Integrating Biophysical and Socio-Economic Models to Achieve Triple Bottom Line Outcomes on Queensland State Forests

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Abstract: Management on public lands has generally been focused on promotion of sustainable practices and maintenance of biological diversity to achieve desirable social outcomes. These objectives call for application of a Triple Bottom Line (TBL) approach that is capable of consistent and accountable integration of expert assessments of biophysical and economic resources and community preferences with clearly defined management priorities and values. In Queensland, several approaches to native forest management have been developed in the past few years to achieve individual elements of this goal. Some approaches focus on systematic assessment of biophysical and economic aspects of resources. Others address the Government commitment to the participatory democracy model of natural resource management and explored various methods and models of public involvement in land use allocation. Lastly, new models of decision-making have also been developed and tested. However, the integration of these social, biophysical and economic components remains difficult and methodologically uncharted territory largely due to the complexity of the management environment. New challenges in the future arise from managing sustainability on leasehold and freehold tenure, particularly with respect to vertical integration of private property management objectives with a broader catchment and regional scale planning decisions. An Integrated Forest Management (IFM) Framework is being developed by the Queensland Environmental Protection Agency (EPA) in Australia to facilitate the planning and management of Triple Bottom Line outcomes on forested lands. The framework follows on the previously implemented Multiple Use Management System and in its new capacity aims to balance the decision choices of land managers on the EPA managed estate. This paper gives a brief overview of two elements of the framework and design principles used to integrate the two modules. This will be demonstrated using an open space planning exercise in South East Queensland, Australia. It also gives insights into learning outcomes of this approach and discusses future directions.

Keywords: *Integrated land management; complex land use allocation; natural resource management decision support system*

1. INTRODUCTION

Native forests have always been managed for multiple objectives to meet the demands of the society. The Forest Service included a conservation objective when it was established in the early 20th century. Today, the management of forests continues to focus on a whole range of values in a manner that promotes social, economic and environmental outcomes, commonly referred to as Triple Bottom Line (TBL). There are two major resource management dilemmas - one is long-term conservation and the other managing contemporary demands of society. The rapid pace of changes in socioeconomic and political fabric of society introduces new aspects of native forest values. Evolving community expectations and values for which forests should be managed has brought about a shift in management paradigm from a mainly economic-oriented management goals to more socially accepted TBL outcomes. Although overall it has been a positive shift, it brought new challenges and complexities. One of them is a requirement for better understanding and integration of information and knowledge about both natural and social systems and long-term impact of current uses[1].

Generating this information is a formidable challenge, considering the complex nature of such systems. Further exacerbating the issue is the need to consult with the stakeholders and integrate these types of information into formats useful to decision-makers. Chikumbo and Davey (2001) pointed out that, quite often, collaboration between all parties: forest planners, managers, ecosystem modelers and stakeholders is required in undertaking a holistic approach in sustainable

[1] The term “use” within the context of this paper is applied to represent both production and non-production aspects of human interaction with the natural environment.

forest management. Such approach is in need of a model that could integrate "hard science" (knowledge generated from research and modeling) with "soft science" (community-related processes) since stakeholders and the community influence most of the forest management decisions (Harris, 2002). Decision-makers have a demanding task of ensuring holistic consideration of both since decision-making also needs to be transparent, accountable and capable of resolving conflicts among stakeholders (Sayer, *et al*., 1997).

In planning for multiple values on forest lands in Queensland, Australia, an IFM Framework is being developed, with some elements tested in several planning sites. The system follows the basic tenets of Ecologically Sustainable Forest Management (ESFM) as part of a bilateral agreement between the Commonwealth and State Governments.

Under ESFM economic activities such as timber harvesting, quarrying and forest grazing on former State Forest estate are recognized but need to be conducted at a more sustainable level with further emphasis on restoration. Other activities that promote environmental values and socio-cultural opportunities are also considered equally viable. More conventional environmental values are assigned to ecosystem functions that maintain its health and vitality and intrinsic values such as scenic amenity, air, soil and water quality. In addition, socio-cultural values include those that promote educational and recreational opportunities within the forest ecosystem.

This paper discusses the integration of scientific and social components of the IFM Framework and subsequent application of these components during a planning exercise at the Glen Rock Regional Park in South East Queensland.

1.1. Sustainability Issues on Queensland State Forests

There are about 4 million hectares of State forests, Timber Reserves and Forest Entitlement areas, which are subject to ESFM. Apart from about 425,000 ha being converted to protected forest status, the rest are being managed for multiple values that include both utilitarian and non-utilitarian aspects. The former include: timber harvesting, nature-based recreation and education, ecotourism, grazing, quarrying, honey production and military training. The latter values include conservation, cultural heritage, scenic amenity, education and appreciation values and water quality.

The multiplicity of these values implies a potential for spatial and temporal conflicts among various uses. In addition, the relative scarcity of forests and growing community and industry demands means that forest values need to be managed with social, economic and environmental outcomes.

Sustainability as a goal is dynamic, changing through time and space as resource attributes and population needs and perceptions change. Decision-makers need a knowledge base about the natural and social systems in order to respond to these changes. Thus, assessment and decision support systems are required (Sayer, *et al.,* 1997). Harris (2002) also emphasizes the importance of integrating science, economics and society as foundations in resource analysis and management.

2. DEVELOPMENT OF AN IFM FRAMEWORK FOR QUEENSLAND PUBLIC FORESTS

2.1. Features of the IFM Framework

The IFM Framework being developed is based on the hypothesis that there is a symbiotic relationship between forest ecosystems and that of the community. The community is defined in a broader sense and may consist of local, regional, State, National and International constituents. For example, the local community consists of those individuals, businesses and organizations whose livelihood and opportunities for maintaining a quality of life depends on the forest ecosystems. The international community interests are represented through signed international treaties and convention, such as World Heritage Conventions, Conventions on Migratory species and Montreal Process, among others. It is not uncommon that in practice there is a tension between interests of these communities. IFM also recognizes that there are inherent risks and threatening processes and social conflicts in managing more than one value in an ecosystem setting or in achieving a trio of outcomes such as TBL.

The IFM framework will serve as blueprint in identifying, assessing and managing the pressures from various activities in forest lands, and can provide long-term forest management guidelines. These management guidelines are designed to be transparent, accepted by stakeholders, accountable and science-based.

2.2. Components of the IFM Framework

IFM hopes to address Government commitments to ESFM. It provides a policy context for ESFM, as well as strategic guidelines designed to achieve ESFM while meeting the needs of the community and industry. It also specifies management guidelines and prescriptions designed to achieve a desired long-term forest condition. This is defined through estimation of ecosystem health, its diversity as well as opportunity to provide for economic, cultural and social aspects of the community. Figure 1 shows the components of the IFM framework.

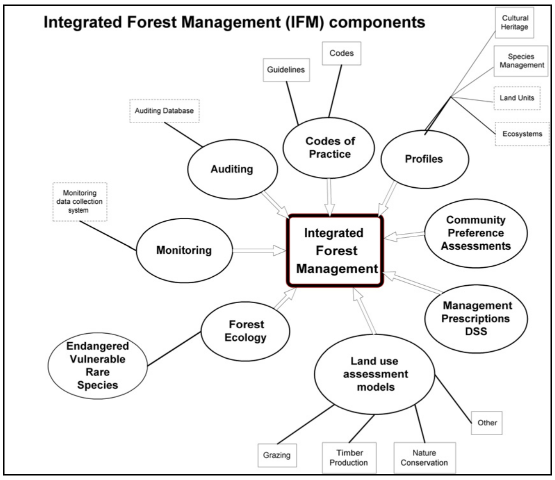

Figure 1. Conceptual elements of IFM framework.

Complexity is perhaps one common feature. Incorporated in the model are the policy and legislative mandates for ESFM, gathering of basic information about the forests being managed, analysis and predictive modeling. The framework includes the development of management guidelines based on threatening processes and land use conflicts. A long-term nature of forest management requires management feedbacks consisting of a review and audit process to facilitate continuous improvement of management processes.

The framework can integrate expert opinions on quality and quantity of resources in question with wider community perceptions of how these should be used within both local and regional contexts. It also provides information on complex resource systems, albeit mostly qualitative, which at present is mostly wanting.

2.3. The Land Use Assessment Models

IFM is using a suit of forest values identified in the National Forest Policy Statement 1992. These have been covered with a range of assessment models. Each of these models is a multi-criteria based tool, which provides experts with a consistent way of describing and evaluating forests with respect to their capability and fitness for the single assessed land use. It is achieved through the use of a series of criteria to produce an index that describes how significant (from the expert point of view) the area is for undertaking the assessed land use. There are currently 12 forest values that are modeled independently (Figure 2). An example of the various criteria dealt with in a model is demonstrated in the case of Conservation.

The outcome of the IFM assessment stage is an expert evaluation of forest fitness for each identified land use as if it were to be conducted in isolation. At this stage, community preferences for the identified forest values can be factored in.

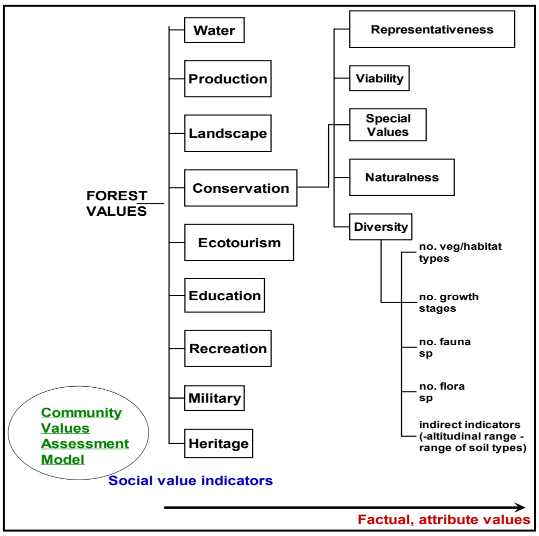

Figure 2. Hierarchy of forest values

2.4. Model Assessing Community Preferences

The community preference model provides the basis for assessing the type of forest values that a social group prefers to be managed in a certain area of forest. It is a multi-criteria-based model that assesses preferred forest values relative to a broader goal of optimizing a range of benefits to the community.

The Community Values Assessment (CVA) model is based on Saaty's (1988) Analytic Hierarchy Process (AHP), which uses pairwise comparison to determine the relative importance of a group of alternatives. The relative value of an alternative is represented as:

$$Ui = \sum_{j} w_j u_{ij} \qquad (1)$$

where $\Sigma\ w_j = 1$, U_i is the composite score of the alternative i, w_j is the relative weight of criterion *j* in contributing to higher level criteria, and u_{ij} is the score assigned to each alternative use *i* in contributing to criterion *j*. A two-level hierarchy was used in the study, with 12 alternatives (forest uses) that can be instrumental to the maximisation of sustainable community benefits.

Broader community benefits are taken into consideration in the assessment model. Traditionally, economic well-being has been thought as the main driver of policies and other forest management strategies. However, in recent years, it appears that the community has increasingly recognized that economic well-being should be balanced with other goals such as social equity and environmental integrity.

The inclusion of community preferences in natural resource management is not new. Blending expert knowledge with local knowledge has been experimented with by Zanettell and Knuth (2002). Michaelidou, *et al*. (2002) also emphasizes the importance of the symbiotic relationship between natural ecosystems and social systems. Consulting the community is important because of the interdependency of natural ecosystems and social systems.

2.5. Integration of Resource Value Assessments and Community Inputs

The integration of community and expert inputs is achieved within a decision support component of the IFM framework. Figure 3 shows that community preferences are used as weights to produce the overall index of land use significance in each planning unit. This information is the primary input of IFM into the land use allocation stage. It provides a management team with a tool to make relative comparisons of identified uses and considers community preferences. It also points out some urgent management issues that need to be addressed in the case of each land use allocation.

The analysis and synthesis of information about the natural and social systems is important in natural resource allocation and management decisions. These facilitate the interpretation and use of information (Pirot, *et al.,* 2000).

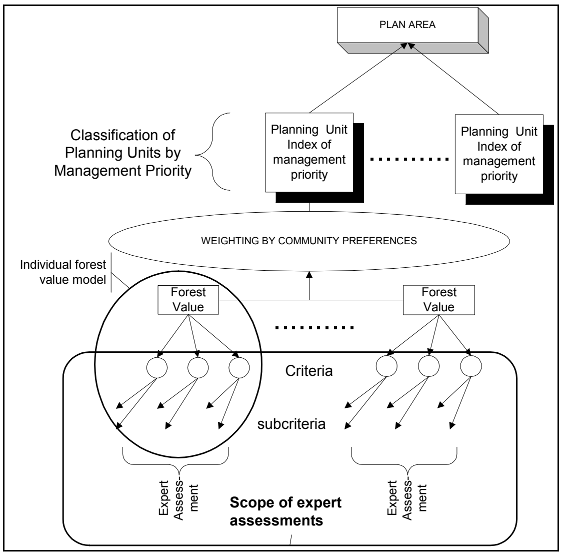

Figure 3. Integration of expert and community assessments

3. TESTING THE IFM MODEL: GLEN ROCK REGIONAL PARK

3.1. Description of Study Area

Glen Rock Regional Park is a 6,000 ha property purchased by then Department of Natural Resources to provide a range of community benefits. The area is in close proximity to population centres such as Brisbane, Ipswich and Toowoomba. It also shares a border with Main Range National Park, part of the Central Eastern Rainforest Reserves (Australia) World Heritage Area. The Regional Park supports various endangered flora and fauna as well as regarded as an important aquifer recharge area.

3.2. Methodology: Generation of Land Suitability Index

The study at Glen Rock Regional Park is the first stage of the application of components of the IFM framework – that of determining resource capacity, suitability and manageability, and assessing social consensus on the types of forest values that need to be managed in order to deliver optimum benefits to the community. The following methods were carried out:

a) Resource assessment**.** Each of the 12 forest values in consideration was assessed separately using respective resource assessment models. A team of experts assessed 77 predetermined planning units with respect to the criteria indicated in each model.

b) Community Assessment**.** A survey using the Dillman approach (1978) was used in selected localities surrounding the study area. Three hundred prospective respondents were randomly selected from several places with postcodes corresponding to shires within a 50 km radius of the Regional Park. The response rate was 25 %.

Interest groups who attended meetings and community displays were also surveyed. These represent groups who are highly involved in the planning process.

The respondents were asked to do pair-wise comparisons of forest values that should be managed. The responses were analysed using the Community Values Assessment Model developed as a component of the IFM Framework.

c) Integration of resource and community values. Resource and community values were combined to derive the integration of these models formed the basis for determining land suitability for specific planning units. The suitability index is a combination of resource capacity, social consensus about managed forest values, and technical and management feasibility for these values.

4. OUTCOMES OF THE IFM CASE STUDY AT GLEN ROCK REGIONAL PARK

4.1. Assessment of resource value

Each of the selected resource assessment models indicated the relative importance of pre-set criteria with respect to the ecological capacity and suitability of the various planning units (Table 1). Recreation received a more specific level of investigation due to the number of interest groups seeking activity sites within the study area.

GIS maps for each of the forest values indicating relative importance or significance were also generated, enabling planners to pinpoint which parts of the Regional Park were suited to the maintenance of a particular value.

Table 1. Significance ratings for various forest values

Planning Unit 1	
Activity Type	**Assessed Value**
Nature Conservation	8.0
Ecotourism	6.0
Forest Production	1.1
Forest Grazing	5.9
Honey Production/Beekeeping	3.3
Landscape/Scenic Amenity	1.3
Non-indigenous Cultural Heritage	2.0
Rec 2WD	2.8
Rec 4WD	2.6
Rec Bike Riding	2.3
Rec Camping	2.0
Rec Horse Riding	7.9
Rec Outdoor Education	2.3
Rec Picnicking	2.5
Rec Trail Bike Riding	1.9
Rec Walking/Nature Study	4.3
Catchment Protection/Water Quality	6.9

4.2. Community Preferences

Survey outcomes indicated that the community prefers forest values such as catchment protection, nature conservation, outdoor education and research, and nature-based recreation for consideration in forest management (Figure 4). Of the 12 forest values, quarrying, military training and grazing were the least preferred.

The four preferred forest values could be considered as passive or non-extractive activity. This is consistent with the strong community preference for maximizing environmental attributes of the Regional Park, relative to their social and economic attributes.

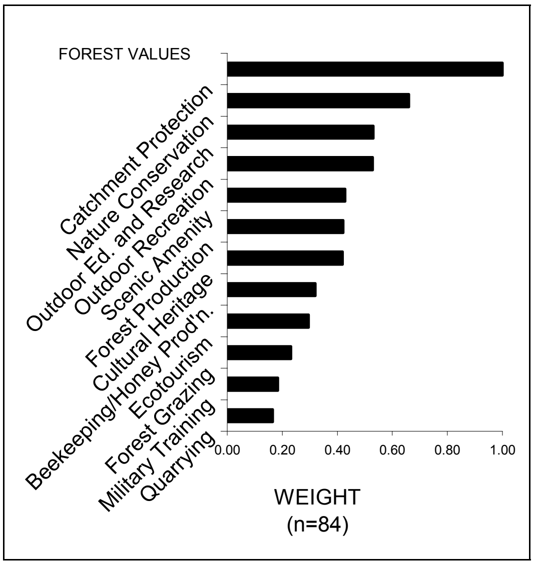

Figure 4. Community values

4.3. Land Use Suitability Index – An Integration of Biophysical Assessments, Socio-Cultural Consensus and Management Decisions

A vital issue in managing the right values is how these resource and community information are combined in order to maximise benefits for the community on a long-term basis. Thus, a decision recording system was used to process the information generated, and for the management team to gauge technical and management feasibilities for such forest values (Table 2).

Table 2. Land use suitability index

Planning Unit 1				
Activity Type	**Assessed Value**	**Socially Constrained Value**	**Technically Constrained**	**Land use Suitability Score**
Nature Conservation	8.0	5.3	1.0	5.3
Ecotourism	6.0	1.8	0.8	1.4
Forest Production	1.1	0.5	1.0	0.5
Forest Grazing	5.9	1.4	0.7	1.0
Honey Production/Beekeeping	3.3	1.1	0.0	0.0
Landscape/Scenic Amenity	1.3	0.5	1.0	0.5
Non-indigenous Cultural Heritage	2.0	0.8	1.0	0.8
Rec 2WD	2.8	1.5	1.0	1.5
Rec 4WD	2.6	1.4	0.1	0.1
Rec Bike Riding	2.3	1.2	0.0	0.0
Rec Camping	2.0	1.1	0.0	0.0
Rec Horse Riding	7.9	4.2	1.0	4.2
Rec Outdoor Education	2.3	1.2	1.0	1.2
Rec Picnicking	2.5	1.3	0.1	0.1
Rec Trail Bike Riding	1.9	1.0	0.1	0.1
Rec Walking/Nature Study	4.3	2.3	1.0	2.3
Catchment Protection/Water Quality	6.9	6.9	1.0	6.9

For example, in planning unit 1 the land use suitability score as generated in each resource assessment model was weighted by social preference index. Further considerations, such as activity incompatibilities within a planning unit and the presence of endangered species and fences in adjacent planning units were then analysed in terms of technical feasibility and manageability.

5. CONCLUSIONS AND POLICY IMPLICATIONS

With Triple Bottom Line outcomes expected from the management of forested landscapes in Queensland, the development of an Integrated Forest Management Framework is timely. The elements of this framework such as the Land Use Assessment Model and the CVA Model as well as the integration of outcomes of these assessments can facilitate the generation of informed land use decisions. Instead of relying on desktop exercise in allocating forest land uses, the land managers can rely on scientifically assessed resource values as well as draw on community values as indicators of social aspirations.

Land use decisions for these ecosystems require more careful consideration of irreplacibility factors and restoration costs pointing out to the conflict between present day resource utilisation and long-term conservation strategies. The transparency of the process to stakeholders and to the community may also be a step forward in eliciting support in managing forest values that contribute to environmental, economic and social outcomes. This paper discussed only some elements and conceptual issues of the IFM framework. The details of specific modules and their operation may be scope for future papers.

Although the case study at Glen Rock Regional Park presents opportunities for testing various assessment models as an aid in land use decision processes, the application of the model may not be cost-effective to inadequately resourced forest management agencies.

Where to from now?

The IFM Framework can be implemented in private lands where a substantial amount of forest resources are found and needing to be managed as part of the broader landscape. It could help private owners to not only demonstrate compliance with current legislation and Government policies but also genuinely improve land management practices.

6. ACKNOWLEDGMENTS

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