5. DISCUSSION

This study indicates that the spatial database can be adequately managed under a micro-computer environment. The storage media required depends on the type of GIS implemented. Since the PC ARC/INFO package stores data in the vector format, which requires less space than the IDRISI format. In the vector format, point, line, and area are used to represent geographical features, only coordinates and essential relationships among different spatial objects are stored. The IDRISI is a raster GIS, which stores spatial information in the cells format therefore it uses more space than the vector-based GIS. In addition, The PC ARC/INFO is more efficient during in the stage of digitizing and storing spatial data at the provincial level. The constraints of PC ARC/INFO are its hardware requirement and demand for resources both capital and personnels.

Different methods of storing and retrieving spatial data for land evaluation are possible depending on the hardware and software available. In the case that only PC ARC/INFO is available, the spatial database should be saved as coverages and named them according to mapsheet series number. The boundary of the target area is required for intersecting those coverages to create the coverages that contain the spatial information of the target area. The land evaluation could be then processed, the output maps have to be saved as the plot files and can be stored in the subdirectory that can be called by the menu in the developed shell. The advantage of this system is that it requires less space for data storage and the higher quality output. The disadvantage is the large number of plot files needed to store the results of land evaluation.

If the PC ARC/INFO and the IDRISI packages are available on the same machine. The storage of spatial data should be the same as above. The LMU should be created by overlaying the soil and slope coverages in PC ARC/INFO. The resulting coverages should be exported to IDRISI using POLYGRID command in PC ARC/INFO and ERDIDRIS commands in IDRISI. The results from land evaluation could be displayed with IDRISI command which are embedded in the developed shell. The advantage of this system is that the display of the land evaluation result can be interactively queried on the screen using the command COLOR in IDRISI. For instant, the coordinates of particular zone of suitability class are shown according to the position of the cursor, zoom-in, and zoom-out can also be done.

However, if only the IDRISI package is available, manual entry of spatial data for the whole province in IDRISI format is almost impossible. Spatial data have to be imported from other GIS systems e.g. PC ARC/INFO package, which correspond to mapsheet series numbers using the same procedure described in the second case. IDRISI images are also recommended to be named as mapsheet numbers. An image for a specific target area could be created from the image of defined boundary of the target area and various commands in IDRISI e.g. CONCAT, RECLASS, OVERLAY, etc. The major disadvantage of this system is the high demand on harddisk space for data storage. However, the system is suitable for a modest project or office in which resources are limited. This happens to be the case in most governmental offices in the regions outside Bangkok.

The IDRISI package version 4.1 (Eastman, 1993) also provides the new features such as, scale bar, north arrow, and ability to change the logo for the

output map. The IDRISI package also provides feature for exporting the map to the TIFF file format. This is an important format to link with other commercial graphical packages such as CorelDRAW, Paintbrush, and Photo Finish which can be used under Windows environment. Therefore the Thai script for the map output could be added to produce the final map on a printer or an inkjet printer (Appendix Figure 9).

The non-spatial database was used to describe the characteristics of the object in the spatial database. This could be done in the forms of attribute values or look-up tables. In this study, data on LC of each LMU were stored as a look-up table. This process resulted in less space required to store information for the coverages. The other information such as climatic data, population, other economic data, etc., should be included in the non-spatial database for using in evaluation in the future. Before storing the new information in non-spatial database, care should be taken to plan the structure and the key attributes to link with the spatial database.

Land evaluation using two sources of LUR resulted in different suitability classes for each LUT. The LUR from CSR/FAO (1983) yielded the suitability classes ranging from S1 to N but those from DLD (1991) resulted in the narrower distribution of the suitability classes. The reasons of the differences are the larger number of LQ used for evaluation as defined by DLD comparing to CSR/FAO and the range of LQ in each suitability class are not the same.

Four methods of assigning suitability ratings also produced different suitability classes. This was affected by the procedures in calculation process. The Law of Minimum has the strength of being fast and simple in the process of

calculation, its weakness is its inability to consider interactions among various LQ. The Multiplication method is also fast and simple but the weakness is the lower rating it gave during the process of calculation. For example, if more than one LQ fall into the range of S3 the result of rating using multiplication will be lower than S3. The Modified Multiplication method is not too complicate but the process in calculation takes longer time than the Multiplication method. This method overcomes the error occurred with the multiplication of method.

The Fuzzy land evaluation could produce the relative suitability rating and was not subjected to the error from the calculation as mentioned in above methods. Although Fuzzy land evaluation has several advantages over the other techniques and is able to store membership grades in the database that can be examined in case the evaluators would like to adjust the results of rating. The relative suitability could be assessed from this method. The weakness of the fuzzy method used in this study is that the Similarity Relation Model (Wang et al., 1990) gives equal weighting for each LC used for evaluating LQ, for example, phosphate level is as important as available water or soil depth in determining a membership grade for certain suitability class. In the future study , the Semantic Fuzzy Model such as described by Burrough (1989) should be explored. This method allows the evaluator to assign different weighting for each LC according to the known theory or past experience. Moreover, different fuzzy set membership functions can be used to suit different response functions of crop to each LC. IDRISI version 4.1 also provides capability to work with fuzzy sets and GIS databases.

The results of the accuracy assessment using KHAT statistics clearly demonstrated that the results of suitability rating largely depend on the choices of

selecting the source of LUR and the methods of rating the suitability classes in the process of matching the LC and LUR.

In this study LUR for mungbean seems to be consistent when LUR developed by CSR/FAO (1983) and DLD (1991) were compared using fuzzy method (Table 18). The rating for other crops were not in good agreement even for wetland rice. When comparing the results of relative suitability by fuzzy land evaluation method with the present landuse and based on DLD description of LUR, twenty percent of land used for wetland rice was rated as being suitable for field crops (Table 20). The suitability class defined by DLD in manual process did not include to compared in this study. Because of the source and the manual process did not the same.

Although part of the gently sloping land that should be used for field crop could be converted to terraced paddy by the farmers but inaccurate rating could be minimized by better definition of LUR. The research that directly addresses the problems in this direction is very scarce if not exist in Thailand. Even the details on the values of LQ for LUR of each LUT which appeared in the published land evaluation manual of DLD did not refer to the source of information (DLD, 1991). Therefore, there is an urgent need to initiate serious investigation on proper LUR in Thailand. This information could be drawn from past research results, extensive on-farm studies which cover wide range of agroecosystems and management conditions, and indigenous knowledge of farmers in matching crops with land conditions.

Care must be taken also in selecting the suitability rating technique. The Modified Multiplication method seems to be a reasonable technique if traditional

boolean logic is used in suitability classification. This method did not give too low ratings when many LQ are used for evaluation.

The system shell can be expanded for the future use to accommodate the linkage between the shell with other quantitative land evaluation techniques such as crop models and watershed models as well as economic analysis procedures for economic suitability ratings. The design of system shell depends on the objectives and requirements of land evaluation. The system shell may be modified to allow the user to retrieve the map according to the mapsheet or the boundary of the target area.