THE PROBLEMS ASSOCIATED WITH LAND USE PLANNING WITHIN THE MURRAY CATCHMENT IN WESTERN AUSTRALIA

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ABSTRACT

A quadratic programming model has been adapted to investigate optimum land use plans for a catchment in Western Australia. The model, the approach, the problems and the possible benefits from the study are discussed.

INTRODUCTION

Timber, water, recreation or mining? Which of these or several other uses should take priority? What forms of land use are best in the short and long term interests of this State?

In the northern jarrah forest in Western Australia, competing land uses are vying for preference. In view of the value of this resource to the community, and its proximity to the State's capital and main centre of population, a considerable number of people will eventually be affected by land use decisions made here.

The resources of the area provide both wood and agricultural products, minerals (bauxite, gravel and blue metal) and various recreational and conservational values. Of paramount importance is its use as a catchment for domestic and industrial water supply and for irrigation. The bulk is held as dedicated State Forest and managed by the Forests Department of Western Australia. However, resource utilisation involves other Government departments, private companies and the individual landowners.

The Murray is the largest and the last undammed stream in the region. The catchment is located some 100 km to the south of Perth, has an area of 708,400 ha and extends eastwards well into the Agricultural belt. Precipitation varies from 500 to 1,300 mm per annum. Some 45 percent of the catchment has already been cleared, causing severe salinity problems (the present average is 1,200 p.p.m. total dissolved salts). It is likely that this stream will be used for metro-

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politan water supplies by the late 1980's (3), and this would drastically affect the current recreational and conservational values of the main valley.

Within the catchment are some of the finest pole stands of jarrah as well as some high quality bauxite deposits. For these reasons, the catchment of the Murray river was chosen as a study area for the development of catchment land use models.

THE STUDY TEAM

The team comprises members from CSIRO's Division of Building Research and Land Resources Management, the University of W.A., the Department of Agriculture and the Forests Department. Members of other Government Departments and private companies have assisted as advisers in their specialist fields. Public opinion on some aspects of the study has been obtained through surveys and questionnaires. Three bus tours of groups ranging from scientific personnel to members of the public have been arranged within the catchment.

THE MODEL

A quadratic programming model, namely an Urban Planning model developed by Brotchie and others, has been adapted to produce optimal land use plans for this catchment. This model allocates activities to zones in an optimal fashion, through an extended linear programming algorithm (1,2,4).

Land use activities considered include indigenous and plantation forestry (eucalypt or pine), agriculture (beef, orchards or mixed farming), bauxite mining (followed by production or protection forestry or agriculture), National Parks, Flora and Fauna Reserves and water storage. The benefits evaluated include the primary products (timber, fibre, bauxite, etc.), water and conservation values. These benefits will be calculated for each of 53 "homogeneous" zones (defined primarily by landform, rainfall and degree of clearing).

The landform approach is based on the position and shape of the landscape units. These, in turn, reflect the distribution of soils and of vegetation. Although a single landform may contain several soil and vegetation types, it is still suitable for broad-scale classification. Rainfall was selected because of its influence on land use and on productivity. Existing land use and an indication of flexibility is provided by the degree of clearing which has already occurred.

Not all of the benefits and costs have been evaluated to date. A suitable data base for some others (recreation, employment, sediment load, etc.) is currently being investigated.

The model optimises land uses subject to various constraints (that a dam is or is not constructed, that viable areas are reserved for conservation purposes, that

stream salinity is held below specified levels, that mining is held to the capacity of the processing plant, etc.). In the output, the preferred land use activities are listed for each of the zones.

THE OUTPUT

To date, the outputs explored have been obtained solely from the 15 zones which comprise the westernmost (and heavily forested) part of the catchment. This includes the first area to be mapped into landforms (McArthur and Churchward, pers. comm.); the other 38 zones have now been delineated and are being measured for area.

The water yield from the Western portion of the catchment is considerable and the yield of salt is low. Its role, on a total catchment basis, is to dilute the highly saline, low volume flows from the largely cleared upper reaches. Because of this, the data cannot be taken as being representative for the whole catchment.

Preliminary runs have explored these five solutions.

1. Land use constrained to existing uses.
2. With dam, without flora and fauna reserve.
3. With dam, with 5410 ha of flora and fauna reserve (in a total of 77,560 ha).
4. Without dam, without flora and fauna reserve.
5. Without dam, with flora and fauna reserve.

Some of the findings to date are:

* The financial returns from bauxite mining and from water dwarf those from all other forms of land use.

* The model is sensitive to a small change in the price of water (from 2 to 3c. m^{-3}), and reallocates land uses to those favouring increased runoff. These land use practices tend to increase stream salinity. When the costs of increased salinity are accounted for, the increased runoff could be more than offset by the loss in water quality. (As a comparison, 2c.m^{-3} approximates current pipehead values for Perth water and the cost of desalinating sea water with fuel at \$46 $tonne^{-1}$ is estimated as 34c.m^{-3}.)

* The opportunity cost for the flora and fauna reserve is at least \$4,500,000 (discounted cash flow over 160 years) or about 2 percent of the Total Merit Value from the land use activities. The opportunity cost is about 10 times the estimated discounted cost of managing the reserve.

THE PROBLEMS

One of the greatest drawbacks so far has been the formulation of an appropriate economic philosophy. Some of the problems encountered are:

* Different land use activities have different levels of infrastructure. This makes it difficult to find a common basis.

* Land transactions are, in essence, transfers of resources and so have not been considered. Some (especially resumptions) have both real and social costs, which should not be ignored).

* It would seem logical to consider all projects over a similar time horizon. That for the jarrah forest is about 160 years. If one looks back 160 years one is beyond the period of white settlement in the Swan River Colony. Who dares to forecast the future for that span of time? However, the model is capable of planning land uses over a number of time steps. We aim to make use of this facility but have not started work on it as yet.

* Other, more pragmatic problems (inflation and discount rates, option value, opportunity cost, consumer surplus, recreational value of a visitor day, etc.) are common.

* Is optimisation a real life solution, or should we seek a different goal (diversity, flexibility, resilience)?

As expected, a number of inadequacies in the data base soon became obvious.

* Physical parameters for water and salt yield need to be estimated for 12 land uses over 53 zones, but there are only 13 gauging stations in the whole catchment. Most of the gauged catchments include a combination of landforms and of land use practices.

* Estimating biological input/outputs is difficult in those areas outside current experience where no trials have been performed, or where experimental work is in the very early stages of development. In contrast, other aspects (e.g. silviculture, fire, production agriculture) have been researched to considerable depth.

* Even if data were available, there is the problem of extrapolation from the micro to the macroscale.

The next class could perhaps be described as the human element.

* The "bias" of the study team. No member is going to let HIS profession suffer - at least not without a fight!

* The poor cooperation from organisations and individuals who already have full works programmes and are uncertain about the ultimate implications of the study.

* Since the limitations of the data base have not been covered up, some of the private organisations which could be affected by the findings have already expressed their refusal to be influenced by them. Yet their own decisions are obviously taken on even flimsier evidence and lack of environmental considerations.

* There is also the dissatisfaction of the scientist at the "uncontrolled" nature of the experiment and the inadequate data base. Yet while scientists remain silent, important decisions affecting social welfare may be made.....

* The "acceptability" of the results to the Government, the public and the people employed in the catchment (farmers, miners, forestry and mill workers) remains an unknown. It seems obvious that the opportunity to make informed comment on the study should be given to all these groups.

Fourthly, there are the problems of scale and of boundaries.

* A dam on the Murray river would cut off the last and the major stream which feeds into the Peel Inlet (an important coastal tourist facility). What is the likely environmental impact of such a proposal? Can the effects on Peel Inlet be ignored in a study of this kind?

* The conservation, water, bauxite, timber and agricultural benefits are not exclusive to this catchment. The study is obviously dependent on the availability of these products in other catchments, or perhaps even other States. No catchment is an island ..... where does a study such as this end?

THE BENEFITS

After discussing all the problems, one may wonder if there are really ANY benefits from the study. Perhaps these could include:

* The mutual exchange of data, of philosophies and of techniques between the individuals and the organisations.

* The cooperation between the various bodies with a vested interest in the area does not ensure, but may lead to, reasonable compromise rather than to direct confrontation between the various parties.

* By changing the weightings used, the views of different parties can be represented. Conflicts can then be explored by sensitivity tests.

* We do not claim that the model provides an "infallible" solution, but rather a means of examining the consequences of a particular decision or assumption. Used in this role, it can be a most useful tool.

* The redirection of research emphasis and of staff into more "fruitful" avenues.

* The airing of "new" concepts - such as agroforestry (low density forestry to stabilise salt outflow from farmland).

* The ability to write "learned" papers and to attend interstate conferences.

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