INTEGRATING CROPSYST WITH A MULTIPLE-OBJECTIVE LAND USE PLANNING TOOL (LADSS).

M. Rivington[1], K.B. Matthews[1], A.R. Sibbald[1] and C.O. Stöckle[2].

[1] Macaulay Land Use Research Institute, Craigiebuckler, Aberdeen. AB15 8QH. Scotland.
[2] Dep. Biological Systems Engineering, WSU, Pullman, WA, USA.

Introduction

There is increasing interest from land managers and policy makers in tools that assist in the process of evaluating alternative land-use strategies, particularly those seeking to achieve multiple objectives. Plans to achieve multiple objectives are particularly relevant because of: tighter regulation of land management; the need to evaluate novel, science-based land-use strategies; increased public interest in land-use change and new land-owners with non-financial goals. This paper presents the challenges faced in integrating a sophisticated cropping systems simulation model, to increase land-use representation, with a land-use decision support system.

Materials and Methods

The Land Allocation Decision Support System (LADSS) seeks patterns of land-use that define the trade-offs between multiple, non-commensurable land-use objectives (Matthews *et al* 2000). Operating at the scale of the individual land management unit (farms or estates), LADSS uses *land-use planning tools* linked to *land use systems models* (LUM) and *impact assessments*, (see Fig 1). The LUM make predictions, at the individual land parcel level (LP), of suitability, productivity (under alternative management regimes) and profitability (under varying market conditions). The biophysical information required by the systems models is supplied by a *geographic information system* (GIS). The impact assessments, made at the management unit level include financial, social and environmental metrics.

For LADSS to be of utility in evaluating novel land-use or management strategies is it essential that it be able to accurately evaluate existing land-use systems, including a wide range of arable systems. CropSyst was chosen as the best source of arable land-use systems information, as it is appropriately responsive to bio-physical and management protocols (Stöckle *et al* 1994). CropSyst also provides the opportunity to extend the range of possible environmental impact assessments to include relevant issues such as fertiliser leaching. CropSyst integrated with LADSS could thus fulfil a dual role of systems model and impact assessment.

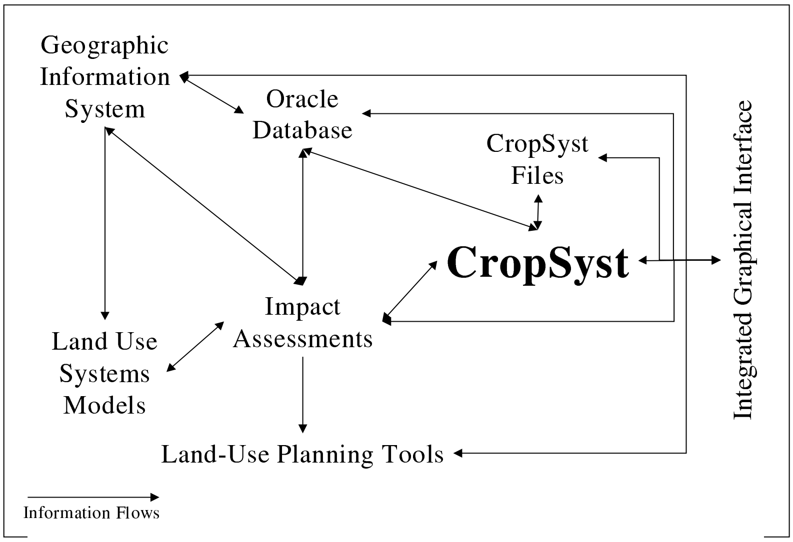

Fig 1: LADSS modules linked with CropSyst

Integration Strategy

Realising the potential benefits of such integration first requires the software engineering of the linkage. This has been accomplished using a common database (Oracle) to supply both CropSyst input parameters and to store selected CropSyst outputs for subsequent analysis using the LADSS land-use planning tools (Fig 1). Beyond this information systems integration, however, is the need for the careful validation of the outputs for the new land-use systems models for the agro-ecological conditions in which the model will be applied and with the input parameters available. The strategy being adopted and the challenges remaining is presented below.

Systems Model Validation

The main CropSyst functions requiring validation are: initialisation data and parameters and model output values. It will also be necessary to validate relationships between arable crops. If these can be demonstrated as correct, then output from the land-use planning tools will be reliable. Validation currently uses a limited range of data, such as on-farm and regional yield records. Complete spatially and temporally synchronised sets of data (productivity, climate, soils and management) are rarely available together. Validation is often carried out for internal model (i.e. mechanistic) processes with mis-matched data of varying scales of spatial and temporal resolution. This can lead to inappropriate assumptions being made about the inter-relationships between model components. It is crucial to LADSS that there is parity between data used to run LUMs, and between the LUMs themselves. Currently there is a range in acceptability of data quality available to LADSS. **Validation Data:** To validate LUM functions and their inter-relationships, we require spatially and temporally synchronised validation data, i.e. from crop trials where physiological, productivity, soils, climate and management data are recorded simultaneously. **Biophysical:** Topographical data (as a DEM within the GIS) is assumed to be correct. Soils data is collected at the LP scale by site-surveys, based on a sampling framework derived from remotely sensed data. Hence LUMS are run using appropriate soils data, allowing pedotransfer methods to derive additional parameter values. Climate data are problematical as they are rarely site-specific and complete on a daily basis. Currently the LUM use the same climate data for all LPs, with no adjustments for topographic variation between LPs. Existing sources include nearest met. station data and model generated values based on interpolated mean monthly data. **Land-use Specific:** Each crop can potentially have a range of management techniques. Crop physiological parameters are therefore problematical as they may be difficult to determine, and vary with biophysical environments. Validation will be stream-lined by separating data and parameters that are either site-variable or site-independent. Calibration of LUM can partially be achieved by fitting simulation parameters to site-specific validation data. The application of LADSS to different agro-ecological conditions however, will require a transferable method for validation.

Conclusion

Integrating CropSyst with LADSS necessitates the completion of the loop between model output validation and re-calibration of input parameters. To achieve this we need to create a shared, interactive on-line data and parameter (biophysical, land-use specific and validation) database. Modellers will detail the scale of influence of parameters / data types, values used and results of sensitivity analysis. The database concept permits the synchronisation of data types, both spatially and temporally. Identifying the hierarchy and scale of effect of data and parameters on output will allow the focusing of research efforts. Specification of tolerances for parameters within the database enables the use of automated re-calibration algorithms (Sequeria *et al* 1994). The combined use of a database and re-calibration algorithms will enable the development of a transferable system validation mechanism. In producing suitable patterns of land allocation, we need to demonstrate confidence in the quality of data used within the LUM. The database will help support that confidence, for both LADSS and CropSyst users. Our proposal represents a key step in creating links between cropping models and spatial decision support systems.

References

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