

**GIS as a Decision Support Tool in the Conversion to Organic Farming**

**Consideration of Data Issues**

**(Submission of an extended abstract for GISRUK 2001)**

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**December 2000**

## **Introduction**

This paper explores data issues raised during the development of a GIS as a decision support tool for the farm manager for the University of Central Lancashire's farm at Newton Rigg. The Farm Estate's Committee began considering the conversion from intensive to organic farming practices in 1999 and is still investigating alternative land use options. The decision to convert requires a high level of commitment on the part of the farm manager, involving a degree of risk and financial uncertainty during the conversion period (MAFF 1999). As many of the factors to consider are spatial in nature, a GIS may perform a crucial role in a Decision Support System (DSS) designed to assist the farm manager in reaching a decision as to the future direction of the farm.

The development of the DSS requires a thorough investigation in which the farm manager's requirements are specified and the analysis of the underlying spatial data sets is defined. The initial data issues to address relate to the identification of existing and missing data sets and the creation of metadata describing the data sets. An assessment of the quality and accuracy of the data is essential if they are to be the basis for decision support (e.g. consider (Veregin 1998)).

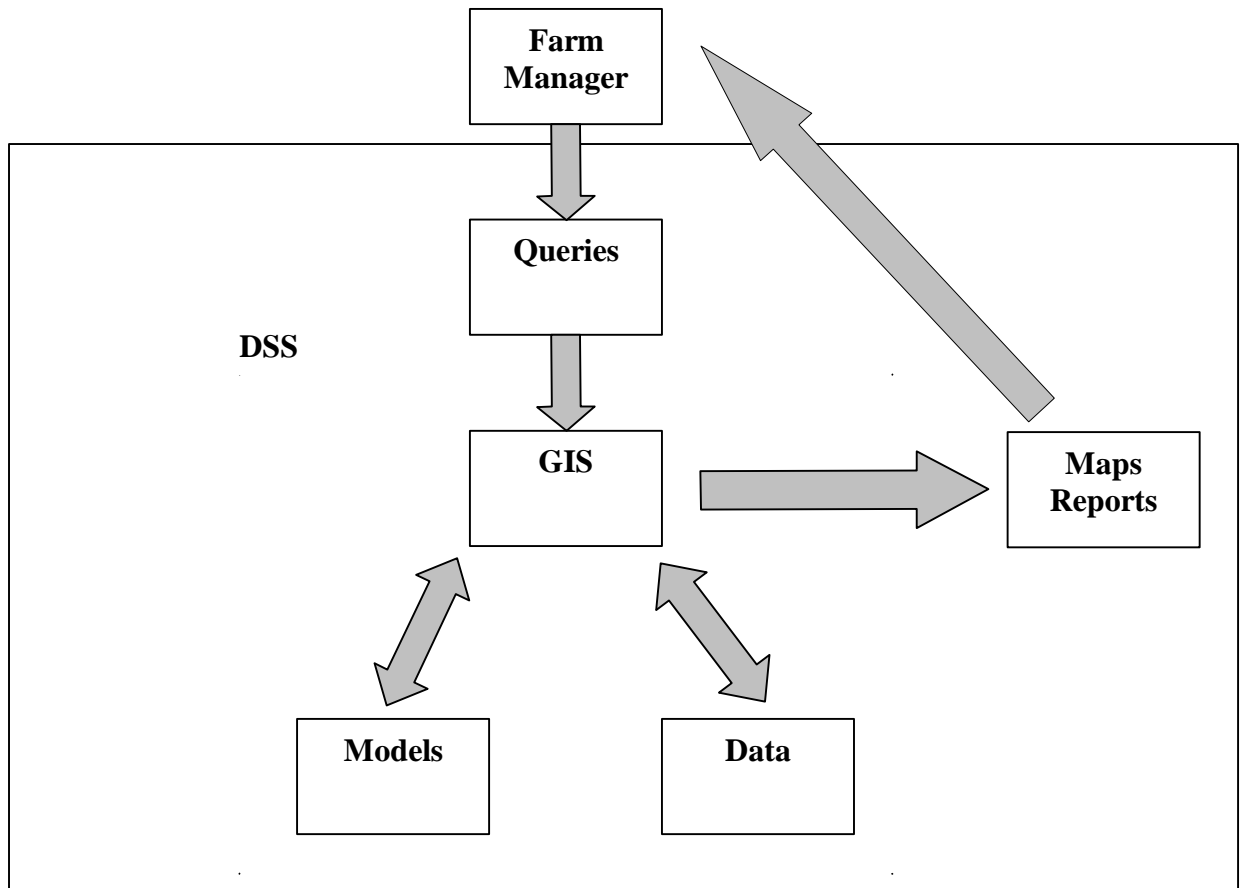
The second area to be explored relates to interoperability. This is relevant when users must access more than one data set using distributed computing resources (Sondheim 1999). The use of the GIS must be intuitive, allowing the farm manager to explore different scenarios for land allocation effectively. The interface must allow the farm manager to amend input parameters easily and observe the results from each scenario in a clear, understandable format. The quality of the decision made by the farm manager will depend on the clarity of the results produced by the GIS.

## **The Role of GIS in a Decision Support System (DSS)**

In simple terms, the DSS must assist the farm manager in making decisions about the allocation of land for organic conversion. Heywood & Carver (1994) introduce the concept of using GIS as a medium to explore and visualise ideas. It is this strength that this research topic intends to exploit in the decision making process, presenting information and displaying alternative solutions for consideration by the farm manager.

## **GIS as a Decision Support Tool**

The GIS will be part of a DSS for the farm manager and so a major part of the development will involve defining models used by the farm manager, identifying and specifying links to existing data sources and designing appropriate user interfaces, dialogues, automated functions and output formats (Figure 1).



**FIGURE 1** The role of GIS in a DSS for the farm manager

In schematic form, Figure 1 describes the integration of the GIS within the DSS and agrees with the approach proposed by Fedra (1996). The farm manager generates a query that is passed into the GIS. The GIS locates the data required for the query and transfers the data into the modelling facility. The results of the analysis are presented to the manager in a suitable format, a report or a map. This may lead to further refinement of the query.

### **The Development of the GIS as a Decision Support Tool**

#### **Users**

The primary user of the system will be the farm manager. However, the farm is a teaching resource for agricultural, forestry and environmental students at the University of Central Lancashire and it is envisaged that the GIS and data will be made available to staff and students.

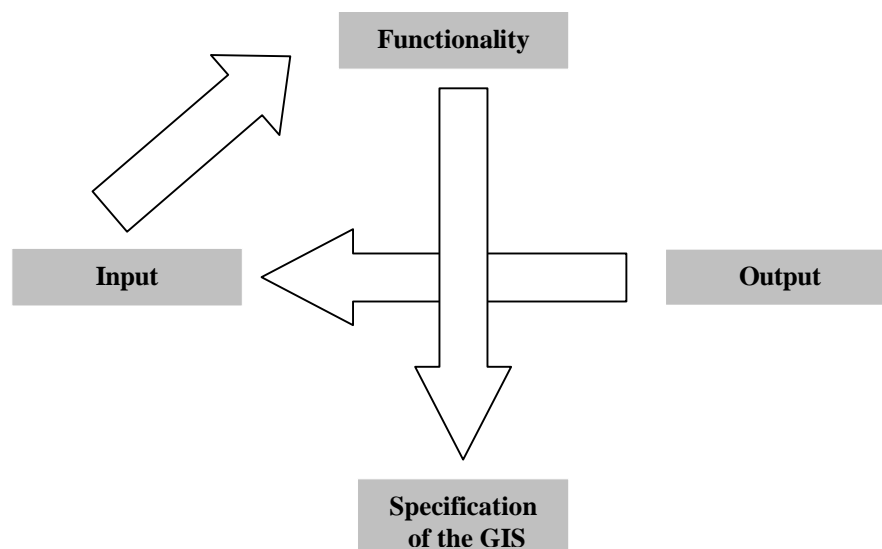
## Development Methodology

The design of the GIS should be driven by the user's needs (Honea et al. 1990). In the development of the GIS, an information centred approach has been followed (Frank 1995), clarifying (Figure 2):

- ?? the users' requirements (**output**) from the GIS;
- ?? the data needed to provide this information (**input**), what is there and what is missing;
- ?? the functions required to transform the data into information (**functionality**);

and leads to (Cremers 1995):

- ?? the **specification** of the proposed GIS.



**FIGURE 2** The Process Driven Approach

The remainder of this paper addresses the data issues raised through this approach.

### Data Issues

#### Metadata

It will be important for users of the GIS to be aware of what data is available. Paper reports and booklets are catalogued in the library system and references can be located using the on-line catalogue. A similar system describing other data sets in digital format is desirable.

Metadata is "*data about data*", describing:

- ?? what data is available;
- ?? who owns the data;
- ?? who is allowed to access or update the data;
- ?? how the data is stored (analogue or digital form);
- ?? when the data was collected and whether it has been validated.

Initial discussions with users suggest that there are two likely forms of enquiry:

- ?? what data do we have? (discovery metadata);
- ?? where will I find data about a particular item? (inventory metadata);

Studies are currently being undertaken to establish international standards relating to the composition of metadata (Salgé 1999). A decision was made to restrict the metadata catalogue to discovery level metadata and to consider digital data sets only at this stage. The catalogue was created following guidelines produced by the Dublin Core (Gupthill 1999) and includes:

- ?? Subject
- ?? Name / Title
- ?? Data set summary
- ?? Author/ creator
- ?? Publisher
- ?? Owner / source/ organisation
- ?? Data currency/ last update
- ?? Data items/ object type
- ?? Data set format
- ?? Spatial Identifier
- ?? Spatial Coverage
- ?? Data lineage/ quality
- ?? Staff contact details
- ?? Access rights
- ?? Keywords

A data collection sheet was created and an *Access* database constructed to record the data collected. It is envisaged that access to the catalogue will be required from the GIS itself and over the Internet by students visiting the University web-site.

### **Interoperability**

The farm secretary has recently acquired a database package, *Agridata*, and is currently adding records relating to cattle, sheep and land parcels. Between 1996 and 1999 however, a separate database system, *Optimix*, (Farmplan Computer Systems, 1996), was in use. *Optimix* contains historical field records of soil analyses, applied nutrients, fertilisers, crop varieties and yields. To date, there has been no transfer between the two systems. This is undesirable and indicates a role for the GIS in combining data from the two systems.

To preserve data integrity, the GIS must access existing data sets. Many database and GIS packages offer Open Database Connectivity (ODBC), where data in one application may be accessed by a second application (Lorents 1998). The Optimix directory structure showed that the data files had .dbf and .cdx extensions. These files were imported successfully into Access as dBase files. Some of the fields were unreadable and were obviously in a binary format. The files were also opened in MapInfo and ArcView, with the same result.

The report facility within Optimix allows the export of a report into Comma Separated Variables (CSV) format. This gives scope for converting the source data into a format readable by the GIS. This “bridge” however must be totally transparent to the user of the GIS and will require customisation (Maguire 1999). An additional constraint placed on the GIS is that both Optimix and Agridata are installed as stand-alone systems with a single licensed user. It is not anticipated that a site licence will be purchased for these packages.

The farm manager uses paper Ordnance Survey maps, scale 1:2500, dating back to 1969. Although they have been manually annotated, they are not completely up to date. Four 1 km<sup>2</sup> Ordnance Survey Land-Line tiles at scale 1:1250 cover the majority of the farm and the field boundaries have been digitised using MapInfo. This map will form the basis of the GIS. Linking this polygon data with the attribute records in Optimix will be a key problem to solve in establishing the GIS, irrespective of the GIS package used.

### **Data Access**

The existing hardware and software resources at Newton Rigg will be evaluated for their suitability as a platform for the proposed GIS. A computer-networked solution is likely to be sought, given that staff and students will eventually use the GIS.

### **Conclusion**

This paper has represented data as the major component of a system designed to support users in the decision-making process. Users must be aware of the data sets available, their quality and accuracy. The system must allow easy access to data and permit the transfer of data and commands between applications through the design of interfaces acting as bridges (Djokic 1993). A careful consideration of the interoperability of systems will ensure data integrity by granting access to common data sets and, with sound management of the selected computer platform, data will be protected from accidental changes. To make informed decisions, the user must have confidence in the underlying data.

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