3). The lack of usefulness of a completed Bn is quite likely to be a reflection that many NRM regions had not completed their own, or used an already completed Bn relevant to their work. Only one NRM region responded (12.5%) that they had minimal to adequate time to develop their own Bns, all other respondents said that their available time was rare (25%) or they didn't attempt to develop one (62.5%).

<sup>1</sup> This NRM body is known to be experiencing staffing problems



**Figure 2: Percentage of survey respondents who believed that Bns would be a useful tool for their work in May 2007, and September 2009.**



**Figure 3: Percentage of survey respondents who believed that particular steps in the development of a Bn was most useful, September 2009. Note that respondents could nominate more than one process.**

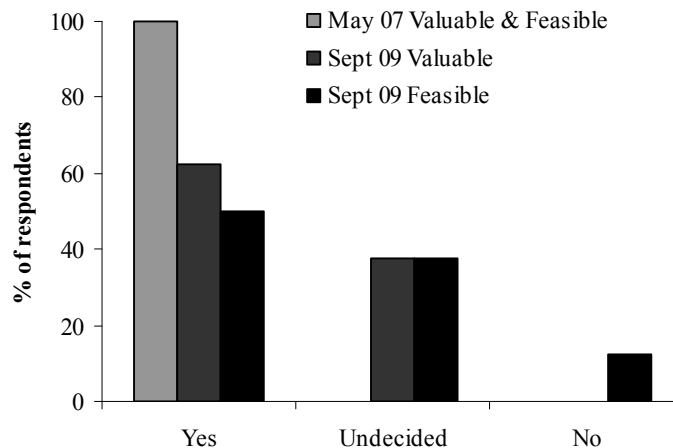
After the March 2007 training exercise, the 57% of NRM region staff believed that time would be a key limiting factor in their development of their own Bns (For details see Ticehurst and Pollino, 2007). This belief was reiterated in May 2007, where time and time of other stakeholders to be engaged in model development were ranked as the two greatest barriers to them developing their own Bns. In September 2009, time and stakeholder time are still key barriers to the NRM regions developing their own Bns with still 57% of respondents naming time as the biggest barrier. . The latest survey also showed that the level of understanding of the focus issues and Bns in general have risen in importance as a barrier. This could reflect that as NRM staff have developed their own Bns or been engaged in the development of the ‘collaborative’ Bns, they have come to recognise that there is a considerable amount of technical knowledge and system understanding required to convert a pictorial conceptual model into a fully functioning Bn.

Consistently, in March 2007, May 2007 and September 2009, the lack of data resources was perceived to be the next greatest barrier to the NRM regions developing their own Bns. Expert elicitation from local stakeholders can be used in the Bn approach to estimate the missing probability tables. However, stakeholder time was generally ranked as a greater

limitation than data resources, which means that the opportunity to fill data gaps with expert opinion is strongly restricted, and may not be a feasible solution.

After the May 2007 follow-up visit, it became apparent that the time lines and resources (staff time and money) that each NRM region could contribute to Bn development varied. Therefore we revised the proposed follow-up visit of August 2007, so that each NRM region could contact us whenever they were ready for such a visit. To date, only one of the six NRM regions has utilised their second visit by the research staff. Also, after the May 2007 visit, all but one of the NRM regions had been able to develop at least one influence diagram, ready to be populated into a working Bn. However, to date the only influence diagrams that have been converted into working models are those that had NRM staff dedicated to their development for a specific project delivery. One NRM region sent a staff member to a Bn short course run by the same researchers at the ANU, to get more technical training in developing Bns before a populate model was produced. Some NRM regions have produced working Bn models, by funding (to our knowledge, 2 NRM regional bodies) and contributing to their development based upon the 'collaborative model' approach, using other external researchers to develop the Bns. Another 2 NRM regional bodies have used their skills in developing influence diagrams to assist in their project planning and communication processes. This suggests that there is a barrier in NRM regions developing Bns themselves beyond the influence diagram (Step 3, Figure 1), unless specific funding and resources has been allotted to that task.

This is further supported by fewer NRM regional staff believing that it is valuable and feasible for them to development their own Bns (Figure 4). Once it was 100% supported (May 2007), but now only 62.5% see the value in the NRM regions developing their own Bns, and 37.5% still think that it is feasible, and 12.5% believe that it is not feasible.



**Figure 4: Percentage of survey respondents who believed that NRM regions developing their own Bns would be valuable and feasible in May 2007, and September 2009.**

#### 4. DISCUSSION

Because the number of responses for each of the three surveys conducted here are limited, these results are only indicative. However, evidence suggests that there is still overwhelming support by the NRM regions for the potential of Bns to assist in NRM decision making processes. More NRM staff had begun to support Bns as a useful tool for their work. We believe that a key contributing factor to this is the logical framework in building a BN and how this related to decision making and the ease of use and understanding of the software used to introduce the technique at the beginning of the project (See Netica at [www.norsys.com](http://www.norsys.com)). The NRM regions found that developing their own conceptual models was the most useful of the Bn development steps (See Figure 1),

but barriers such as lack of time, stakeholder time and data resources seems to have created a cyclic problem inhibiting them from populating and creating their own working models. Only the NRM regions who, through project delivery demands, were able to dedicate resources (mainly money and time) to populate the Bn were able to develop it beyond the influence diagram. This is supported by the response of one NRM regional staff member “We are not funded to undertake activities such as decision support systems [and] strategic planning”. It is likely that the NRM regional staff have gained a greater understanding of the magnitude of work required to complete a working Bn, and that the barriers (lack of time, stakeholder time and data resources) that they have identified are even more pronounced in the data population process. Consequently, fewer NRM regional staff still considers that it is valuable and feasible for them to develop Bns independently. This indicates that, to complete a Bn, the most successful process is the building of *collaborative models*, but this does not exclude the value of the *capacity building*.

It is suggested that Bn training early in this project, as requested by the NRM regions, provided three key outcomes. Firstly, the NRM regional staff had an in depth knowledge of the process that was to be undertaken in the collaborative modelling. This would have enabled them to contribute more in depth, with a greater understanding to the collaborative modelling process. Secondly, by responding so rapidly to their requests for training, we were able to rapidly begin building trust in an open honest two way communication between the researchers and the NRM regional staff (our stakeholders). This enabled us to maintain a good relationship and always find participants to provide feedback on the collaborative models as required. Finally, the NRM regional staff gained an understanding on how to manage their natural resource systems with an integrative systems view, through the development of influence diagrams. This has been a lasting success and a technique that some of the NRM regions continue use.

## 5. CONCLUSIONS

Stakeholder involvement in model development is becoming a more common component to model development, increasing the adoption of the resultant model into decision making. In this four year project, Landscape Logic, it was intended that Bn models be developed in collaboration with the partner researchers and the NRM regional bodies (*Collaborative models*). However, the NRM regions requested to be trained in the Bn approach early in the project, so they could develop their own working models to meet their specific needs (*Capacity building*). Consequently the NRM regions were trained in how to develop Bns and were supported throughout their development process, in parallel with the development of the collaborative models.

Only a few fully functioning Bns were completed by the NRM regions themselves, as part of the capacity building approach. These models were attached to funded project deliveries, and therefore had sufficient staff resources allocated for their completion. Most NRM regions completed an influence diagram for their Bn (Step 2-3, Figure 1), but could not find the time, stakeholder time and/or the data resources to populate it. To overcome this, we suggest that models should be built collaboratively. In addition this should be supported by focused capacity building very early in the project, to provide stakeholders with an in depth knowledge of the expected end product and the methods to be undertaken, and therefore allows them to provide more considered feedback for the collaborative models. The capacity building exercise also enabled us to build trust and a two-way communication very early in the project. Using the Bn approach as our integration technique, we were able to instill a systems thinking approach to environmental management in the NRM regions, through the conceptual modelling exercises, which has provided a useful outcome of its own.

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