NOTES

THE USE OF A GRID-BASED GEOGRAPHIC INFORMATION SYSTEM TO EXAMINE ECOLOGICAL RELATIONSHIPS WITHIN THE PASOH 50-HA RESEARCH PLOT

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The study of ecological relationships among species of flora and fauna can be facilitated by the analysis of large demographic databases, but spatial analysis of such data sets is limited because the work is often difficult and time consuming to accomplish. Geographic Information Systems (GIS) can provide accessible tools to conduct spatial analysis in an effective, rapid fashion where some type of geographic referencing is included in the data set. The inventory of trees in the Pasoh 50-ha research plot is a large demographic database of this type which provides a rich and detailed source of data on a lowland forest complex in Peninsular Malaysia. (Manokaran & LaFrankie 1991). The plot is maintained by the Forest Research Institute Malaysia (FRIM) and is the site of an extensive research program. This note describes the steps required to bring the Pasoh data into a GIS environment.

Each stem in the Pasoh 50-ha plot has been tagged, identified and its diameter at breast height (dbh) measured. Also included in the database are the *x* and *y* coordinate locations of each stem within a surveyed five meter grid that has been marked on the plot by ground survey. Records are organised in the database by these coordinates within the five meter cell and also by aggregated cells of twenty and fifty meters. Maps have been prepared for each of the major species types through meticulous digitisation of the *x* and *y* coordinate locations (Manokaran *et al.* 1992).

Since these data are recorded by their location with cells of varying resolutions they can also be mapped and analysed using a raster or grid based GIS. To be used in this way the data have to be aggregated in terms of their frequency of occurrence within raster cells and thus are subject to generalisation when compared to coordinate locations. Nevertheless the 20 000 five meter cells which cover the plot offer a dense network of observations for mapping and analysis that can be valuable in some ecological studies.

The advantage of frequency data in conjunction with the GIS is the ability to quickly extract information on individual species within any dbh range and view the distributions. Analysis can take the form of comparisons of small trees with larger ones, looking at the comparative distribution of two or more species or the association between species distribution and other data that have been generated for the 50-ha plot such as small mammal populations.

Work on developing this capability has been undertaken at the FRIM using the IDRISI GIS. This is an inexpensive raster based system, with limited vector capability, developed for use on standard desktop computers (Eastman 1992). It can import data from databases linking them to geographic definition files that describe the geography of the land that is to be analysed. To make data for the Pasoh 50-ha plot compatible with IDRISI, it was necessary to create a geographic definition file that described the locations of the 20 000 five meter cells surveyed for the area and assign each five meter cell within the database a unique identification code to match this geographic definition file. Creating the geographic definition file involved a series of steps. The reference system used to organise cells in the 50-ha plot had to be modified to mesh with the standard conventions of raster numbering used in GIS systems. This restructuring resulted in a unique geographic identification number being added to the database which could then be exported to IDRISI to establish the geographic definition file. The export step was executed by transferring the new geographic identification number from the database to a spreadsheet, with each spreadsheet cell representing a five meter ground cell. Within IDRISI this set of unique locational identifiers provides the structure of a geographic definition file facilitating transfer of substantive data. Establishing a geographic identification number in the database and a geographic definition file in the GIS now made it possible to execute searches within the database and export the results to the GIS for mapping and analysis.

A program was prepared which would extract the frequencies of occurrence of designated species with specified dbh ranges for each five meter cell from the original database. Initial work has focussed on two small projects. The distributions of eight *Shorea* species are being examined for potential spatial interrelationships among their growth patterns. This study is replicating similar work using a different methodology (Appanah & Weinland, in prep.) and will provide a valuable verification of results from the GIS analysis. A second project involves conversion of small mammal population data to the GIS format and linking these data to the distribution of fruiting species that are potential food sources. The program code to create geographic definition identifiers in the Pasoh database, transfer them to a geographic definition file in IDRISI and create frequency data sets for analysis is available from the authors.

Selection of a raster GIS to accomplish the tasks described above has to be made with care. Raster systems can encompass a wide range of capabilities. They are valuable for map overlay, map combination and spatial analysis applications (Burrough 1987). They are also ideal for cartographic modelling applications where individual elements from a variety of compatible data sets can be recombined in unique ways to address specific problems (Tomlin 1990). The raster data structure, which is based on cells or pixels arranged in a standard order, is also directly compatible with the structures used in satellite remote sensing systems facilitating exchange between image classification software and the GIS (Davis & Simonett 1991). This is often a substantial advantage in natural resource applications where classified remote sensing data sets can form one or more layers in a project data set (Star & Estes 1990). Since many of these applications are oriented to the import and manipulation of various map layers, linkages to external tabular databases which may then be connected to individual map elements are not always present in the toolboxes of individual softw are packages. A full range of statistical analysis capabilities may also not be present. This variability within packages reflects the overall emphasis of the software developer and it necessitates careful review of analysis and data conversion capabilities required in a project before a final software selection is made.

IDRISI has extensive GIS capabilities including display, attribute and spatial data management, database query, map algebra and distance and context operators. It also includes a set of programs for statistical analysis, digital image processing and an independent digitising module for data entry. The software has a strong set of conversion modules which facilitate linkage with external data sets and thus proves ideal for the Pasoh application. The IDRISI system is available for both DOS and Windows based IBM compatible computers. The DOS version, on which the work described was completed, requires at minimum 512kb of free RAM, a hard disk and an EGA, VGA or 8514/A graphics adaptor. The program also requires 5 mb of storage and comes with documentation and an exercise data set that requires a further 2mb of storage. The cost of the software for academic and government institutions is US$ 360 for the DOS version and US$ 495 for the Windows version plus approximately US$65 for shipping to Asia (June 1996). More information about IDRISI can be obtained from: The IDRISI Project, Graduate School of Geography, Clark University, 950, Main St., Worcester, MA 01610-1477, USA, or electronically through IDRISI@VAX.CLARKU.EDU or http://www.idrisi.clarku.edu.

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