

# Appropriate Multi-Criteria Decision Support Tools for Aiding Indigenous Decision-Makers in Aurukun Shire, Cape York Peninsula

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**Abstract:** The uniqueness of the political and socio-economic environment in Aurukun Shire necessitates careful consideration of the appropriateness of various multiple criteria analysis (MCA) techniques for forest use planning, and here the literature offers little guidance. Criteria are derived from a description of the decision-making problem to assess the applicability of several MCA methods. It is found that goal programming is an appropriate MCA method to support forest-use decision-making in Aurukun Shire.

**Keywords:** MCA selection; MCA evaluation criteria; Wik people

## 1. INTRODUCTION

The Wik, Wik-Way and Kugu peoples (referred to here as the Wik people) living in Aurukun Shire, Cape York Peninsula (CYP), aspire to be economically independent and self-reliant – a vision shared by the Queensland and Federal Governments. The High Court's *Wik judgement* in 1996, confirming the existence of native title on pastoral leases on Cape York Peninsula, and the granting in October 2000 of native title over a portion of the Wik land claim, have been major steps toward fulfilment of this vision. However, Wik people remain dependant on government welfare and the Community Development Employment Program (CDEP) for income. The *Cape York Partnerships Plan* has committed the Qld. government to developing a strategy to drive a regional economy on CYP, which builds on the strengths of the region – its people, culture, history and extensive range of natural resources. Balkanu Cape York Development Corporation (Balkanu) representatives of Wik people have identified the timber resources in and adjacent to Aurukun Shire as one potential engine with which to drive the elders' vision of economic independence.

Aurukun Shire covers 735,000 ha of the western coast of CYP. The only permanent settlement in the Shire is Aurukun, with population 781 in 1996 [ABS, 2000], 89% of whom are indigenous. The Shire has large areas of tall *Eucalyptus tetradonta* (Darwin stringybark) and *Melaleuca* forests and

patches of cedar mangrove with commercial forestry potential. CYP has been identified as having the largest uncut native forest resource in Queensland, with potential to make a major contribution to future timber supplies [Wannan, 1995]. However, impediments such as remoteness from markets and perceived lack of timber resource security on pastoral leases and indigenous lands have stifled necessary investment and research into resource inventory, wood properties, silviculture and marketing. A Rural Industries Research and Development Corporation (RIRDC) postgraduate project, receiving substantial assistance from an Australian Centre for International Agricultural Research (ACIAR) project in Aurukun, is assessing the potential for establishment of ecologically sustainable forestry operations in Aurukun Shire.

In complex multiple objective resource allocation problems, MCA methods can provide valuable assistance to assess potential land management scenarios and subsequently generate relevant and easily understood information to support decision-makers. One problem faced by the analyst is the selection of an appropriate MCA technique. This paper examines the uniqueness of the decision-making environment and the multiple objective forest management problem in Aurukun Shire. Appropriate MCA evaluation criteria for Aurukun Shire are then presented, followed by a discussion of implications for suitable MCA techniques.

## 2. THE MULTI-OBJECTIVE FOREST MANAGEMENT PROBLEM IN AURUKUN SHIRE

The authors' role in Aurukun Shire is contractual in nature and Balkanu has specified that the objectives of the research are to identify size and value of the timber resource, potential processing opportunities and markets for timber products produced in the Shire. Balkanu have discouraged the researchers from involving Wik people in participatory analyses of potential forestland allocation and processing options. Within the limitations of research budget and timeframe, the economists seek to provide Wik people with information about economic consequences of several alternative forest use options, to aid traditional decision-making processes.

### 2.1 Forest Management Stakeholders in Aurukun Shire

The major forest management stakeholders are the Wik people. The 23 separate clan groups residing in Aurukun do not regard themselves as belonging to an *Aurukun community*, but rather as belonging to families, clans, regional ceremonial and political associations and other social groupings [Adams et al., 1991, cited in Leveridge and Lea, 1993]. 'The whole community is unwilling to collectively set goals, decide options, reconcile differences and to present a united front to the outside world' [Lea and Clark, 1995, p. 48].

Numerous government and private organizations also claim a stake in the management of forests in Aurukun Shire, each with their own political, economic, social and preservationist objectives. Key among these are environmental groups and the mining company, Comalco Pty Ltd. Several forest types found within Aurukun Shire are poorly represented in conservation reserves and are considered to have high fauna habitat, wilderness and old-growth forest values [Wannan, 1995]. The freshwater and estuarine wetlands of Aurukun Shire, which have tributaries in the forests, have been identified by conservation groups, such as the Wildlife Preservation Society of Queensland, as a region that may prove to be equivalent in biological diversity to Kakadu [Smyth, 1993]. The mining industry has a large stake in the future of forests in Aurukun Shire, because the tall *E. tetradonta* forests grow predominantly on deep red kandosols that contain valuable bauxite deposits. A large proportion of tall forests in Aurukun Shire are on mining tenure and are destined to be cleared as mining progresses on CYP [Wannan, 1995].

### 2.2 Forest Management Objectives and Constraints in Aurukun Shire

Wik people have identified their economic objectives of forest management as maximising the generation of income and employment for the benefit of Wik people. Social objectives, such as facilitating population decentralisation through provision of outstation work, and environmental objectives including maintenance of water quality, are other important management goals. Wik people also aim to fulfil their cultural obligations to manage forests. That is, forests must continue to provide traditional game, plant foods, tools, arts and crafts, venues for traditional ceremonies, *classrooms* to pass on indigenous knowledge, and habitat for clan totem beings.

While developing management options to achieve these objectives, the analyst must be mindful of the constraints on forest management in Aurukun Shire. Little is known about the timber resources in the Shire and non-indigenous scientific knowledge about ecological relationships between flora and fauna species and their environments is sparse over much of CYP. The Federal and Queensland governments have established frameworks for ecologically sustainable development on CYP through various planning projects [CYRAG, 1997; Commonwealth of Australia, 1998; Department of the Premier and Cabinet, 2000] that, in some cases, conflict with Wik management objectives and may constrain particular management options. There is a lack of public infrastructure on CYP, most notably roads. Limited electricity and water supply in Aurukun could also constrain forest management options, e.g. some timber processing options use large amounts of water. Establishment of an industry will be dependant upon government or private investor funds, the availability and size of which are uncertain. The availability of local labour and the relatively low non-traditional skill base in Aurukun will constrain the size and appropriate level of technology in the absence of training. The location and size of markets for outputs from a forest-based industry in Aurukun will also impose bounds on the type and size of commercially viable operations. Cultural constraints will limit the set of potential non-traditional forest management options; however, at the request of Balkanu, these constraints will be accounted for within the decision-making processes of Wik people and do not form part of the economic assessment.

### 2.3 Forest Management Opportunities in Aurukun Shire

A myriad of forest management opportunities exist in Aurukun Shire, which may or may not include

timber harvesting. Two common forest species in Aurukun Shire, *E. tetradonta* and *Erythrophleum chlorostachys* (Cooktown ironwood) are highly regarded as strong, durable, attractive timbers. The reputation of *E. chlorostachys* as a fine timber for musical instrument manufacture has created small, high-value, domestic and export markets for this species. Within a 50 km radius of Aurukun town are about 266,000 ha of high quality stands of these species, indicating the potential for small-scale portable sawmilling or larger-scale fixed-site sawmilling operations sustainably milling several thousand cubic metres of timber annually. Value-adding, for example, via floorboard or furniture manufacture, could be undertaken to maximise returns to Wik people.

Other forest management options in Aurukun Shire include seed collection for rehabilitation of local mine sites and for timber plantation establishment in Australia and abroad. Wik people may also consider the manufacture of traditional tools, weapons, arts and crafts from their forests for sale in regional souvenir markets. Forest grazing in Aurukun Shire had been marginally successful in the past, and forest-based recreation and ecotourism has potential in the region.

### 3. MCA EVALUATION CRITERIA FOR AURUKUN SHIRE

A surprisingly large number of MCA methodologies have been described in the literature [e.g. see Hwang and Yoon, 1981; RAC, 1992]. Each method has its own underlying principles, data requirements, and ways of incorporating preferences, processing data, generating solutions and presenting results, which can affect the outcome of the decision-support process. The literature offers little guidance in model selection [Bogetoft and Pruzan, 1997]. Consequently, analysts often make methodological choices based on their familiarity with techniques, rather than suitability for the decision problem. However, MCA evaluation criteria that consider the type of multiple objective problem and decision-maker characteristics are increasingly being applied to select MCA tools. An appropriate MCA method for decision-support in Aurukun must accommodate:

- resource allocation options;
- decision criteria measured in their standard (traditional) units; and
- non-participatory approaches to generation and assessment of management options.

The MCA technique must be able to determine an efficient *allocation* of the forest, labour, and capital

resources of Aurukun Shire with the aim of meeting the objectives of Wik people, subject to management constraints. This is because a well-defined set of management alternatives does not exist and creating an incomplete set of management alternatives runs the risk that potentially desirable outcomes are excluded at the outset from the decision-support process. In Aurukun for example, it is more appropriate to consider a continuous suite of forest management options between a small-scale timber harvesting operation sawing 1,500 m<sup>3</sup> per annum and a larger-scale operation sawing 50,000 m<sup>3</sup> per annum, rather than assuming that a small and larger-scale operation are two alternatives in a finite set. Proceeding on the false assumption that a well-defined set of management alternatives exists is a shortcoming of many MCA studies [RAC, 1992].

The MCA technique must produce outcomes that Wik people can easily understand. Measurement of decision criteria in or transformation of standard units of measurement into non-standard units is unlikely to facilitate this. For example, evaluation of environmental criteria in dollar terms or transformation of all criteria via a scale transformation technique into a common unit of measurement would produce meaningless results for Wik people.

For several reasons, non-participatory approaches are preferred over participatory approaches to decision-support in Aurukun Shire. Firstly, poor literacy may mean that many Wik people have difficulty comprehending what is required of them in formal participatory MCA approaches. Secondly, Carter [2000] has expressed doubts about the usefulness of any information collected from Wik people through short-term participatory procedures. She asserted that Wik people would answer questions with responses they believed the researcher wanted to hear - a phenomenon called *gratuitous occurrence*. Thirdly, organising successful community participation in Aurukun to contribute to a decision-support process would require detailed knowledge of the community's internal governance structure to avoid the risk of further disadvantaging particular elements of society, such as less influential clans and women. Clifford [2001] reported that for Australian indigenous communities generally, appropriate and representative community consultation processes can only be developed following an ethnographic study over a considerable length of time. Fourthly, elicitation of information from Wik people through workshops would most likely be unsuccessful in Aurukun today, just as they were during the 1980s and 1990s under the banner of community development planning (CDP). Lea [1996, pp. 4-5] asserted that the CDP approach:

'presupposes a set of people... with a vision of a desired future; a clear idea of what development – and particularly community development – is; and a concept of planning that does not reduce planning to plan writing, but includes implementation, management, learning, monitoring and evaluation of an interlocking set of actions or projects. In Aurukun and, we suspect, many other Aboriginal communities these preconditions do not exist yet'.

Fifthly, Wik people have expressed a preference not to be involved in multi-stakeholder workshops. In the past, Wik people and their representatives have had unfavourable dealings with some government organisations that would be obvious inclusions in multi-stakeholder consultations. Wik people feel they will be disadvantaged in such a forum where other stakeholders have more detailed knowledge, and have greater capacity to articulate their particular preferences and concerns about forest management options than Wik people. Another concern with multi-stakeholder workshops is subsequent ownership of information:

'governments must accept that Aurukun people are very worried about the threat that public ownership of resource information poses to their efforts to preserve their cultural integrity and protect their land for their children...we feel that public ownership and access to information relating to our land will only serve to increase pressure on us to permit development of these resources or allow greater access to them' [Aurukun Community Inc. and the Cape York Land Council, 1992, p. 14].

#### 4. IMPLICATIONS OF MCA EVALUATION CRITERIA: MODM OR MADM TECHNIQUES FOR AURUKUN SHIRE?

The three MCA criteria have been used to limit the set of suitable MCA approaches for analysts aiding decision-making in Aurukun Shire. For the purposes of the following discussion, it is convenient to classify MCA techniques as either multiple objective decision models (MODM) or multiple attribute decision models (MADM)<sup>1</sup>. The main difference between the two is that the former can aid analysts to design management options from a continuous decision space subject to particular targets and constraints, while the latter

<sup>1</sup> 'DM' in MODM and MADM is sometimes interpreted as 'decision-making', but in practice these techniques are limited to decision support.

assist analysts to select (evaluate) management alternatives from a discrete decision space of predetermined alternatives. Emphasis has been placed on this simple classification because there is wider agreement among practitioners about the general advantages and disadvantages that MODM and MADM bring to a decision-support problem, than about the specific pros and cons of particular types of MODM and MADM.

MODM generally require: a) development of a model of the problem (requiring knowledge of management variables and the relationships between them); b) specification of management objective(s); c) assignment of preference weights for each objective; and d) generation of management options. Examples include linear programming (LP), goal programming (GP), lexicographic vectormax, the generating method and simulation models such as simulated annealing. MADM usually consist of: a) specification of management alternatives; b) specification of decision criteria to measure the relative benefits or disbenefits of each management alternative; c) scoring of alternatives according to the decision criteria; d) assigning preference weights to decision criteria to describe the relative importance of each criterion; and e) evaluating the alternatives. Examples include maximin, simple additive weighting (SAW), compromise programming (CP), ELECTRE, TOPSIS and MODSS (the Yakowitz method; see Yakowitz et al. 1993).

#### 4.1 Criterion 1: Accommodates Resource Allocation Problems

Efficient employment of MADM requires a complete set of predefined management alternatives. In general, MADM are most attractive when the set of management alternatives is small and easily represented [Bogetoft and Pruzan, 1997]. The set of potential culturally, ecologically and economically sustainable woodland management options for Aurukun Shire is neither small nor easily represented. On the other hand, MODM are well-suited to resource allocation (management option generation) problems [Hwang and Yoon, 1981; Mardle and Pascoe, 1999], because they can identify Pareto efficient outcomes, and provide an intellectual framework that permits a greater understanding of the proposed alternatives.

A limitation of the scoring approach of MADM is that if each option has been scored assuming it would be implemented on its own, it is only methodologically sound to compare alternatives (mutually exclusive options) that serve roughly the same purpose. For example, if an alternative is to

have several smaller projects rather than one large one, then the alternative 'several smaller projects' should be scored. Summing the scores of the individual small projects is unlikely to be equivalent to the combined effect of 'several smaller projects' [Eisner et al., 2000]; decision matrices of MADM must be re-scored. Conversely, by having modelled the resource allocation problem, MODM avoids the need to re-investigate the decision matrices of the problem.

#### **4.2 Criterion 2: Decision Criteria Measured in Standard Units**

The implication of using standard units of measurement for decision criteria is that the MCA method adopted in Aurukun must be able to incorporate non-commensurate criteria (*i.e.* criteria measured in different units of measurement). Therefore, total economic value approaches to MCA, whereby all decision criteria (*i.e.* cultural, ecological and economic) are measured in dollars, are unsuitable. Equally, MADM such as CP, SAW utility function methods, MODSS and TOPSIS are inappropriate as they employ scale transformations that are likely to be confusing for Wik people.

#### **4.3 Criterion 3: Non-Participatory Approaches to Generation and Assessment of Management Options**

Many MCA methods, and MADM in particular [Bogetoft and Pruzan, 1997], are designed to utilise participatory procedures such as workshops and surveys, to aid generation of management alternatives and elicit stakeholder preferences. MODM may be preferable to MADM where stakeholders do not wish to be involved in participatory approaches [Romero, 1991]. This is because MODM approaches place more emphasis on representation of the multiple objective problem in the model, than on decision-maker preferences, which is more the focus of MADM [Ignizio and Cavalier, 1994]. Also, because MODM can generate management options, Wik people would not be required to participate in developing alternative management options.

### **5. AN APPROPRIATE MODM FOR AURUKUN SHIRE**

In general, MODM appear to be better suited to the type of problem and decision-making environment of Aurukun Shire than MADM. All MCA methods benefit from participation of stakeholders in the decision-support process; however, MODM can contribute more to decision-making than MADM when this is not possible. However, there is less agreement in the literature about the advantages

and disadvantages of employing particular MODM techniques in particular situations.

Among the more common MODM, GP has stood out as a feasible technique in Aurukun. The intention is to develop a sound model of the forest management problem and generate a range of management options with this technique by varying the importance weights attributed to each management objective. Casual conversation with Wik people, their representatives and other stakeholders has already highlighted multiple objectives. It is envisaged that participation of Wik people in GP will not occur until a set of management options are produced, where each option's achievement of the various objectives is measured in standard units. Wik people can then assess these options by a means preferable to them. Possibly, they will provide feedback about preferred options, which the GP could be used to explore further.

For this type of decision problem, GP appears to have advantages over other common MODM. An advantage over LP is that each goal is individually represented in the model and thus decision-makers can deal with an array of performance measures rather than a single proxy measure. This is likely to make the output of GP more easily understood than LP by Wik people in their multiple objective environment. In addition, with GP it is possible to specify which goals are unattainable and identify how closely they can be approached. This assists analysts to work independently of stakeholders, thus limiting the need for participation of Wik people. A common criticism of GP is the need to set aspiration (target) levels for objectives (goals). However, with knowledge about the multiple objective problem, analysts can set appropriate and realistic aspiration levels or, alternatively, targets can be set objectively, for example, to their maximum values by solving a series of LPs.

GP is perhaps more appropriate than the lexicographic vectormax MODM in Aurukun Shire, because the latter technique often ignores objectives below the first or second priority level. There does not appear to be any benefit in adopting the generating method over GP because, by altering the objective function (as proposed above), GP can be used to support decision-making in the exactly the same manner.

### **6. CONCLUSION**

Wik people in Aurukun Shire, CYP, are in the process of making decisions about the future management of their forests in an environment of multiple stakeholders, multiple management

objectives and constraints, and multiple management options. Appropriate MCA techniques for analysts supporting the decision-making of Wik people must accommodate: resource allocation problems; criteria measured in standard units; and non-participatory approaches to generation and assessment of management options. This appears to discriminate against the employment of many popular MCA techniques in Aurukun Shire, in particular, MADM. In general, MODM and particularly GP, are well-suited to assisting analysts aiding the decision-making of Wik people in Aurukun Shire.

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