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N. F. Herron

S. M. Cuddy

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# DSS Success Measures: Evaluating the SCaRPA DSS

**N.F. Herron<sup>a</sup> and S.M. Cuddy<sup>b,a</sup>**

<sup>a</sup> *Integrated Catchment Assessment and Management Centre, The Fenner School of Environment and Society, The Australian National University, Canberra ACT 0200, Australia ([natasha.herron@anu.edu.au](mailto:natasha.herron@anu.edu.au))*

<sup>b</sup> *CSIRO Land and Water, Black Mountain Laboratories, Clunies-Ross St, Canberra ACT 2600 Australia ([susan.cuddy@csiro.au](mailto:susan.cuddy@csiro.au))*

**Abstract:** The evaluation of a decision support system (DSS) should take account of the intended scope of the system, which has usually been defined as a result of consultation and planning between the developer and client. Project governance and decision-making roles need to be clearly assigned, performance targets and measures established, together with an analysis of external factors that could affect DSS adoption. We propose that different criteria should be used for evaluating environmental DSS, specific to its intrinsic and its extrinsic values. The intrinsic value relates to utility or how the DSS facilitates process, and includes elements such as design, content and process. It is relatively easy to plan for success, where success equates to adoption of the DSS. The extrinsic value of a DSS relates to its usefulness or impact, which for an environmental DSS means the extent to which environmental outcomes are achieved more efficiently than without the DSS. Evaluation against this measure is difficult for the project team. The authors use the approach to evaluate the SCaRPA DSS, an environmental DSS for catchment planning and on-ground investment assessment.

**Keywords:** decision support system (DSS), software evaluation, adaptive management

## 1. INTRODUCTION

What constitutes a successful decision support system? Given the time and resources that are thrown at their development across a large range of disciplines and the very high potential for ‘failure’ [Mysiak, 2005], the question is an important one. General consensus in the literature is that the mark of success for a DSS is adoption by the client or intended end-user. Adoption is an attractive measure of DSS success because it acts as an umbrella indicator for a range of ‘success’ criteria and, assuming that adoption is voluntary, gives a positive signal that the DSS meets the client’s needs. Moreover, adoption of a DSS is relatively easy to measure – at the most basic level, a DSS is either adopted and continues to be used, or is abandoned. But is adoption a meaningful metric for evaluating a DSS?

Suppose the main purpose of a DSS is to improve the efficiency with which a limited pool of resources is channelled into management activities to maximise environmental outcomes. Success, then, will reflect the extent to which decisions made with the DSS lead to a better environmental outcome per dollar spent than decisions made without the DSS. However, measuring success using this criterion is significantly more complex. Issues relating to the models/assumptions informing the DSS, the data used to inform the models/decision steps, what the outputs from the models represent (e.g. are they indicators or actual measures of an environmental value), the time-scales over which the environmental benefits are assumed to occur, etc. confound the evaluation process. And a deficiency in any one of these is not necessarily a failure of the DSS, although it could be.

To evaluate whether use of the DSS is leading to better environmental outcomes, a monitoring and evaluation (M&E) program is needed to assess the extent to which the magnitude and direction of environmental change is predicted correctly by the DSS. But is this enough? Could not the same decision, and hence the same environmental outcome, have been made without the DSS? To properly evaluate the DSS, the M&E program needs to determine whether use of the DSS improved the likelihood of achieving the environmental objectives relative to not using the DSS, or putting it the other way, that a worse outcome would have been achieved had the DSS not been used to inform the decision-making process. Neither the biophysical assessment, nor determining the efficacy of methods, is an easy task.

But suppose a particular DSS can be shown to improve decision-making for environmental outcomes, would we still consider it a good or successful DSS if it is not adopted? The answer is probably not, even though the failure might have little to do with the DSS itself, and a whole lot to do with the environment into which the DSS is delivered. How do we deal with externalities, those factors which neither the development team, nor the end-user can control, but which impact on adoption, when evaluating a DSS?

In this paper, we consider some of these questions in relation to the SCArPA (Site and Catchment Resource Planning and Assessment) DSS. What criteria do we use to evaluate an environmental DSS (EDSS) and should these be the same for every EDSS? For the SCArPA, the satisfaction of our clients, the Catchment Management Authorities (CMAs) of New South Wales (NSW), Australia, is paramount, but the system should also satisfy the requirements of the independent auditors of CMA natural resource management planning and investment. We suggest that some measures of success are relatively easy to assess and design for, others are harder, and that there is an element of risk over which the DSS developer has no control.

## 2. ELEMENTS OF ENVIRONMENTAL DECISION SUPPORT SYSTEMS EVALUATION

In evaluating an environmental DSS (EDSS), it is useful to differentiate between what we have chosen to define as the *intrinsic* and *extrinsic* value of the system (Table 1).

**Table 1.** Definition of value elements of a EDSS.

Values	Description	Analogous to*
intrinsic	utility – the extent to which the DSS is user-friendly, logical in its construction, fit for purpose, adaptable, enhances knowledge and facilitates a decision-making process	Usability Functionality
extrinsic	the extent to which the EDSS contributes to achieving environmental objectives more efficiently than without the EDSS	Impact

\* Analogous software terminology: [ISO, 1998]

### 2.1 Intrinsic Value

An EDSS can be conceived of as having three intrinsic elements:

- a *design* element, which relates to the technical implementation of the system; such as the software architecture, the efficiency and logic of the code, run times and the aesthetic and logic of the interface;
- a *content* element, which relates to the data and models needed to use the EDSS to inform a decision-making process; and
- a *process* element, which translates content into a form for decision-making.

How well each of these elements is handled within an EDSS determines its utility, and ultimately its adoption and continued use. The intrinsic value reflects such things as the models used to explore what-if scenarios; the supporting tools for analysing and visualising

results, generating reports and storing supporting information, the implementation of a formal process for the making of transparent, repeatable, defensible decisions; and/or its data management capabilities. EDSS developers have significant control over the intrinsic elements. Through close consultation with the client and detailed planning at the outset of development, they can put into play a plan to maximise the likelihood of adoption.

## **2.2 Extrinsic Value**

Adoption and ongoing use of an EDSS suggests that end-users believe it adds value to the decision-making process, even if they cannot confirm that it is contributing to better environmental outcomes. We define a useful EDSS as one that contributes to making better decisions for the environment, in terms of more efficient progress towards an objective or set of objectives than without the EDSS. It reflects the extent to which the underlying science, as conceptualised in the environmental assessment models, and the data informing the models are an adequate representation of the physical reality. If the data are incorrect or the assumptions about process reflected in the models are wrong, then the predictions about environmental impact will be wrong. EDSS developers might have some influence over model and data selection, but equally they might not. This will depend on the scope of the EDSS, specifically the extent to which it is to be a fully-contained system with hardwired models and prescribed data sets, or has a more flexible framework into which models and data are added by the end-user.

## **2.3 Externalities**

Finally, there can be barriers to adoption that do not relate to intrinsic or extrinsic elements, but which can doom a DSS to an immediate archive, irrespective of the utility and usefulness of the DSS. We are thinking specifically of the political, institutional and funding environment into which a DSS is delivered, but there are no doubt other external forces which can also have this effect. Of course, some have the opposite effect and result in promotion of the product and increased uptake.

# **3. A DSS FOR NATURAL RESOURCE MANAGEMENT IN NEW SOUTH WALES, AUSTRALIA**

## **3.1 Natural Resource Management in New South Wales**

In New South Wales, Australia, 13 Catchment Management Authorities (CMAs) have responsibility for managing the natural resources in NSW to maintain and improve environmental outcomes. CMAs are required by legislation to develop Catchment Action Plans (CAPs) that set out region-specific targets for improving natural resource condition and help prioritise their investment in reaching these plans. Development and implementation of each CAP must be consistent with the *Standard for Quality Natural Resource Management* (the Standard) and contribute to the state-wide targets for natural resources included in the NSW Government's State Plan. The Standard aims to promote consistent, high-quality practice across the natural resource management (NRM) sector, and encourage adaptive management to achieve goals and targets for resource condition improvement. To implement their plans, CMAs have been given AUD\$436M specifically for investment in on-ground works (to be undertaken by willing landholders) that will contribute to improved environmental outcomes. CMAs need to adopt procedures for investment decision-making which demonstrate a sound basis and are likely to result in the intended outcomes.

## **3.2 CMA Decision Support System Needs**

The TOOLS2 project, which commenced in 2005, was established with the express purpose of developing decision support tools to assist CMAs in catchment planning and

on-ground investment decision-making. CMAs were extensively consulted to elicit details of their environmental issues, their assessment tools, their business processes, the influence of non-biophysical factors (e.g. cultural, risk, capacity building, etc.) on funding determinations and what enhancements were needed to their existing methods to facilitate planning and investment processes. In this paper, we restrict our discussion to the latter, i.e. their site-level investment processes.

For incentives assessments, most CMAs reported that they have satisfactory procedures for assessing the environmental benefit per unit cost of an investment proposal in terms of soil, salinity, riparian zone and native vegetation outcomes, but they generally lacked capacity to assess aquatic habitat and biodiversity outcomes. Many CMAs were quite attached to their existing suite of assessment methods, and some indicated reluctance to change. Generally, CMAs said they would consider alternatives, if they could be convinced that the alternatives improved on their existing methods. Improvements were not construed simply in terms of better science or more sophisticated models. The challenge for CMAs is finding a workable balance between the demands for good science, robust models and adequate data collection and the day-to-day imperative of processing large numbers of funding applications with limited time and resources. They also stressed that the level of investment in collecting data and assessing proposals should not be disproportionate to the proposed funding amount.

CMAs were questioned about their methods for calculating environmental benefits, their business processes and funding models. We needed to know how they used biophysical model results, together with considerations about costs and social values, to inform the decision to fund. While their methods differed in the details, their funding models could be broadly categorised as ranked (tender-based) and threshold-based approaches. All CMAs took non-biophysical values, such as cost of proposal, cultural heritage, risk factors, community capacity building, etc., into account when making a decision to fund.

CMAs saw enormous value in a DSS that had corporate support, including linking into a centralised data, financial, contract and reporting management systems, and ongoing training and product maintenance.

The key messages from consultation were that CMAs:

- see themselves as autonomous;
- have different issues;
- have considerable knowledge and experience;
- want a DSS that is consistent with the existing policy environment;
- want a DSS that has corporate support and links to corporate systems;
- want good science;
- want the level of assessment burden to be commensurate with the size of the investment;
- need a transparent, defensible, repeatable, auditable process.

There were many other must-haves and desirables, but the foregoing were fundamental in shaping the design of the DSS. To the extent that these criteria are catered for in the DSS, they are part and parcel of a major success marker: adoption of the DSS by CMAs.

### 3.3 SCArPA – Site and Catchment Resource Planning and Assessment – EDSS

SCArPA comprises two core modules, a catchment planning (SCArPA-cp) module and an incentives assessment (SCArPA-ia) one. The EDSS is supported by a configuration tool, which allows a CMA to populate the system with region-specific data, such as resource condition and management targets, biodiversity benchmark data and other reference data. Technical details of SCArPA are reported in Murray *et al.* [2008].

SCArPA-cp was developed to assist CMAs in developing Catchment Action Plans and Implementation Strategies through the provision of catchment models and priority mapping tools, spatial multi-criteria analysis and scenario building tools. It has been designed so

that, provided certain protocols are followed, CMAs can ‘plug in’ catchment-scale assessment models of their choosing. It contains tools for registering catchment models and data layers, generating priority maps, visualising multiple priority layers, building scenarios and evaluating the environmental impacts of land cover/management changes using the registered catchment models. SCaRPA-ia was designed to assist CMAs make funding determinations about proposals for environmental outcomes. It is also intended as a planning and education tool, where CMA staff can work with landholders to explore alternative management options and develop property plans. This module allows CMAs to design funding programs, evaluate the environmental benefit of landholder proposals against criteria specified in a funding program and rank or rate proposals by their cost-benefit ratio, leading to a determination to fund or not fund.

#### **4. DEFINING EVALUATION CRITERIA FOR SCaRPA**

Firstly, the selection of success metrics to evaluate an EDSS must be appropriate to its intended scope and use, i.e. the metrics cannot be pre-determined and need to be identified at project inception. The umbrella marker of success adopted by the project team was that SCaRPA would be adopted by the majority of CMAs in NSW. Thus our aim was to build a system that would perform well in an evaluation of intrinsic value. From a CMA perspective, we considered the extent to which SCaRPA delivered on content and process elements vital, but so too the design elements, relating to qualities such as the attractiveness, usability, efficiency and stability of the software. These design qualities very much determine a user’s level of satisfaction with a piece of software [ISO,1998].

In terms of content, we determined that SCaRPA would include models that are based on good science and would, with the ‘right’ data, give reasonable predictions of the impacts of different management interventions on a range of environmental variables. As the project team was responsible for the development of the EDSS framework and component assessment models, our evaluation of success must necessarily include how well individual models meet the criteria of good science and rapidity and ease of use, as required by the CMAs. However, when it came to data considerations, we resolved that we would not construe as failure poor DSS performance resulting from the use of poor quality data sets. Responsibility for the selection of data to inform models within SCaRPA was devolved to the CMAs.

An evaluation of SCaRPA’s extrinsic value is by definition a post-project exercise and thus out of scope for the project team. This highlights a disjunct between the short-term nature of EDSS development projects (typically 1-3 years) and principles of adaptive management that assume adjustments to an EDSS’s utility based on ongoing evaluation of the environmental impact over the longer-term. However, an evaluation of SCaRPA’s extrinsic value is important in terms of the long-term adoption and support of SCaRPA.

#### **5. PLANNING FOR SUCCESS**

##### **5.1 Acknowledge Existing Capacity**

Even though the CMAs are relatively new organisations, many staff members have come from the NRM agencies that previously managed those regions. They have extensive knowledge and experience of their region, and they have a very real sense of what is practicable. To improve the likelihood of adoption, and at the same time acknowledge CMAs’ existing capacity, we incorporated their current practices into the design, i.e. CMAs could continue to do assessments they way they currently do.

With 12 CMAs engaged in the project, this had significant design implications as the EDSS needed to cater for 12 different methods. For site-scale incentives assessments, this has been achieved via a template builder. The Template Builder is where the CMA designs their funding program – it steps them through a series of data entry screens which capture

details about the program and from which they select the assessment criteria for evaluating incentives proposals from landholders:

- *Overview of program* – source of funds; how much funds; aims of investment; links to catchment, resource condition or other targets; closing date; other details;
- *Environmental model selection* – what environmental models will be run; what weights to give to them when combining model outputs; details on the assessment within individual environmental models;
- *Method for combining model outputs* – different methods for combining model outputs into a single environmental index are offered;
- *Funding model selection* – tender-based or threshold-based options; cost-sharing;
- *Social and other criteria selection* – select from existing criteria or create new assessment criteria regarding the social, cultural and other value of the proposal (e.g. protects an indigenous sacred site; encourages innovation; contributes to community capacity building)

This template is then used to create the assessment form for each application received within that funding program. An application will only need to provide data or answers to the criteria nominated in the template, and all applications within the funding program are subject to the same rules. This approach addresses itself to the first three key messages from consultation (s3.2), as well as establishing a transparent, repeatable, auditable process. By allowing them to populate SCArPA with CMA specific lists of management and resource condition targets, the framework facilitates reporting against targets, as required by the auditors.

## 5.2 Enhance Capacity

CMAs tended to lack capacity to assess aquatic habitat and biodiversity values. Developing models for catchment and site level assessments of aquatic habitat resource condition and response to management changes was a critical component of the project. Work also continued on developing existing models for land and soil capability, salinity, carbon and terrestrial biodiversity for incorporation into SCArPA. As much as possible, the model developers have tried to cater for different levels of assessment, consistent with the CMAs' desire to keep the burden of assessment commensurate with the proposed level of funding. This means that for low priority outcomes or proposals where funds are capped at relatively low amounts can be assessed using simpler methods than the methods for assessing environmental outcomes from proposals involving large sums of money.

By catering for all CMAs, we have enhanced individual CMA capacity by offering a wider range of assessment criteria to choose from, and we have included the option of adding new criteria. We also provide options for combining model outputs into single environmental benefit indices (EBI), visualisation and reporting tools and a transparent, repeatable, defensible, auditable decision-making framework. SCArPA builds CMA capacity in catchment planning and the linking of catchment planning to on-ground investment (Herron et al, 2008).

## 5.3 Improve Environmental Outcomes

Planning an EDSS to ensure that the decisions arrived at from using it will lead to better environmental outcomes is challenging. Model developers can make every effort to ensure that the component assessment models are based on good science. Where the physical processes and relationships are well understood and are backed up by considerable data, there is a reasonable probability that assessments made using these models will provide the 'right' results. If the underlying data are wrong, or the model is wrongly applied, then its predictions will be wrong. Provided that we have documented the assumptions of our models within the SCArPA, we contend that poor results from SCArPA due to inappropriate use by the CMA do not constitute a failure of the DSS.

However, without a long-term monitoring and evaluation (M&E) program, it is difficult to evaluate the performance ('success') of component models. Here M&E serves two purposes: first, monitoring the physical changes that come from a management intervention allows progress towards environmental targets to be tracked over time, which leads to second, an evaluation of the accuracy and reliability of the models that predicted particular outcomes. For the SCArPA project, which runs for 3 years, this is entirely out of scope.

M&E can pose further difficulties. To be of value, an M&E program needs to differentiate between changes in the environmental value(s) caused by the management intervention from those caused by external controls. An example of this is where a comparison of habitat condition metrics at two points in time shows a deterioration in condition, despite the implementation of conservation activities (informed by an EDSS) to improve site condition. Has the EDSS contributed to a perverse outcome or have external factors, such as drought, fire or plague, overwhelmed the management impact? An evaluation done at a single point in time is unlikely to be sufficient, unless the evaluation criterion is area or length of change. Monitoring data needs to span a sufficiently long time that the direction and magnitude of improvement can be discerned above the 'noise' caused by climate or other drivers. Environmental response times to management intervention do not conform neatly to political and management time frames.

This discussion highlights the difficulty in evaluating the contribution of an EDSS's component models to effective decision-making and the attainment of resource condition targets. As a consequence, measurement and reporting is more often focussed on achievements against management targets (e.g. area of land re-vegetated), which SCArPA does support.

#### **5.4 Reality Bites**

Linking the SCArPA system to corporate data management, contract reporting and financial management systems, identified during the consultation process as a key desirable of the CMAs, became an important goal of the project. The ability to access data from centralised databases, maintained by state agencies, had proved invaluable in the corporate rollout of a closely-aligned tool for assessing applications to clear native vegetation and CMAs wished to have the SCArPA plugged in too. While this was included in the implementation specification, the hurdles associated with porting an external product into a corporate network were too high to be overcome within the life of the project. As a result the current version is stand-alone, but designed with enough forethought that when it is eventually linked, all the information regarding funding programs, implemented works and data collected as part of site assessments can be uploaded to the central system for permanent upkeep. We would argue that this inability to deliver on a key success measure cannot constitute 'failure' as it proved to be beyond the control of the project team, and thus became out of scope.

### **5. CONCLUSIONS**

Evaluating an EDSS requires consideration of a range of success criteria. These will not be the same for every EDSS. We contend that the developers of an EDSS need to define their success criteria at the outset of the development process, having regard to its intrinsic (i.e. its utility) and extrinsic (i.e. its impact) values within the scope of the EDSS. This means the developers need to consider the experience of the end-user, the interest other stakeholders might have in the use of the EDSS for environmental decision-making, and finally success criteria which are meaningful to them as software architects. As part of this preliminary planning, it is useful to identify what aspects of the system the developers can own and plan for in the system design, and what components of their system they might need to consider, but which they have little influence over. External factors, pertaining to the environment into which the EDSS will be launched and which could threaten adoption, should be anticipated, and to the extent possible, a plan should be developed to address the threat. This process contributes to setting success criteria and the scope of the EDSS.

In the SCArPA project, via a process of active consultation with our CMA clients throughout the life of the project, we have designed a catchment planning and incentives assessment system that performs well in terms of its intrinsic elements. By assuming responsibility for the component models that we have developed as part of the project, we have assumed some responsibility for performance against extrinsic outcomes, but how well our models perform against real physical outcomes has yet to be assessed. The metrics for evaluating the extrinsic value of an EDSS are tightly coupled to those for assessing achievement against resource condition targets. How to measure outcomes (condition targets) as opposed to outputs (management targets) is a challenge facing all resource managers and researchers. Experimentation, implementation, M&E and adjustment are the adaptive management stepping stones towards this goal.

While much has been written about the success or failure of DSSs, it has not yet been harnessed into developing an evaluation framework. We consider this paper, a first step in that direction.

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### REFERENCES

- ISO, *ISO 9241-11: Guidance on usability*, 1998. Retrieved February 5, 2007: [http://www.usabilitynet.org/tools/r\\_international.htm](http://www.usabilitynet.org/tools/r_international.htm)
- Herron, N.F., Barrett, T.W. and Cuddy, S.M. Linking catchment environmental planning to on-ground investment: the SCArPA DSS, this proceedings, 2008.
- Murray, N.I., Cuddy, S.M. and Herron, N.F. *SCArPA User and Reference Manual*, CSIRO Land and Water, Science Report 08/xx, 2008.
- Mysiak, J. *Success and Failure of Decision Support Systems for Integrated Water Resource Management*, Venice, Italy, 6-7 October, 2005.