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Community Based Decision Support Systems in Honduras: Developing an Internet Based Tutorial for End Users

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COMMUNITY BASED DECISION SUPPORT SYSTEMS IN HONDURAS; DEVELOPING AN INTERNET BASED TUTORIAL FOR END USERS

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Abstract

The Royal Agricultural College is a collaborator on a long term project to develop a methodology for decision support which is applicable to the hillside regions of the Central American republic of Honduras. This methodology aims to aid cross-scale decision making and is based on a large collection of spatial, demographic and biophysical data which has been collected for the region. Other collaborators are the Universities of Florida, Georgia, Leeds and Kings College, London. The project leaders are the International Center for Tropical Agriculture (CIAT) based in Colombia.

The finished project will consist of a structured spatial database, an interactive decision support system linked to that database and a tutorial which will train users of the database and explain the methodology. CIAT has carried out and coordinated most of the work on the database construction and the creation of methods and models for using it. The Royal Agricultural College is responsible for creating the tutorial which will explain the decision support system (DSS) to end users and give them training in its use. This paper covers the development of that tutorial and looks at how the final DSS will be developed alongside it.

Introduction

The Royal Agricultural College has been a collaborator on a three year project entitled *Methodologies for integrating data across geographic scales in a data-rich environment: examples from Honduras*, which will be completed this year (2000). The lead partner is the International Center for Tropical Agriculture (CIAT) based in Colombia. The purpose of the project is to enhance the management of the natural resources of eco-regions of the Republic of Honduras by making the large collections of spatial data held by that country fully accessible to all decision makers, from national to village level. This should improve the decision making processes by allowing equal data access to all and by enabling users at any one level to look at the data through the eyes of those at another. The key outcomes of the project are to enhance the decision making capabilities of all stakeholders in the Honduran economy, and to give all those stakeholders the ability to see the problems and potentials of the country from any other stakeholder's point of view and scale of responsibility.

Background to the project

The project forms part of a much larger programme of sustainable land management research in the hillside areas of Latin America being run by CIAT (CIAT, 1998). The importance of these areas to the economy of Latin American countries cannot be over-emphasised. They provide an agroecosystem of nearly 100 million ha. of which 75% is already experiencing rapid or high levels of degradation (Swindell 1999a).

Honduras was chosen as the site for this particular project for a number of reasons. Most importantly, it is highly dependent on hillside agroecosystems for its national economy and it has a large and up to date collection of spatial databases which could to form the basis of a participatory, community led decision support system (DSS). If the project outcomes can be successfully achieved, it is hoped that the results can be used for establishing similar DSS

for other countries with similar agroecosystems, which do not currently have such good spatial information resources.

Project outcomes

The fundamental outcome of the project is to be a multi-scale national decision support system for the management of the hillside agroecosystems of Honduras. This fundamental outcome will be built up from a number of constituent outcomes:

- The collection, correction and rectification of a large number of geo-referenced databases. These consist of soil maps, meteorological records, farm and demographic censuses, satellite imagery, transport maps and many other sources of spatial information about Honduras. (This data collection was greatly enhanced by the huge amount of spatial information donated as disaster relief aid by foreign and commercial organisations after the natural disaster of *Hurricane Mitch* in 1998. The result of this is that Honduras now has one of the largest collections of accurate and up to data spatial information for any developing country in the World.) (CINDI 1998) This work has been carried out by CIAT in Colombia
- The development of analytical tools for multi-scale visualisation and interrogation of these databases. Broadly this means that users at any scale of interest should be able to see the information that relates to their own region of study, generalised to the scale that they wish to work at. For example, a national policy maker or advisor needs to interrogate data for the whole country, generalised to a small scale view. A farmer needs to query only the data relating to the region containing his or her land, usually a single watershed (drainage basin), and that data needs to be generalised to the highest level of detail the data can support. These tools will also allow any user to role-play the view of any other user, giving them an insight into why certain decisions may have unexpected consequences for different stakeholders. This work has been carried out largely by CIAT, with input from many researchers.
- The development of a computer based tutorial for the users of these tools. This tutorial is to serve three purposes:

    1. It is to be a proof of concept for the DSS. To this end it will simulate the appearance and the functionality of the DSS, showing the ways different users would use the system and the type of output they would receive.
    2. It is to be a tutorial for users of the DSS. This is vital as many of the potential users will be people with little or no experience of using a formalised decision making process or working with computers and databases.
    3. It is to be an interactive help system for users of the DSS. At any stage in the DSS it will be possible to switch to the equivalent stage in the tutorial to receive guidance on what is happening, what input may be needed from the user or what any output from the DSS means.

    This work is being carried out by the Royal Agricultural College in collaboration with CIAT and the University of Florida. The work in developing this tutorial forms the core of this paper.

The requirements of a community led decision support system

The two key ideas of community led decision support systems are participation and local knowledge. It is intended that the communities that are affected by decisions can make a valid contribution to the decision making process. This validity is established both by the use of their local knowledge in the system, and by the ability the system will give all users to see how decisions are arrived at, at different scales of interest. A farmer in a watershed can role-play the view of a government official who has to make national policy decisions. A regional

policy maker can see how that regional policy may affect individual farms in differing watersheds in the region.

To meet these requirements it is essential that all users have access to the same data. This can best be done by holding a single database at a designated institution, which is accessible via the internet to all end users. This means, in turn, that all of those users need to have access to the technology to use the databases, and training and experience in using the query and analysis tools.

Making the base data available to the end user

One key requirement of the project is to make the original data that has been collected available to any end user. No-one will have to work with generalised data that has been processed for someone else's needs. This will allow any user to make the best use of the information as they can. It also has the important benefit referred to earlier, of enabling any user at any level to see the data as a user at another level would see it.

A second great strength of always referring back to a single database is that keeping data up to date is comparatively simple. If new data is collected and added to the system, everyone immediately has access to it. To benefit fully from this capability it is essential that the system is internet based, giving immediate, real time access to the current database from anywhere in the World.

The need for a tutorial

Any DSS is complex in its use. The assumptions underlying models may be opaque at best. The way a user works through a hierarchy of choices and decisions can be anything but intuitive. The output of a query can seem illogical without explanation. At the same time it can be distracting to the point of unworkability to have explanatory messages, prompt boxes or confirmation requests popping-up every time you use an information system in real working situations. To overcome this, a tutorial in the use of the DSS is being developed alongside the DSS itself. This tutorial will mimic the DSS and will be designed to look like the full working system. However, the processing will be simulated, the range of localities and scenarios will be restricted and the output will be pre-formed. Each stage will be accompanied by explanatory text which will explain what is happening at that stage, what the consequences of any choices will be and the significance of the output generated. There will also be a feedback forms to allow the users to communicate directly with the development team so that they can modify the tutorial in line with user comment.

The tutorial will ultimately be packaged with the full DSS so that it can give context sensitive tuition at any stage of use of the DSS itself. It will initially be developed before the full DSS as a proof of concept for the donor bodies of the project. In light of this proof, the DSS will be refined, the working interface designed and then the tutorial and the DSS integrated.

Using the web to bring technological power to the technologically deprived

It has been intended from the very start that the DSS and any support materials would inevitably be computer based. There is no other realistic way of accessing the amount of data that is available. At first it was planned to use dedicated software to process and display the data, but even over the short time of the project, the developments of the world wide web have made it an obvious vehicle for the DSS and the tutorial. This is for a number of reasons:

- The collaborators on the project are spread around the globe and the web is their own means of communication. By developing the materials directly on the web, it is possible for all to see what is happening as it happens. This collaboration is likely to continue during the lifetime of the DSS itself, and so keeping it web-based makes organisational sense.

- As web browsing programs become more powerful and versatile, it is possible to run an increasing range of queries and functions through the browser itself. This means that end users do not have to learn how to use specialist programs, but can use what is probably a fairly familiar interface. This trend is illustrated by the number of developments in web-based GIS programs, which make it easier to handle geographic data directly over the internet.
- Developing countries with weak communications infrastructures are finding that by taking direct advantage of wireless communication technologies, it is possible to leap-frog traditional stages of development,. Cellular phone systems can be established much more cheaply and quickly than cable based systems. Satellite receivers can pick up broadband internet data streams almost anywhere in the world. This means that internet based information systems can technically be accessed anywhere in the World, where a non-internet system may require an expensive, ground based transmission network which is simply not available.

  An example of this technological leap-frogging was seen in Honduras itself after the *Hurricane Mitch* disaster. One of the early relief deliveries was a number of mobile cellular phones. By setting up a basic network of ground stations, a usable communications infrastructure was established in days, rather than the months it would have taken to replace destroyed cables.

The structure of the DSS

Any decision support system consists of a range of components. These will break down into five main parts:

1. The database which contains the raw data drawn on by decision makers.
2. Analytical tools which allow these data to be combined, filtered, smoothed, sampled or processed.
3. A query interface through which a user can access these tools and data.
4. An output system to show the results of queries
5. An updating system to allow the data, the tools and the interface to be maintained during the life of the system

In addition to these five parts there will be the essential background information system components of storage, backup, LAN and WAN networks and so on, which are needed to support any distributed system. In the context of the DSS under discussion, there are a number of particular points to be considered.

Database size and comprehensiveness

Honduras was chosen for development of this methodology as it was considered a *data rich* environment. Large data sets were available for it already and more have been collected. These were compiled from a variety of sources, ranging from digitised paper maps to satellite imagery and government statistical records. A planned outcome of the project is a measure of the best size and type of data collection needed by a country to make best use of a multi-scale DSS. Knowing this will make it much easier to export the methodology to other countries which do not yet have adequate data collections. Too little data, and the methodology will not work. Too much data, and resources have been wasted in collecting it.

Fig. 1 illustrates this problem diagrammatically. A country has a range of data sources shown quantitatively by the shaded oval. The development scenario 1 uses most of these sources and has only a small additional data requirement. There is a good match between needs and resources. Scenario 2 is over resourced, using only a fraction of the data. Scenario 3 can hardly be considered because the data collection is almost completely inadequate. If the

types of scenarios and their data needs are established by this project, suitable data collections can be built up by other countries wanting to adopt this methodology.

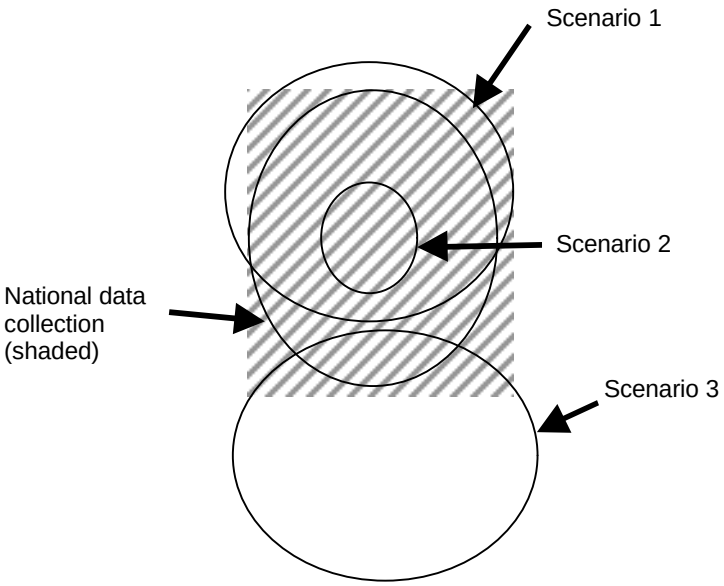

Fig. 1 Relationship of data collection size with decision making needs

Cross-scale decision making

Particular requirements of the project are that the database would be used by stakeholders in the national economy who work at different scales of interest. They may be making national policy, or they may be farmers planning next year's crops in a field in a small river valley. The methodology should allow either user to make use of the same national data collection to support their decision making. It also allows users at any scale to role play users at different scales.

This cross-scale functionality imposes several requirements on the methodology. It must be easy for users to specify their scale of interest, the locality they are interested in, and their basic requirements for data. There must be analytical tools built into the system which will select relevant sub-sets of data, and generalise them at an appropriate level for the chosen scale of interest. A government minister needs a simplified overview of the country, whereas a farmer needs to see the fine detail, or at least be told that the fine detail is not available. There must be a feedback system, so that the experiences of users at any one scale can be communicated to users at other scales. This accretion of local knowledge must be incorporated into the DSS as it develops.

Process Models

Information systems experts can take databases and apply analytical and compilational methods to them, based on the outcomes they seek. Inexperienced users of the database cannot do this, they have neither the skills nor the experience. The system must therefor have models of processes built into it which the users can call on to study their own environments. These models will be created by experts and will be modified by user feedback. The ideal model would be a single one which mimics the entire system being studied. Data could be fed into it and the outcomes should give an idea of how the real system will perform. Such a model of an agroecosystem is shown in fig.2 below.

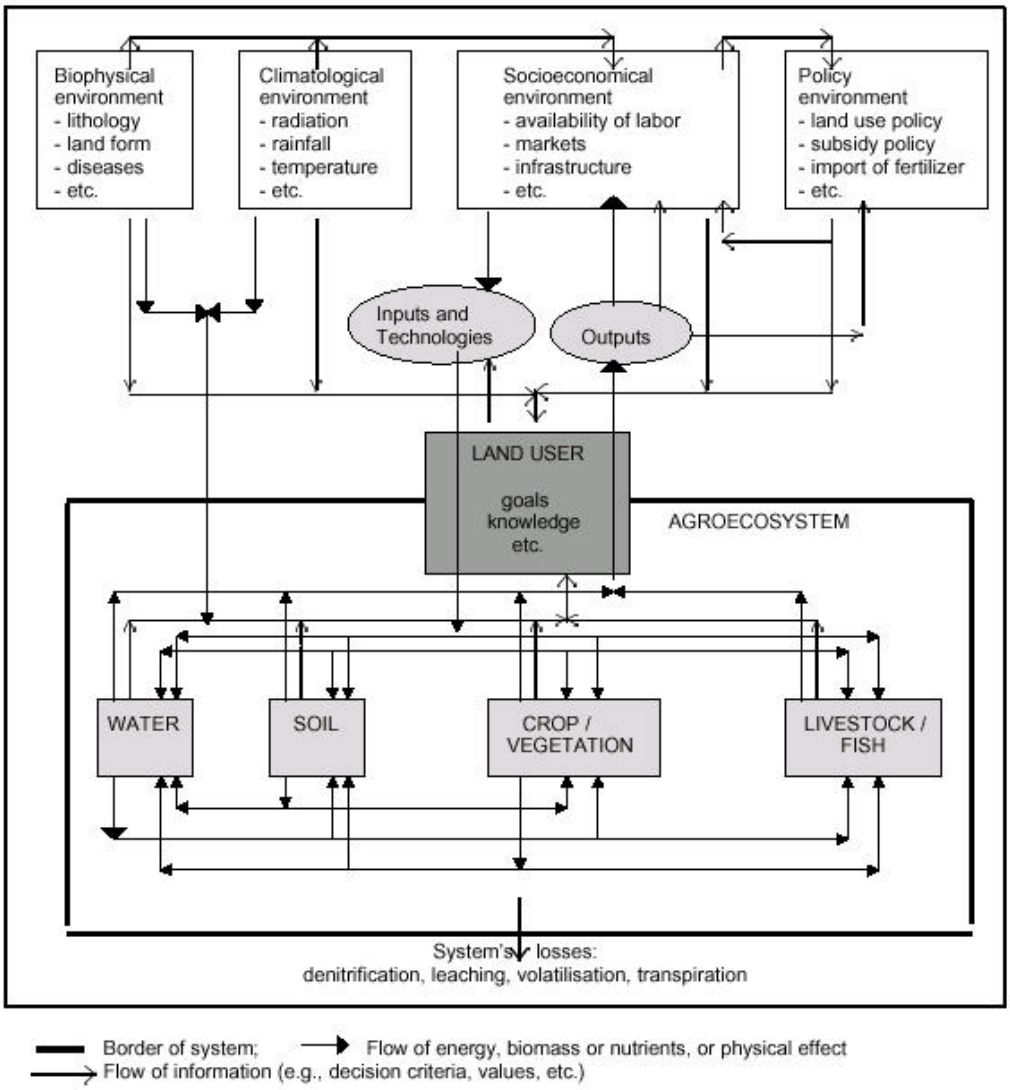

Fig. 2 Land use model of an agroecosystem system (from van Duivenbooden, 1997)

Such a holistic model can be useful in demonstrating just how complex the whole system is. The problem is that it is far too complex to actually use when making real decisions in the dynamic, real world. In practice, the total system must be broken down into a collection of constituent component systems whose interactivity will mimic that of the total system. A reductionist approach is needed to reduce complexity to manageable proportions, whilst systems modelling will help to retain the interactivity of all these parts. Adinarayana's (1997) approach to watershed modelling, shown in figure 3, shows how the holistic model may be reduced to linked components, which can be studied in turn and which can be linked to simulate the whole system. Each component can be modelled individually, with the inputs coming from another component and the outputs contributing to yet another.

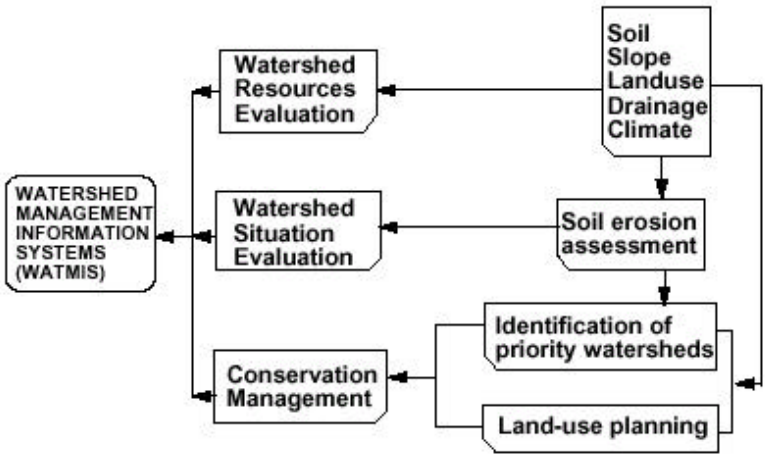

Fig. 3 Watershed management information system built from functional components (from Adinarayana, 1997)

Information flow; sharing of outcomes

As mentioned above, the flow of information and the accretion of local knowledge is a fundamental part of this project. It is also one of the hardest to implement and control as it occurs independently of the project designers. As users of the system make choices and create new outputs, these need to be incorporated into the knowledge base of the system. The results obtained need to be accessible to other users, and should not just be ephemeral answers which go unrecorded. This may mean that the main use of the DSS will be in facilitated workshops, where the facilitator can highlight useful outcomes, unsolvable problems and new ideas which can be fed back to a continuous development of the DSS and its interface.

The tutorial design

It will be apparent from the preceding discussion that this is a very complex project. The information about the agroecosystems of the hillside regions of an entire country are to be represented in a computerised system in such a way that inexperienced users with widely differing needs and backgrounds can use that information in their own decision making. As mentioned earlier, this makes it essential that the DSS incorporates a tutorial to help these end users. This tutorial is to serve three purposes:

1. It is to act as a proof of concept of the whole project. The project donors and end users will experience the nature and use of the DSS through the tutorial, as it will simulate the appearance and function of the DSS, using a restricted range of scenarios, geographic locations and stakeholder interests.
2. It will form the principal training and support system for the DSS users. They will learn to use the DSS through the tutorial and they will be able to receive support whilst running the DSS by using the tutorial as a context sensitive help system.
3. It will provide the background documentation to the DSS. It will be possible to call up descriptions the process models which are used, data catalogues, metadata indices, credits for the project and contacts for further development of the DSS. This will allow the DSS itself to be relatively uncluttered with support and background information, whilst keeping such material easily accessible.

The interface to this tutorial will be complex, but it must be simple to use and easy to understand. This is best achieved by understanding how people *might* use it, rather than how they *should* use it. This is very similar to the error checking process in computer

programming. It is easy to design a program to carry out an intended action when given the correct input. It is far harder to design a program that can react to the wrong input in such a way as to put the user back on the right track without disrupting the process. This challenge has been addressed in the tutorial under the headings of user familiarity, navigation, help systems, providing input and creating output.

Keep the interface familiar

No interface will be familiar to a first time user, and some of the users of this DSS will be first time computer users. Having said that, the most widely familiar interface is the web browser. It is the same in every language, on every type of computer, and with every operating system (more or less). An increasing number of functions are being added to the browser, but they tend to improve or extend the range of what we see and hear, rather than adding anything new. Their *modus operandi* is simple. You point and click on hyperlinks to display pages. You read text, listen to sounds or view images. You make choices on pages by the same point and click technique. Those choices result in new content being displayed. There is a minimum of text input, so the keyboard is a very secondary input device.

The process is essentially sequential, so you can navigate through the content with simple forward and back commands. The speed at which web browsing can be understood and used can be quite amazing, but is well known to parents with young children! The complexity and sophistication of what can be done through this simple interface increases daily, allowing people to book entire holidays or business trips, enabling garages to monitor the servicing needs of the customers' cars and so on.

The Honduran DSS and its tutorial will exploit the familiarity, simplicity and functionality of the browser interface to the maximum extent. To this end it is hoped that the users will never leave the browser to launch another program, but will interact with the data entirely through the browser window. There will be tremendous activity from database management systems and calculation programs in the background, but the user does not need to know about this. She needs simply to provide input and receive output, and the browser can do that for her.

Finding your way

Navigating through the World Wide Web is a simple sequential process. Because it is so simple, it is very easy to get lost. This is because we can branch off in unexpected directions, windows may use complex nested frames, new windows may open automatically and in some cases the user is invisibly redirected to unrequested sites. This problem is addressed in two stages, by clearly defining the route(s) through and around the site, and by designing the interface so that "finding your way back" is as easy as possible.

The first stage involves flowcharting the system, to show the stages where user input is needed, where data is added, where information streams interact and where feedback loops occur. This is fairly straight forward work, and the user flow chart for the tutorial is shown in figure 4 below.

Tutorial stages

1. Stakeholder identification
2. Goal determination
3. Scenario construction
4. Data inventory
5. Data selection
6. Process modelling
7. Geographic modelling
8. Output analysis: compare with your goals in stage 2
9. Are you achieving your goals?
   - If **yes**: steps 5, 6 and 7 are a good basis for scenario realisation
   - If **no**:
   - *either*, back to 7 and re-model
   - *or*, back to 4 and choose better data
   - *or*, back to 3 and re-consider the quality of the scenarios you constructed.
10. Repeat the process with different scenarios

    or:

    Repeat the process as a different stakeholder with different interests

Flowchart

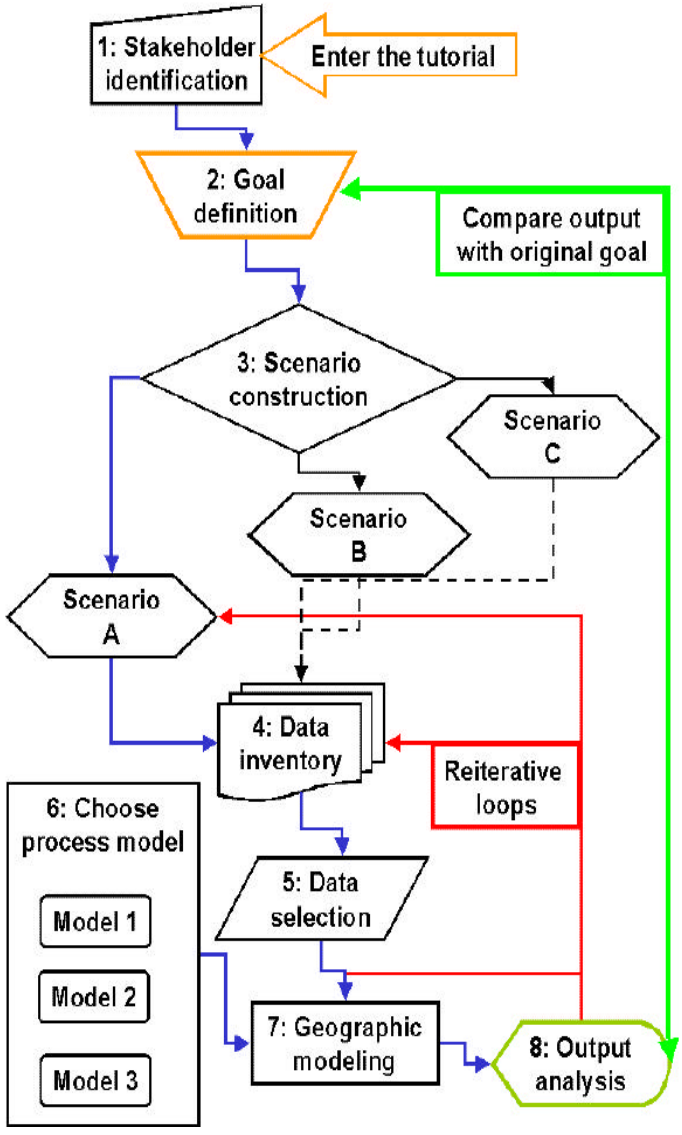

Fig. 4 Tutorial user flowchart. (The final DSS flowchart will be very similar.)

Designing the browser interface for easy navigation is more complicated and debatable. The form adopted is one that has been developed at the Royal Agricultural College and has been used for a number of undergraduate programmes (Swindell 1999b, Swindell and Sutphin 1999) This is essentially a two or three frame web site as shown in Figure 5.

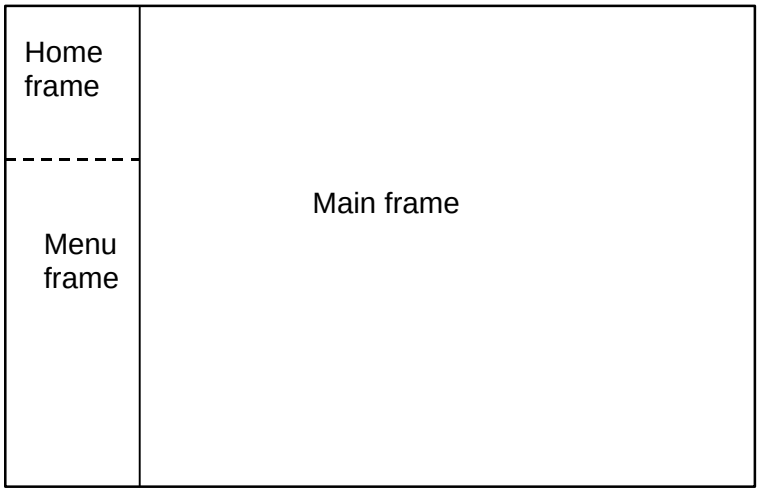

Fig. 5 Tutorial interface layout

The *Home frame* contains one or two links that take the user back to the start of the tutorial or back to the beginning of a subsection. This frame is always the same and is present in all displays. This means that the user can always "go home" no matter how deeply they have delved into the tutorial. If the content of the menu frame is short enough, these two frame can be combined. If it is necessary to scroll through the menu frame, the Home frame is separate so that it is always displayed. This is the user's anchor and emergency escape route.

The *Menu frame* is used for navigation and user support. It contains links to preceding sections, alternative routes through the system, help and user resources. It will not normally contain links which will initiate processes or display data which is needed in the tutorial.

The *Main frame* is where all the work takes place. Here the user makes choices, views maps and other data and gives general input to the system. Actions in this frame will result either in a new display in the same frame, showing the consequences of those actions, or a completely new frameset with a new menu and main display. This latter result happens when the user reaches their chosen scale and region of interest in the flowchart or has chosen to repeat a process. They can step back through a process with the normal back buttons in the browser, or they can return to the start using the home frame.

Interactive help

The user help provided by the tutorial is different from that found in a program such as a word processor. Those help systems simply explain how to use the features of the program. The project tutorial is intended to be an educational product which explains what the DSS is doing and trains users in its use. These explanations are accessed through links in each stage of the tutorial labelled "What is going on here?" If the main frame is displaying a series of choices, this link will explain the significance of the choices, and what will happen after any choice is made. If the main frame displays the results of a process, the help window will explain what the process did and what will be done with the results.

This same explanatory help system will be accessed from the full DSS by switching across to the tutorial. The links between the DSS and the tutorial will be context sensitive, which means that the explanatory support in the tutorial will always be relevant to the stage in the DSS that has been reached. This allows the DSS itself to be relatively uncluttered. Help links here will simply which to the equivalent location in the tutorial.

User input, DSS output

Receiving input from users is crucial but fraught with problems. In general it is best to restrict user input to making choices from options, because this way the format of the input is kept under strict control. This makes it much easier to process, as the possible inputs are known and the combinations of inputs are finite. Where free text is allowed, the possibilities are infinite. It also puts the users who have poor keyboard skills at a disadvantage. This will be compounded in the Honduran DSS as many of the potential users will have little or no keyboard skills and some may be only semiliterate. These problems are further exacerbated by the fact that the tutorial is being developed in English but will be delivered in Spanish.

The solution to these problems is still being considered, but some guidelines are being established:

- Wherever possible, input to the actual models will be made by selecting from menus of choices. The results from these choices will be displayed at the end of an iterative loop, which allows the user to go back to change the choices and see the consequences (the common "what if?" process used n spreadsheets).
- Where text input is used, it will generally be for record purposes only. For example, when a user sets a goal, it may be typed in, possibly with help from a facilitator. This text will then be displayed at stages as a reminder of what the goal was, but it does not feed into the process itself.
- Output from the DSS will be visual rather than textual. It may be a map, a simple chart, symbols indicating a process is high, medium or low risk, or that a trend is positive, neutral or negative. This makes it more meaningful to many end users and helps ease the problems of translation.

Future development

The tutorial is being developed as a proof of concept for the full decision support system. As the DSS itself is developed, the tutorial will be revisited and revised. This is because the tutorial must simulate the appearance and flow of the DSS, and this may be different from that which is currently envisaged. It is also hoped to include internet based interactive mapping programs in the DSS, and to have them running in the main frame of the interface. Should this not be possible, it will be necessary to incorporate these programs into the tutorial as well. This work will not be addressed in detail until 2001. The present timetable is that the tutorial shall be complete in its structure by May 2000 and will be finally presented to the donors and Honduran users at a workshop in Costa Rica in July 2000.

Conclusions

Our ability to collect vast amounts of information about any part of the world is formidable. The question, of what real use is this information, must be answered. Just knowing things is of little consequence if that knowledge cannot be, or is not applied to current and future problems. Nowhere is this more true than in developing countries of the tropics. Their populations are expanding and their land resources are degrading. Planning their development to achieve some degree of sustainable land use is one of the great challenges of the new century. Tackling this problem requires an understanding of the interlinking systems which operate in these environments (Bouma 1997, Fedra et al 1991). The DSS which is being prepared for Honduras shows one methodology for making information about these systems accessible to the people who can truly benefit from their understanding. If it is successful as a methodology, it can be exported to other countries to their future benefit.

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