6 Addressing Socioeconomic Objectives

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ABSTRACT

It is good practice to include explicit socioeconomic considerations into conservation planning. These should be defined clearly and transparently so that all participants understand what information will be included in the analysis. It is possible to develop cost surrogates to represent the cost of conservation when spatially explicit data are not available or are not available at an appropriate resolution. Socioeconomic goals are usually represented as costs (a factor to be minimised) but may also be represented as features (a factor to be targeted). It is also possible to use other Marxan parameters, such as the BLM to achieve socioeconomic objectives. Marxan only considers one cost at a time. Therefore, if multiple socioeconomic costs are present, they must either be treated individually or combined into a single overall cost index. If socioeconomic costs are all measured in the same units and have the same value to stakeholders, they can be combined additively. Often, however, costs are represented in different units, and thus it is not straightforward to combine them. Marxan results are influenced by socioeconomic objectives and their incorporation may be critical in achieving stakeholder support for a network of protected areas.

6.1 INTRODUCTION

The establishment of conservation areas is often a conflict between biodiversity conservation and other socioeconomic objectives. In this chapter, we suggest several ways to address multiple socioeconomic objectives in reserve network design using Marxan. First, we recommend that the costs of conservation (e.g., opportunity cost, management cost, acquisition cost) be minimised given certain biodiversity conservation objectives. Second, we suggest ways that areas of social and cultural importance can be targeted for inclusion in a network of conservation areas. Finally, we provide advice on how to use the boundary length modifier (BLM) to achieve certain socio-economic objective. We believe that careful consideration of socioeconomic objectives is good practice.

Socioeconomic objectives are often not included in reserve network design for a variety of reasons:
• It is difficult to translate qualitative socioeconomic goals and objectives into quantitative, spatial data that can be used in Marxan.

• It can be challenging for stakeholders to communicate their needs to planners and for planners to account for the needs of different stakeholders.

• Incorporating socioeconomic goals requires transparency, and knowledge of the broad goals for the project from the outset.

• Planners who are trained as ecologists or spatial scientists may lack the expertise to process socioeconomic data.

However, we believe the benefits of using socioeconomic data outweigh the challenges:

• Consideration of socioeconomic goals can reduce the overall cost and impact of conservation areas.

• Including socioeconomic goals can increase stakeholder trust and acceptance.

In an effective plan, both planners and stakeholders will work together to translate aspirational socioeconomic goals into quantitative measures that can be included into Marxan. This is often an iterative process. Although development of socioeconomic data and objectives can be time consuming, inclusion of this information at the outset results in solutions that are more efficient and more acceptable to stakeholders, than solutions considering socioeconomic cost post-hoc.

### 6.2 Defining Socioeconomic Objectives

It is critical to define socioeconomic objectives clearly so that all participants understand what information will be included in the analysis. Early education about what Marxan does and how it uses data may be appropriate so stakeholders know what type of data can be included. Socioeconomic objectives will largely reflect the project’s mandate and/or the aspirations of the stakeholders. Therefore, it is important for planners to have a clear idea of the goals of a conservation planning exercise and who the relevant stakeholders are. Again, defining these objectives may be an iterative process. Objectives may change as project goals evolve or as stakeholders are added. While initial stakeholder goals may be aspirational, it is important to emphasise that these objectives must be translated into spatial, quantitative data to be used in Marxan. Socioeconomic objectives that do not meet these requirements are still important, but cannot be included in a Marxan analysis.
Box 6.1: Incorporating socioeconomic information into Marxan

Any socioeconomic goal that can be represented quantitatively and spatially can be included in Marxan. Socioeconomic information can be captured in Marxan through the cost, target, and BLM parameters. Typically, socioeconomic information is factored in through a cost (see Box 6.4). Marxan aims to minimise the cost of a system of planning units, subject to the constraint that biodiversity targets are achieved (see below). If the values of a user group (e.g., fishermen) can be quantified across a planning region, then Marxan can produce solutions that minimise negative socioeconomic impact.

6.3 DATA ISSUES

One of the largest obstacles to using socioeconomic data is the real or perceived difficulty of obtaining it. As mentioned before, data must be spatial and quantitative to be used in Marxan. Data quality is always an issue to consider. Ascertaining data quality can be difficult with socioeconomic data because of constraints on data collection, i.e., to protect confidentiality. OceanMap, developed by Ecotrust (http://www.ecotrust.org/mlpa/index.html), is being used to collate socioeconomic data for the California Marine Life Protection Act and is a good example of a tool to collect, manage, and analyse sensitive data transparently while maintaining stakeholder confidentiality.

Credible spatially explicit data across a study region may not be available at all or at an appropriate resolution. Just as biodiversity surrogates are used to represent biodiversity, it is possible to develop cost surrogates to represent the cost of conservation. For example, the distance from fishing ports or accessibility points (Clark 2007) could be a surrogate for fishing effort in some marine regions. In terrestrial systems, topographic slope may indicate areas that are not suitable for logging, even if no timber volume data...
are available (Cameron et al. 2008). The applicability of using surrogates is dependent upon the predictability of activities within the study region, required scale / detail, the quality of the surrogate data, and the sophistication of the surrogate model. Richardson (2005) showed that the incorporation of fine-resolution commercial fishing information in marine-reserve design substantially reduces the economic losses incurred by fisherman, compared with reserves designed based on coarse-resolution data. It is also possible to combine surrogates to improve coverage. As with any scientific study, it is advised to have explicit collection and analysis protocols agreed on by all participants.

**Box 6.2: Recommendations for incorporating socioeconomic information into Marxan**

By Dave Nicolson, Black Coffee Consulting; and Jeff Ardron, PacMARA

Recommended practices for socioeconomic data incorporation include:

- Collecting or collating human use data is highly recommended and can help start to build bridges to user communities.

- Using human use data in zoning options (Marxan with Zones) was more desirable than using these data to create a single cost layer for use in Marxan, especially if there is more than one human use.

- Designing scenarios with more than one human use zone, which can sort out conflicting uses, is theoretically preferable to a single zone, but these advantages of spatial efficiency have to be weighed against the additional effort, and possible confusion arising when communicating the outputs to users.

- In many cases, for reasons of communication and creating familiarity with Marxan/Marxan with Zones, starting with a simpler zoning scheme may be preferable to a more complicated one, even if the latter is ultimately more realistic.

- Communicating outputs, soliciting feedback, and further building relationships with users is as important in the planning process as the Marxan outputs themselves.

### 6.4 LINKING WITH MARXAN PARAMETERS

#### 6.4.1 Incorporating socioeconomic objectives into the objective function

If socioeconomic goals cannot be translated into spatial, qualitative data they cannot be used in Marxan. However, these data are still important, and should be considered for inclusion at a different place in the planning process. Generally, socioeconomic goals in Marxan are set using the “cost” function. Socioeconomic goals are typically stated as costs to be minimised. For example, the cost function could be used to minimise the cost of land, fishing effort, cost of stewardship agreements, cost of enforcement, or cost of management. There are other ways to include socioeconomic goals in Marxan. Ecosystem services, recreation values and other “positive” socioeconomic objectives can be included as “Features” in Marxan. Necessarily there is a trade off between the budget
and time available for a conservation planning project and money and the number of socioeconomic goals that can be included. Also, as the number of socioeconomic goals increase, balancing them becomes more difficult and the problem itself becomes harder to solve.

It is also possible to incorporate some types of socioeconomic information by targeting areas of social importance. For example, it may be important to include all or a fraction of the cultural sites in a system of protected areas. To do this, the cultural sites would be considered an additional conservation feature and each would have a target amount to be included in each solution. If these socially important areas are essential it is possible to lock them in a priori. For example, sacred sites (“taboo areas”) in New Guinea were included as must-have areas and were used to initialise Marxan (Cameron et al. 2008).

The boundary length modifier can be used to incorporate other types of socioeconomic information. One aim of the stakeholders involved in marine protected area design along the central coast of California was to identify marine protected areas that were adjacent to terrestrial land parks and other “eyes on the water” to facilitate enforcement and monitoring of the marine protected areas (Klein et al. 2008). One way of doing this is to implement a zero boundary length between planning units adjacent to terrestrial land parks and run Marxan with the BLM function. In doing this, Marxan will preferentially identify marine protected areas that are adjacent to the land parks, to reduce the boundary length cost. In conclusion, if credible spatially explicit socioeconomic data are available across a study region, there are multiple ways that it can be incorporated into designing a system of protected areas with Marxan (see Box 6.4).

### 6.4.2 Addressing multiple socioeconomic goals

Marxan only considers one cost at a time. Therefore, if multiple socioeconomic costs are present, they must either be treated individually or combined into a single overall cost index. If socioeconomic costs are all measured in the same units and have the same value to stakeholders, they can be combined additively. Often, however, costs are represented in different units, and thus it is not straightforward to combine them. In that case, it is often necessary to assign weights to each cost before adding them (Sarkar et al. 2006). This process often requires extensive stakeholder engagement (see Chapter 10: *Using Marxan in Multi-Stakeholder Planning Processes*) to assign weights in order to combine them. If costs are not in the same units (e.g., timber volume, agricultural potential, and distance to roads) they must first be standardised into the same units before weights can be appropriately applied. Implications of combining multiple costs should be carefully considered before aggregating them. The weighting process provides a way for stakeholders to participate in explicit goal setting and to visualise tradeoffs. Marxan results may be particularly sensitive to cost weightings, so a thorough sensitivity analysis of this process is recommended. Ideally decision-makers are presented with a variety of Marxan selection frequency maps derived using weightings that emphasise different costs.
Employing a scoring system (i.e., 1-10 for all costs) to combine costs is a quick, but not always very effective or transparent process (Bedward et al. 1991). See Chapter 5: Reserve Design Considerations for an example of combining costs with a cost index. Combining multiple costs requires transparency and iterative stakeholder engagement, to avoid the process being seen as a “black box”. If in doubt, it is best to use each cost individually in a series of Marxan analyses and to then present maps of individual results for each cost. Presenting individual results is often a useful step for stakeholders to visualise how the datasets and goals affect the solution.

6.5 Evaluating Results/Indicators of Performance

Marxan results are dependent upon subjective choices about socioeconomic objectives. Which costs are included and what weightings are used strongly affect the outcome. We recommend thorough documentation of the rationale behind all decisions regarding the socioeconomic analysis, for review by all participants. This ensures that the analysis is transparent and repeatable. Many of the evaluation steps recommended in Chapter 9: Interpreting and Communicating Outputs are relevant for socioeconomic data to ensure a rigorous, defensible analysis.
Box 6.3: Defining conservation “costs” in Marxan

Conservation costs are often considered secondary to biological factors in the designs of protected areas (Scholz et al. 2004), and tend to be analysed post hoc for areas selected based only on biophysical data (Stewart and Possingham 2005). Implicit in Marxan is a cost minimisation objective (see Chapter 1: Introduction) that allows users to consider costs a priori. We review three different definitions of “cost” that have been implemented in Marxan to identify a system of priority areas.

Cost equals area

Many conservation planning assessments define the cost as the area of the planning to identify areas that represent biodiversity targets within the smallest possible area of land or sea. In this case, the spatial variation in the cost of different conservation actions is ignored and may not lead to the identification of the most cost-effective areas for investment (Stewart and Possingham 2005, Carwardine et al. 2006, Klein et al. 2008).

Cost equals foregone fishing effort

The establishment of marine protected areas is often viewed as a conflict between conservation and fishing. In order to minimise this conflict, Marxan can be utilised to identify protected areas that minimise the impact of marine protected areas on fishermen, while achieving biodiversity conservation goals. For example, Stewart and Possingham (2005) used effort data for the commercial rock lobster fishery to reduce foregone fishing effort in a system of marine reserves in South Australia. Similarly, Klein et al. (2008) compiled effort data on 24 commercial and recreational fisheries to minimise the impact of marine protected areas on fishermen in central California.

Cost equals cost of conservation action (e.g., acquisition and stewardship)

In Australia, there are two conservation actions, acquisition and stewardship, under consideration by the national government to protect biodiversity. Carwardine et al. (2006) prioritised areas to meet biodiversity targets whilst minimising the costs of two alternative conservation actions: land acquisition and stewardship. Unimproved land value data was used to represent acquisition costs and agricultural profitability data was used to estimate the opportunity costs of landowners entering into stewardship agreements. This study found remarkable gains in financial efficiency when employing spatially variable data that reflects the cost of the planned conservation action.

A key element for successful achievement of socioeconomic objectives is to approach it as an iterative process. It may be necessary to present results to stakeholders multiple times for refinement of objectives and weights (see Chapter 9: Interpreting and Communicating Outputs and Chapter 10: Using Marxan in Multi-Stakeholder Planning Processes). Stakeholders like to know where their input data are reflected in the outcome and how the solution affects them in terms of costs and benefits. Presenting solutions for different scenarios will help stakeholders visualise and understand the Marxan process.
It is possible to summarise results generated with and without costs included to evaluate tradeoffs and performance (i.e., difference in total cost, targets achieved, total area, total boundary length).

It is important to realise that, despite the complexities of including socioeconomic costs in a Marxan analysis, ignoring costs is generally unwise. The Great Barrier Reef Marine Park Authority spent more than a year running analyses with cost equal to area and found that Marxan was particularly indecisive – providing selection frequency maps that gave little advice to decision-makers. It was only after socioeconomic costs were included that Marxan started to produce useful results. The temptation to create cost-free “pure” ecological results should be avoided in practical applications. Assuming cost equals area is seldom valid, and otherwise can be misleading.

6.6 Research and Development Priorities

To date, there are relatively few studies that incorporate socioeconomic data in the literature. Building this literature will aid planners in selecting appropriate measures to include in their analyses. Developing links between Marxan and existing socioeconomic tools (i.e., multi-criteria decision analysis, MCDA) will likely increase use of socioeconomic data in conservation planning. Resnet, a decision support tool with similar objectives to Marxan, incorporates MCDA into its analysis (Sarkar et al. 2004).

A second area of research and development involves dynamic consideration of time and space. Socioeconomic objectives and priorities change over time and it is possible, though not trivial, to include these types of data into Marxan (Wilson et al. 2006). Further research is needed to link socioeconomic objectives with future growth scenarios and other future projections. Consideration of uncertainty in socioeconomic data is another area for research.

Marxan with zones was introduced recently and allows the user to specify multiple zonings. Thus, some socio-economic uses, for example fishing or logging, could be incorporated as zones each with specified targets. This would allow for the full power of the simulated annealing algorithm to find efficient spatial solutions subject to various competing uses. To do so, however, will require spatial data of comparable resolution to the environmental, species, and habitat layers. Shifting costs to zones could relieve a lot of the difficulty in balancing various costs in the single Marxan cost function. Nonetheless, some socioeconomic costs, such as acquisition costs, management costs and so forth, will remain and would still be a part of the cost function.