Resource allocation and optimisation modelling using economic accounting principles: a tool for river basin planning

R K Walton*, Dr T R E Chidley** and P H von Lany***

* Economist, 100 Coronel Diaz 1777, Buenos Aires, Argentina;
** Resources Modeller, 7 The Green, Chipping Camden GL55 6DL, UK;
***Halcrow Group Ltd, Burderop Park, Swindon SN4 0QD, UK

Introduction

Resource allocation and development

River basin planning involves equitable and sustainable allocation of resources to meet social, economic and environmental objectives, recognising:

- growth in urban and rural population
- land suitable for agriculture
- availability of water
- interdependencies between different economic sectors
- national and international transboundary issues.

Model construction

The model is built as a number of linked worksheets (Figures 2 & 3). The main worksheet represents the agricultural sector. Inputs, outputs and constraints are represented for individual planning zones.

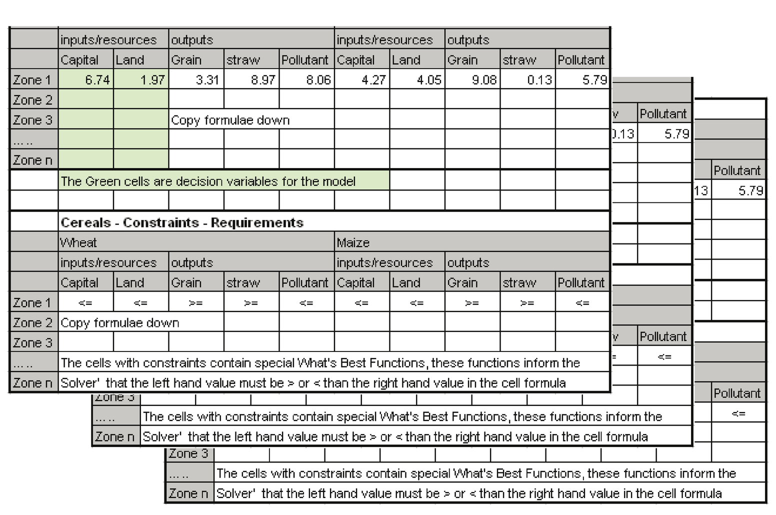

Figure 2 - Example of RAOM spreadsheet

Input information is imported from a database, structured to facilitate transfer of data to the model. Auxiliary worksheets contain data on scenarios and assumptions.

Resource optimisation and allocation modelling helps planners to explore allocations of water, land and other resources for different scenarios. Since econometric models are rarely available for river basins, we describe, in this poster, an alternative approach: Resource Allocation and Optimisation Modelling (RAOM) using economic accounting principles.

Conceptual structure of an economic-RAOM

An economic-RAOM allocates resources to optimise economic value gained, subject to meeting requirements and satisfying constraints:

- production requirements
  eg. production of a commodity + (imports – exports) = (rural + urban) consumption
- resource constraints
  eg. resources used in production ⩽ available resources.

Worksheet	Description
baseline data	This worksheet contains baseline data imported from the ERAOM ACCESS database (containing information on GVP etc.)
Summary Worksheets	4 Worksheets summarise key components: Transport, Labour, Land Use, Production
ValueOptimization	Results of optimizations
Driving variables	This is one of the most important Worksheets of the model. It contains information about each planning zone and each time period concerning population, economic changes and/or decisions made on land use change. In particular rates of change of land use are explored under different scenarios
Inter-zonal Transport	7 worksheets model Inter-zonal Transport of Commodities to meet demands summarises for each time period the interzonal and external import and export requirements
Production-Optimization	6 worksheets, one for each time period, set out the production required to meet the needs of the driving forces,mainly due to population changes and changes in consumption patterns

Figure 3 - RAOM worksheets

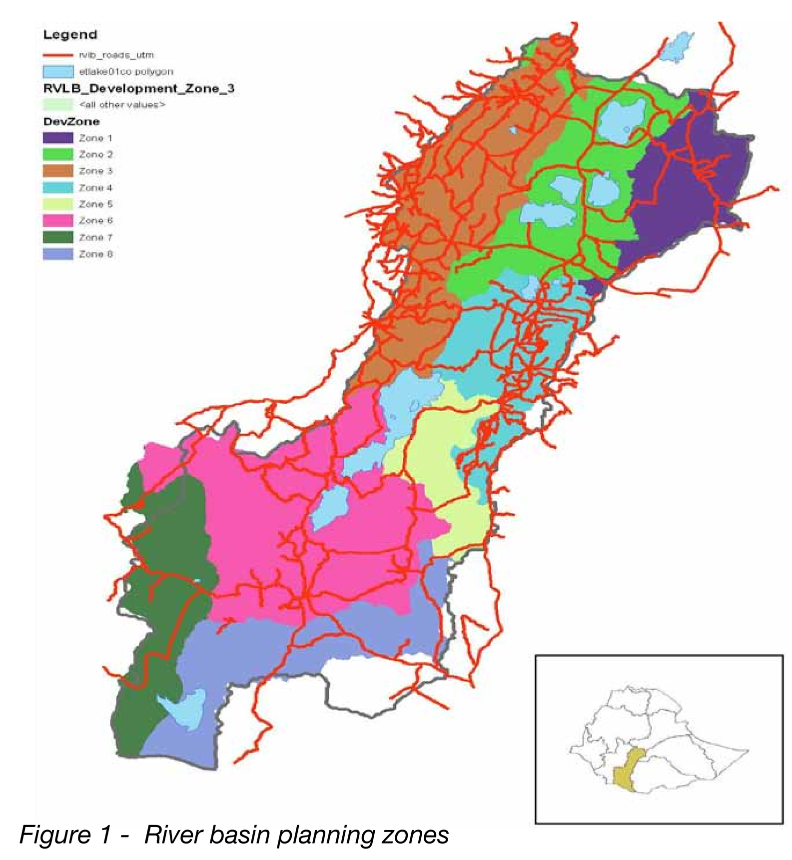

Figure 1 - River basin planning zones

Economic accounting principles

Economic accounting uses internationally accepted measures such as Gross Value of Production (GVP) and Gross Domestic Product (GDP), which can be applied at a basin, regional or national scale.

Figure1 shows the Rift Valley Lakes Basin in Ethiopia, divided into planning zones. An economic-RAOM was used in preparing a Master Plan for the sustainable development of the basin over the next 30 years. This poster describes the main elements of a generic decision tool that can be applied to any river basin(s). Data used includes inventories of land, water and manpower available for economic activity. Currently utilized resources allow estimates to be made of inputs to and outputs from different economic activities.

Longer term planning and economic growth

Long term demand for, say, food, is based on per capita dietary requirements and income elasticity of demand for different foods. As expenditure on foodstuffs increases with per capita GDP, so does expenditure on food processing, packing, distribution and marketing. This expenditure accrues to the industry and service sectors, one of many drivers of economic growth.

Estimating future demand requires an estimate of population growth. Demographic projections are often out of date. Geographic Information System and Remote Sensing data can assist in estimating present population. The economic-RAOM can estimate the rural labour required to meet the demand for different commodities. National economic scenarios can be used to allocate growth in food services to other sectors and predict the labour requirements required to mobilise this growth. The distribution of labour, in terms of the rural-urban split and between sectors, can then be compared with population projections to see if an economically feasible model can be constructed.

A transport model can be added to model intra-zonal trade within the basin and inter-basin trade with the rest of the economy.

Results and discussion

- Basin-wide allocation of water, land and human resources best able to support development objectives
- Incorporating reliable resource limits helps develop sustainable solutions
- Trade-offs are resolved between competing water (and other) resource use
- Testing different development scenarios helps identify robust development options.

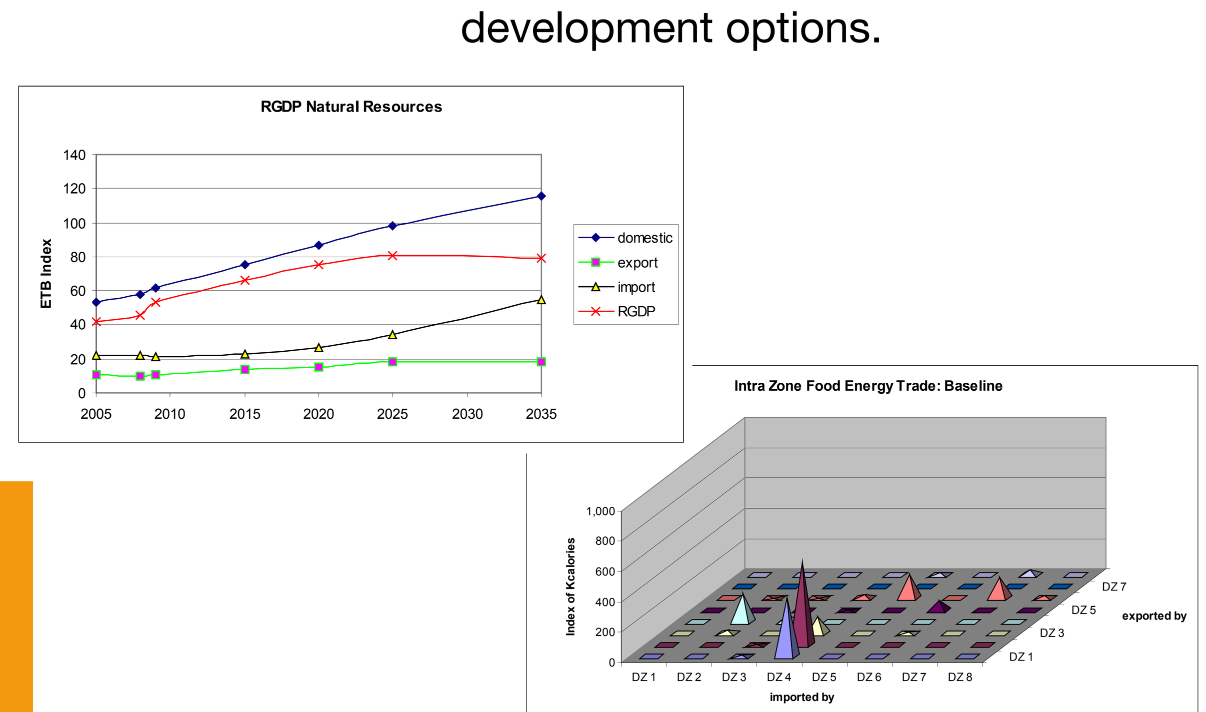

Figure 4 - Example of RAOM results

Resource use optimisation can lead to surprising and useful results. For example, under conditions of scarcity, it can calculate the opportunity cost of devoting a unit of land to food or energy production and scope the interventions required to achieve a different levels of security. Once feasible solutions are identified, the model can be used to help assess the overall demand for resources, skills and services to support a desired level of growth. For example, increasing water abstraction for irrigation, requires strengthening water sector regulation to avoid water stress. Given the model's spreadsheet format it is also easy to perform a risk analysis using the values of key parameters.

Conclusion

The approach described above sets out to model many aspects of a developing regional economy in the context of human, land and water resources.
A word of caution: the model does not provide an exact replica of how an economy may perform. It forms part of a Decision Support System used to advise decision makers on the relationships, and their strength, between social, economic and natural resource variables. It can be used to identify where constraints might become limiting, and where competing objectives require tradeoffs to be resolved.

Environmental requirements can be introduced to assess potential economic impacts – a form of environmental economics.

P133

halcrow.com/iwa-event

Halcrow