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The Establishment of a Geographical Information System (GIS) Department Of Agriculture Sarawak

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Soil Branch, Department of Agriculture, Sarawak

Technical Report

March 1998

Department of Agriculture Sarawak

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EXECUTIVE SUMMARY

The Department of Agriculture Sarawak recognizes the importance of Geographical Information System (GIS) application in spatial planning and decision making for improved sustainable management of natural resources for agricultural production. The result of needs analysis for GIS, DOA indicates that the level of GIS sophistication in the Department of Agriculture, Sarawak is low and ranked below a comprehensive level of coverage in respect of the Infoware (existing and availability of data), Technoware (hardware and software), Orgaware (intra- and inter-institutional collarboration, cooperation and linkages) and Humanware (Personnel and manpower resource) respectively.

As a long-term measure, a Geo-information Branch should preferably be formed at the headquarters level to look into the GIS planning and development of GIS applications in DOA. The correct humanware with the desirable level of specialization is, among other things, the critical success factor to the establishment of GIS in DOA. The present manpower in DOA does not have the GIS expertise and skill neither is there any manpower to spare. Recruitment of a nine-member GIS Work Team viz., GIS Conceptualizer, GIS Application Specialist, RS Application Specialist, Raster and Vector Technicians and System Administrator is mandatory for the establishment of GIS, DOA at the headquarters level.

As a medium-term measure, the present GIS set-up in Soils Branch shall be appropriately maintained and upgraded. The GIS which, as a computer-assisted mapping tool, improves and ensures timely dissemination of information in desirable format and media. The GIS is also be used in research-oriented application such as terrain analysis and land cover change for the generation of erosion risk map, agro-climatic classification and mapping and crop zoning on basis of the differences in bio-physical and socio-economic factors. The present GIS Work Team is formed within own manpower resource by internal appointment and redeployment. It is necessary to be further strengthened. Recruitment of a GIS Application Specialist, Raster and Vector Technicians are essential to make the GIS operational in Soils Branch.

Suggested Infoware for GIS, DOA includes data needs for future planning. Potential areas of GIS application are identified. Suggested Orgaware framework incorporates the present organizational linkages with the insertion of Geo-information Branch at the headquarter levels as data/information depository. Basic considerations on hardware configuration and software for the GIS, DOA are highlighted. The set-up of hardware at "Local Area Network" level of sophistication for GIS, DOA is preferred. Two units of GIS Workstation operating on Windows NT environment complete with perpherals are suggested. ARC/INFO and ARCVIEW GIS Software and ERDAS RS software are suggested for favourable consideration.

The estimate of financial resource requirement for the establishment of GIS, DOA includes the hardware and GIS/RS software, personal emoluments and operating cost. The estimate for the establishment of GIS, DOA is RM 1,170,800.00 during the initial year. The cost of the suggested hardware and software is RM 722,000.00 The total personal emolument is RM 208,800.00 per annum. The annual operating cost is RM 240,000.00 covering multi-licensing and maintenance, analogue-digital conversion and dissemination of information.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the contribution and support of the following :

En. Edwin Liew, Director of Agriculture, Sarawak for his guidance and continuous support in making possible the publication of this Study Report for the successful implementation of a Geographical Information System in the Department.

Members of the Departmental GIS Working Group for their valueable suggestions and contribution in the write-up of this Study Report.

En. Sahibi Moktar, Penolong Pengarah Pertanian (GIS), Jabatan Pertanian Semenanjung Malaysia for his advice and valueable comments on key issues relating to the set-up of GIS and GIS application in the Department of Agriculture.

THE ESTABLISHMENT OF A GEOGRAPHICAL INFORMATION SYSTEM IN THE DEPARTMENT OF AGRICULTURE SARAWAK

by

Teng Chin Siong [1] & Ngab Dollah Salam [2]

January, 1998

BACKGROUND

The State Planning Unit recognizes the importance of automated geographical information technology and Geographical Information System (GIS) application in spatial planning and decision making for improved and sustainable management of natural resources in the State. The proposal to establish a Central Geographical Information System for the State was mooted and presented at the annual State GIS/RS Technical Committee in 1996. This was followed by the appointment of a GIS Consultant Team on a three-month consultancy to study the set-up of a Central GIS in the State.

The Consultant's report on the Establishment of a State Geographical Information System for Sarawak was submitted to the State Planning Unit in May, 1997. The outlined objective of the study covered the technical and functional aspects of a Central GIS which is to be cited at the State Planning Unit in the Chief Minister's Department. Among other things, the Consultant has also identified six core GIS user agency in the State, viz., State Planning Unit, Forest Department, Department of Land and and Survey, Department of Agriculture, Drainage and Irrigation Department and Public Works Department. Detailed appraisal of the GIS needs at the department level was beyond the scope of the study. It was, however, briefly discussed and left much to the initiative of the respective departments to pursue further in detail. The State Geographical Information System Technical Committee, subsequently issued a directive to the six core GIS user agencies, to initiate the implementation of a Geographical Information System in their respective departments.

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A. GEOGRAPHICAL INFORMATION SYSTEM WORKING GROUP IN THE DEPARTMENT OF AGRICULTURE

Inception

The proposal to form a Departmental Geographical Information System Working Group of DGIS in abbreviation was put up for consideration at the Departmental Steering Committee Meeting in January, 1997. The proposal was accepted. The first task of the DGIS was to identify the membership for the Working Group and to prepare the Terms of Reference for the implementation of a GIS in the Department.

Membership of the Departmental Geographical Information System Working Group (DGIS)

The DGIS comprises an Advisor, a chairman, a secretary and one permanent representative from each of the six Divisions and three Branches in the Department. The Chairman and the Secretary were appointed directly to the Working Group by the Departmental Steering Committee at the meeting in January, 1997. Permanent representatives from the six Divisions and three Branches are shown in Table 1.

Table 1 DGIS Working Group

Name	Member	Official Designation (Division/Branch)
Edwin Liew	Advisor	Director of Agriculture, Sarawak
Teng Chin Siong	Chairman	AD (Soils)
Ngab Dollah Salam	Secretary/ Member	Research Officer (Soils)
Maria Hasman	Member	Rep. SAD (Planning, Admin. & Finance)
Michael Lee	Member	Rep. SAD (Farmers Institute)
Boniface Litis Anat	Member	Rep. SAD (Inland Fisheries)
Dr. Francis Sia	Member	Rep. SAD (Veterinary)
Wee Ngo Gim	Member	Rep. SAD (Commodity & Extension)
Fatimah Othman	Member	Rep. SAD (Research)
Ali Mokhtar	Member	AD (Agric. Engineering)
Massumi Bojeng	Member	Rep. AD (Human Resource Management)

B. GUIDELINES AND PREPARATION OF TERMS OF REFERENCE FOR THE ESTABLISHMENT OF GIS IN DOA

Mandate of DGIS

The mandate of the DGIS is to work out the GIS needs and what GIS can do for the Department covering the functional and technical aspects of GIS; and to formulate a work plan matrix for the implementation of a Geographical Information System in the Department.

Basic Issues on the Establishment of GIS

The basic issues which need to be addressed by the DGIS Working Group are:

Infoware - Types of data/information (existing and actual)
Humanware - Personnel and manpower requirement (Manpower audit and training needs)
Orgaware - Interdepartmental/inter-institutional collaboration and cooperation
Technoware - System Configuration (Hardware and Software)
Degree of sophistication - Headquarter/Division/District levels

Methodology and Approach

The methodology and approach adopted by the DGIS are described below.

* To register relevant members/representatives from the six Divisions and three Branches of the Department.

* To conduct meetings and workshops as when and where is required to keep members informed of the development and trends in GIS.

* To distribute questionaire forms to all Divisions and Branches at the headquarter as well as the divisional and district departmental offices on matter pertaining to the types of available data/information and data/information needs for future planning.

* To prepare DGIS Working Group Study Report. The content of the Report should include analysis and compilation of data/information, personnel and manpower requirements, GIS facilities and needs as well as inter-departmental collaboration and cooperation needs for the establishment of a DGIS for onward transmission to the State GIS/RS Technical Committee through the Director of Agriculture, Sarawak.

* To identify and recommend consultant(s) to assist in the implementation of GIS.

* To determined the time frame for the successful implementation of GIS in the Department.

C. TERMS OF REFERENCE FOR THE ESTABLISHMENT OF GEOGRAPHICAL INFORMATION SYSTEM IN DOA, 1997

The DGIS Working Group is to prepare a study report for the successful establishment of GIS in the Department of Agriculture, Sarawak. The Terms of Reference for the DGIS are described below.

* To compile available data/information in the Department encompassing data format, scales and data/information accuracy.
* To compile data/information needs for agricultural development planning and GIS database.
* To compile data bank for the Department of Agriculture.
* To collect and collate information for GIS planning and design.
* To identify and recommend the personnel and manpower resource requirement for operating and maintaining the GIS.
* To identify and recommend GIS training needs.
* To re-look into the organizational structure with a view to optimize manpower in operating and maintaining the GIS.
* To identify and propose the design of GIS infrastructure and linkages within the Department as well as outside the Department.
* To recommend the time schedule and costing for the implementation of GIS.
* To plan the work flow and to submit the Study Report to the Departmental Steering Committee towards the last quarter of 1997.

D. ACTIVITIES AND WORK CALENDAR OF DGIS, 1997

The activities and work calender of the DGIS to prepare the study report on the establishment of Geographical Information System (GIS) DOA are described below.

Time Frame and Activity Plan - 1997

No.	Activity	Indicator/ Report	Implementation period/months												Manpower Involved	Resources Required
			1	2	3	4	5	6	7	8	9	10	11	12		
1	First DGIS workgroup meeting (28.1.97)	28.01.97 (Background on DGIS setup, Intro. on DGIS , draft TOR, workplan 1997)													DGIS Workgroup	
2	Distribution of questionaire form (28.1.97)	28.01.97 (data type, availibility, format, scale validity, other data required)													DGIS Workgroup/ relevant staff	
3	Received of questionaire forms from other branches	29 - 06.02.97													DGIS Secretary	
4	Assessment on questionaire feedback	6 - 14.02.97 (standardisation)													DGIS Secretary	
5	Second DGIS workgroup meeting	15.02.97 (Discuss on the data set prior presented to the State GIS consultant, TOR, workplan)													DGIS Secretary/ADA/ SAINS representatives.	RM100.00
6	Compile findings of the first two meeting.	16 - 24.02.97													DGIS Secretary	
7	Submission of first interim report to DSC for approval.	25.2.97 (Incl. data set, TOR, proposed workprogramme)													DGIS Secretary/ Chair-man	
8	Visit to relevant agencies who had aquired GIS (Sarawak/Pen. M'sia) - Secretary	1 - 7.03.97 (Discuss on the GIS setup, data struct., hardware and software config., organisation struct., network)													Secretary / Chairman	RM 2000.00
9	Workshop for DGIS workgroup	7 - 8.04.97 (To invite GIS expert from Pen. M'sia, exposure to GIS)													DGIS Workgroup	RM 6000.00
10	Visit to the DOA Pen. M'sia Soil Info/GIS and other GIS vendors - DGIS Workgroup	20 - 23.04.97 (Exposure to GIS facilities, organisation, network, data capture)													DGIS Workgroup	RM 15,000.00

Time Frame and Activity Plan - 1997

No.	Activity	Indicator/ Report	Implementation period/months												Manpower Involved	Resources Required
			1	2	3	4	5	6	7	8	9	10	11	12		
11	Third DGIS Workgroup meeting	28.04.97 (Discuss on the compilation of the master and action plans/appoint consultant to come out with the masterplan for the department.)													DGIS Workgroup	RM 100.00
12	Prepare TOR for the consultant	5 - 17.05.97 (Incl. Infloware, Orgaware, Humanware, Technoware)													DGIS Workgroup	RM 300,000.00
13	Appoint consultant	19 - 31.05.97													DGIS Workgroup	
14	Preparation of the masterplan by the consultant	June - October 1997													Appointed Consultant	
15	Received draft of masterplan from consultant for review (20 copies)	1.08.97 (Distribute to DGIS workgroup member)													DGIS WorkGroup	
16	Fourth DGIS workgroup meeting	11.08.97 (Discussed on masterplan draft with the consultant)													DGIS Workgroup Appointed Consultant	RM 100.00
17	Received final masterplan from consultant for review (20 copies)	1.11.97													DGIS Workgroup	
18	Fifth DGIS Workgroup meeting	10.11.97 (Discussed on the final masterplan with consultant)													DGIS Workgroup Appointed Consultant	RM 100.00
19	Final editing of the masterplan	11 - 24.11.97													Appointed Consultant	
20	Submission of final masterplan to State IT Council through the Director of Agriculture Sarawak (Produce 21 copies)	29.11.97													DGIS Workgroup	

THE ESTABLISHMENT OF A GEOGRAPHICAL INFORMATION SYSTEM IN THE DEPARTMENT OF AGRICULTURE, SARAWAK

INTRODUCTION

This report is a compilation of contributions by members of the Departmental Geographical Information (DGIS) Working Group. The report is divided into four parts. The first part of the report discusses basic concepts of GIS as GIS technology and application were not familiar terms to some members of the Working Group. The second part contains the objectives and the study methods of needs analysis for the implementation of GIS in DOA. The third part describes the results of needs analysis in respect of the level of sophistication for GIS on basis of the Four Dimensional Model of GIS. The fourth part contains the findings and recommendations of the DGIS Working Group on successful implementation of GIS in DOA, Sarawak.

1. BASIC CONCEPTS OF GEOGRAPHICAL INFORMATION SYSTEM - GIS NEEDS AND WHAT GIS CAN DO

1.1 Definition of Geographical Information System (GIS)

"GIS is a computerized database management system for data capture, storage, retrieval, analysis and display of spatial and non-spatial data" quoted, The National Science Foundation USA.

Stated differently, GIS is a computerized data/information storage and retrieval systems that comprises of hardware and software specially designed to handle and convert the geographically referenced data or spatial data and their corresponding attribute data or non-spatial data such as tables, chard and statistics into interpretable information.

1.2 What GIS can do - An Automated System

With GIS, data can be maintained in desriable media and format. Data can be processed, manipulated and retrieve at lower cost per unit data and with faster speed. Graphic and non-graphic data can be merged and manipulated by various computerized tools. Rapid and repeated analytical testing of conceptual models about geography can be performed. Change of analysis can be efficiently performed for two or more different time periods. Certain forms of analysis can be performed cost effectively which simply can not, if manually performed.

GIS assists in answering the following questions:

Here is ..... (location)
What is at ..... (condition)
What has changed since ..... (trend)
What special feature exist ..... (pattern)
What if ..... (future/planning)

GIS involves:

* Data capture (ground and aerial surveying, remote sensing, interviewing)
* Data input (manual digitizing, scanning, automated conversion from digital data)
* Data storage
* Data retrieval
* Data transformation
* Data manipulation (analysis, modeling)
* Data display

1.3 Types of GIS Data

* Spatial data	Geographically referenced data/specific characteristic to a location which are presented in x, y coordinates (e.g. rainfall station, longhouse, landslide area.
* Non-spatial data	Non geographically referenced attribute data, without x, y coordinates which are presented in the form of tables, charts, list of data (e.g. race, income, poverty, erosion severity)

1.4 GIS Data Structure

Vector	Fundamental element is cartesian x, y coordinates which identify the location in a defined space in which the entity physically occupies. The spatial nature of GIS model allows to distinguish between non-topological and topological data (ability to distinguish left/right with respect to an edge)
Raster	Stores data as string of characters here each character represents a location/cell based geocoding system where map is represented as an array of rectangular or square system.

The two different types of GIS data structure are compared and described in Table 2.

Table 2 Comparision of Raster and Vector Data Structures

Raster Data Structures	Vector Data Structures
Advantages: 1. Simple data structure 2. Overlay operations are easily and efficiently implemented. 3. High spatial variability is efficiently represented in a raster format.	*Advantages:* 1. More compact data structure 2. Provides efficient encoding of topology, and as a result, more efficient implementation of operations that require topological information such as network analysis. 3. Better suited to supporting graphics that closely approximate hand-drawn maps.
Disadvantages: 1. Data structure is less compact. 2. Topological relationships are more difficult to represent. 3. The output of graphics is less aesthetically pleasing because boundaries tend to have a blocky appearance rather than the smooth lines of hand-drawn maps. This can be overcome using a very large number of cells but may result in unacceptably large files.	*Disadvantages:* 1. More complex data structure. 2. Overlay operations are more difficult to implement. 3. The representation of high spatial variability is inefficient. Manipulation and enhancement of digital images cannot be effectively done in the vector domain.

1.5 Data Analysis and Spatial Modelling

Geographical Information Systems provide a large range of analysis capabilities that is able to operate on the topology or spatial aspects of the geographical data, or on non-spatial and spatial attributes combined. These analysis capabilities will be provided in such a way that a user can work interactively in order to perform the analyses and syntheses required. Methods of data analysis and spatial modelling in GIS include:

* Map generalization
* Logical overlay - impose, map mosaic, combining map layers, matrix overlays
* Spatial measurement - area; length and distance
* Arithmetic overlays - index overlays
* Proximity analysis - buffer and corridor
* GIS Modelling - DEM, TIN

1.6 GIS Applications

GIS Technology and Applications

Aerial Surveying	Facilities Management	Land Surverying	Resource Management
Agriculture	Farming Cooperatives	Land Tax	Retail Marketing
Analytical Modelling	Financial Marketing	Local Government	Roads Inventory
Automated Mapping	Fire Authorities		
	Flora and Fauna	Marine Authorities	Salinity Research
Cadastral	Forestry	Marketing Analysis	Shire Councils
Cartography		Mineral Exploration	Soil Conservation
Conservation	Gas Utilities	Mineral Resources	Spatial Analysis
Crime Analysis	Geological Modelling	Mining Tenements	State Planning
			Sugar Cane Industry
Defence	Health Services	National Parks	Surveying
Demographic Analysis	Housing Development	Network Analysis	
Digital Terrain Model	Hydroelectric Utilities		Telecommunication
	Hydrographic Analysis	Petroleum Exploration	Timber Industry
Disaster Planning		Police Authorities	
Drainage & Sewerage	Image Analysis	Pollution Control	Traffic Statistics
	Insurance Assessment	Port and Habour Auth	Transport Planning
Education	Inventory Management	Primary Industries	
Electoral Analysis	Irrigation Management		Urban Planning
		Railway Authorities	
Electricity Utilities	Land Development	Regional Planning	Water Resources
Emergency Services	Land Management	Remote Sensing	Water Utilities
Energy Resources			Wildlife
Environ. Management			

1.7 Components of GIS - Four Dimensional Model of GIS

The four key components of a GIS are described below. A successful implementation of GIS is dependent upon the stages of sophistication and specialization in respect of each of these four components.

* INFOWARE - Data, information, procedure
* TECHNOWARE - Technical aspect, hardware, software, platform
* ORGAWARE - Management, organizational structure, inter-sectoral linkage
* HUMANWARE - Personnel, expertise and skill.

2. OBJECTIVES AND METHODS OF NEEDS ANALYSIS FOR A GEOGRAPHICAL INFORMATION SYSTEM IN DOA, SARAWAK

a. Organizational Structure, Functions and Linkages in DOA

The Department of Agriculture is a State Department under the Ministry of Agriculture and Food Industry. The mandates of the Department are:

* To bring the farm family sector from low level of commercialization towards a higher level of commercialization at a faster rate.
* To facilitate increased food production and adoption of appropriate technologies towards modernization of agriculture.
* To facilitate the development of sustainable agriculture and substantial improvement in the livelihood of farm families.

The Department of Agriculture is made up of six Divisions and three Branches as summarized in Fig. 1. The mandates in respect of the six Divisions and three Branches are summarized in Table 3.

Fig. 1 Organizational Structure of DOA, Sarawak 1998

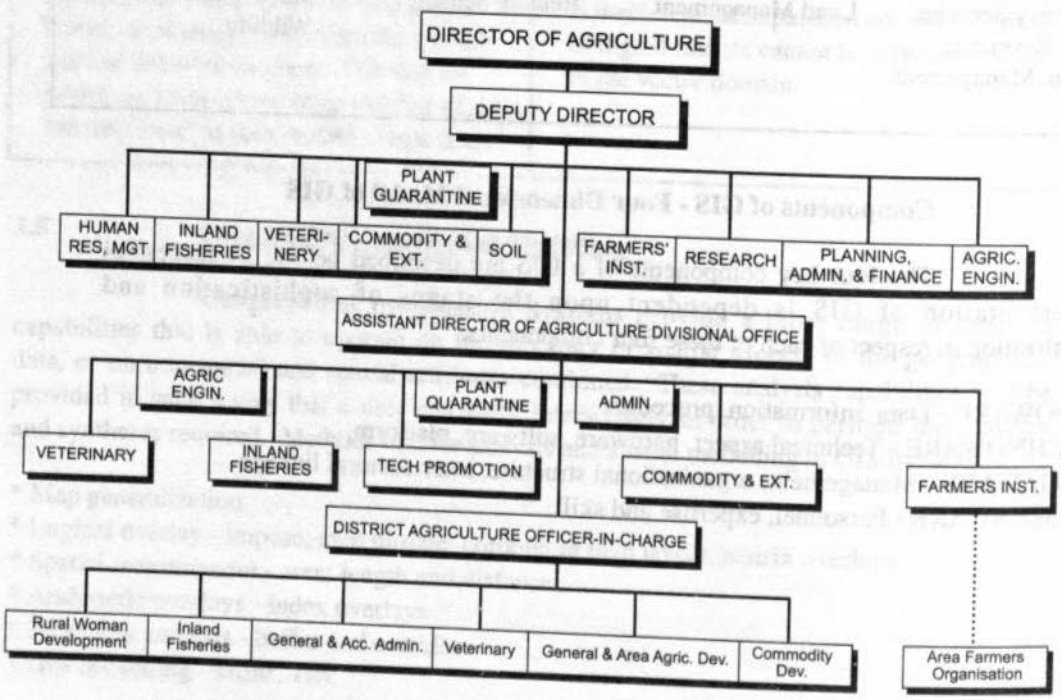


Table 3 Mandates of DOA, Sarawak

Division/Branch	*Mandates*
Crop & Extention	* To facilitate crop industry development. * To facilitate the commercial development of small-holdings. * To alleviate poverty among hard-core poor. * To facilitate the woman sector development.
Veterinary	* To help small holders and commercial livestock farmers maximize their agricultural resources utilization through modern technology for increasing farm productivity and income. * To encourage the development and diversification of livestock industry. * To provide efficient and effective veterinary services thus maintaining an optimal animal health environment conducive to livestock farming.
Inland Fisheries	* To promote commercial acquaculture production as part of the integrated farming activities throughout the State. * To improve family income of the small-holder farmers and fishermen through viable commercial acquaculture and down-stream projects. * To facilitate the production of fish protein in the rural areas as a means of reducing the incidence of malnutrition among the small-holder farmers and fishermen. * To formulate plans for the proper management of the aquatic resources of the riverine and esturaine ecosystems.
Farmers' Institute	* To develop Farmers' Organization as a leading self-reliant, progressive and sustainable farmers' institution and be the prime mover in improving the socio-economic status of its members.
Research	* To develop and market new or improved farming technology packages capable of increasing productivity and efficiency towards commercialized agriculture for income maximization of farmers.
Planning, Administration & Finance	* To provide coordination in the preparation of Departmental five-year plans. * To monitor and evaluate the programmes/projects implemented. * To undertake the collection, collation and compilation of both current and structural statistics on agriculture sector.
Soils	* To generate accurate and up-to-date soil resources information for objective agricultural development and land use planning. * To apply and assist in the promotion of sustainable agriculture through better understanding of soils and adoption of newly developed technologies. * To promote timely release of soil resources information and to enhance product output in desirable media and format.

Contd. Table 3 **Mandates of DOA, Sarawak**

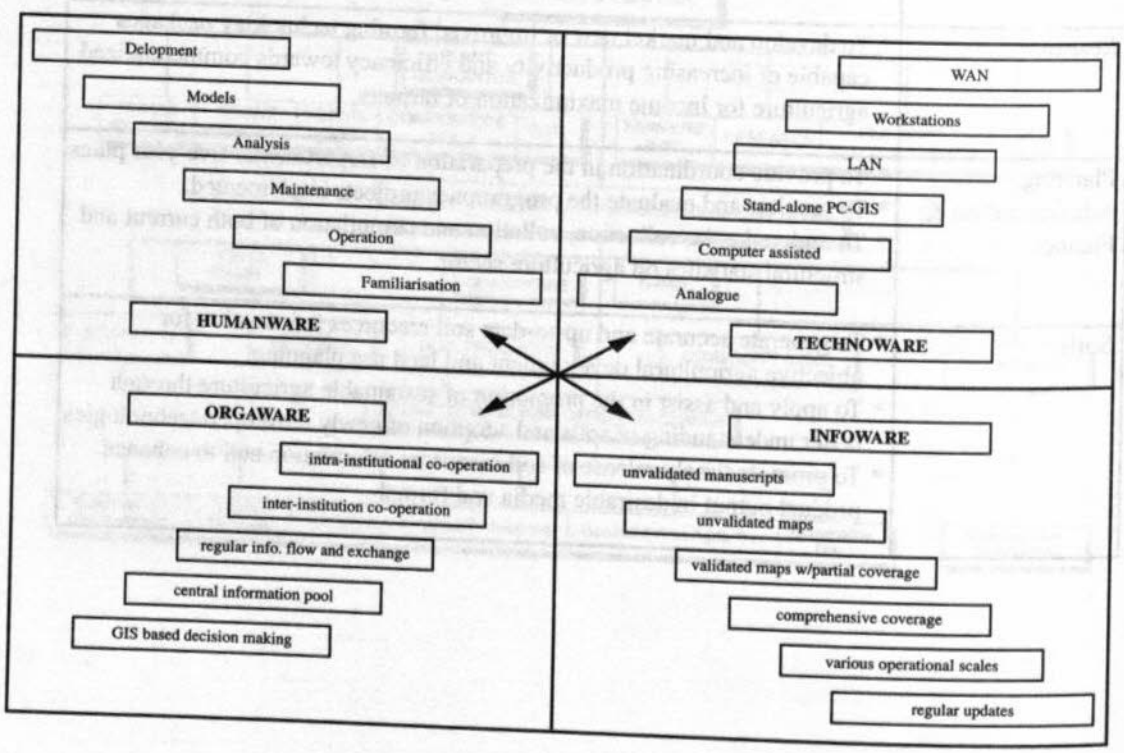
Agriculture Engineering	* To provide institutional infrastructure facilities in order to bring Departmental services closer to target groups. * To provide appropriate farm infrastructure facilities in order to enhace farm productivity.
Human Resource Management	* To facilitate the development of competent human resource and innovative work processes in order to realize a culture of excellence in total quality agric-business.

b. Methods of Needs Analysis for GIS in DOA

The 'Four Dimensional Model' and the level of sophistication for Geographical Information Systems developed by Traub (1997) is adopted for the needs analysis of GIS in DOA. The degree of Sophistication in GIS is also assessed in respect of the Four Dimensions of GIS as shown in Table 4.

Questionaire were designed to collect feedback on the current status of GIS in DOA pertaining to the existing/available data/ information, type of data, scale and storage format and validity (Infoware). The questionaire also include feedback on the technical aspect of GIS, hardware, software and platform (Technoware); data/information management, organizational and inter-sectorial linkages (Orgaware); and the availability of resources in terms of personnel, expertise and skill (Humanware) in operating and maintaining a GIS in DOA.

Table 4 The Four Dimensional Model and the Stages of Sophistication for GIS



3. NEEDS ANALYSIS FOR GIS IN DOA - AN OVERVIEW BY THE FOUR DIMENSIONAL MODEL OF GIS

3.1 INFOWARE

The 'Infoware' dimension covers the data aspect (quality, spatial and temporal coverage). The quality and quantity of available data contribute significantly to the successful implementation of any GIS. Several stages of sophistication in respect of data and information organization are recognized (Traub , 1997). These are described in Table 5.

Table 5 Infoware and Stages of Sophistication

Stages of Sophistication	Description	Remark (Applied in DOA)
Unvalisdated manuscripts	Documents without coordinates and scales and date	Difficult for analogue-digital conversion
Unvalidated maps	Content and accuracy not being validated	Quality and reliability is uncertain
Validated maps	Partial coverage	Various scales
Validated maps	Comprehensive coverage	Various scales
Validated and updated	Partial coverage	Various scales
Validated and updated	Comprehensive coverage	Regularly updated

a. Available Data/Information and Databases in DOA

The results of analysis on available data/information in DOA are compiled and annexed in Appendix I. The existing data/information in DOA can be divided into two types, viz. graphic and non-graphic data/information.

The non-graphic data/information comprise largely the agricultural statistics used in agricultural development and land use planning. They are largely present in series of databases in the forms of tabular files and statistics. The geographic data/information is made up largely of soil resources data/information and some agriculture capability related themes. They are largely presented in analogue form or paper maps of various scales ranging from 1:10,000 to 1:3,000,000.

The conversion of analogue data into digital format has been done for a restricted number of soil and agriculture related themes. The analogue data are available for four soil and agriculture capability related themes (Table 6). The level of coverage of the analogue data varies with the scale. The coverage of the soil analogue data is complete at a scale of 1:500,000 and 1:50,000 respectively; and is partially complete at a scale of 125,000. The coverage of the analogue data for the agriculture capability related theme is complete at a scale of 1:250,000 and 1:50,000 respectively; and is only partially completed at a scale of 1:125,000. The coverage of the analogue data for land use is complete at a scale of 1:500,000. The level of validity for the soil analogue data can be

Table 6 : Soil Inventory (Analogue/Digital Format)

Bil	Nama Peta/ Aktiviti/Program	Rujukan/ Siri	Jenis Output Bercetak/Digital	Bentuk Data Vector/Raster	Format Data Digital	Skala Output	Keupayaan Pengeluaran Bulanan/Tahunan	Edaran Dalaman/ Umum	Media Setoran
1	Soil Map Of Sarawak	DNMM.No.38-1969	Bercetak/Digital	Vector	ArcInfo	1:500,000	<5	Dalaman/Umum	Kertas**/Disket
2	Soil Map Of Sarawak	N/A	Bercetak (amonia print)	-	-	1:50,000	350	Dalaman/Umun	Kertas/filem
3	Agriculture Capability Map*	DPMN.24.04.1/JLD.46/23	Bercetak	-	-	1:500,000	100	Dalaman/Umun	Kertas/filem
4	Agriculture Capability Map	N/A	Bercetak	-	-	1:250,000	100	Dalaman/Umun	Kertas/filem
4	Agriculture Capability Map	N/A	Bercetak (amonia print)	-	-	1:125,000	100	Dalaman/Umun	Kertas/filem
5	Landuse Map (Sheet A)		Digital	Vector	.dxf	1:500,000	N/A	Dalaman	HD/Disket***
	Sadong River Basin								
6	*i. Soils*	N/A	Digital	Vector	.dxf	1:125,000	N/A	Dalaman	HD/Disket***
7	*ii. Landuse*	N/A	Digital	Vector	.dxf	1:125,000	N/A	Dalaman	HD/Disket***

* Baru siap dicetak dan diedarkan pada lewat Nov. 1997
** Pengeluaran terhad sebab kekurangan stok
*** HD - hard disk / Diskette (backup data)

supported by a complete soil survey coverage of the state at a reconnaissance level; and a coverage of 15% of the State's land area at a semi-detailed level. The progress of soil survey at a detailed level is insignificant covering only 0.05% of the total land area in the State.

b. DOA's GIS Sophistication in Infoware

A rough estimate of the existing data/information as against the data/information requirement indicates that approximately 10% of the needed data layers are presently available largely in analogue form for DOA databank. The soils and the related agriculture capability themes provide the only complete data layers for the DOA Databank. The data situation of DOA has been assessed to be at a ***'comprehensive coverage'*** stage in the 'Infoware' dimension (Table 5). However, most of the data/information generated or collected is either area or site specific. The data/information format is not standardized and does not have geo-referencing coordinates and scales. Data are commonly unprocessed and not properly analyzed or updated. The existing data/information are, as a whole, difficult for analogue-digital conversion.

c. Data/Information Needs for GIS Applications in DOA

The existing data/information is collected and generated, to a large extent, for intra-institutional planning use. Data availability versus data needs at the intra-institutional level in DOA can probably be described as near to a satisfactory level in fullfilling DOA's mandate.

The intra-institutional data needs of DOA are compiled and summarized in Table 7. The result of analysis indicates that there are many common information/ theme layers which are needed for inter-sectorial planning. By cross-matching the available data/information with data/information needs, a tentative Databank for DOA is identified as summarized in Table 8. However, coverage of data for the DOA Databank is, as a whole far from being complete. The data that are not available will need to be collected or generated. The types of data and the data sources for future planning and GIS applications in DOA are summarized in Table 9.

Table 7 Data/Information Needs for Future Planning

Type	Title	Layer/Theme	Weightage (out of 9)
Land Based Resources	Agriculture	* Arable land	6
		* Farming system	6
		* Land use change	8
		* Integrated Agric. Development Plan	8
	Forestry	* Forest types	5
		* Forest cover change	5
		* Forest Management Unit	3
		* Integrated Forest Management Plan	5
	Hydrology	* Water bodies	6
		* Water quality	6
		* Coastal Zone	6
		* Major catchment area	7
		* Flood hazard	8
Soils/Mineral Resources	Soils/Minerals	* Soil Types	8
		* Soil Erosion	8
		* Geological Features	5
		* Mineral Resources	3
		* Off-shore Exploration	2
Climate	Rainfall Distribution		8
	Wind Speed/Direction		6
	Temperature		7
Terrain	Contour		8
	Elevation		7
	Slope		7
	Digital Terrain Model		4
Socio-economic Resources	Population	* Age distribution	4
		* Gender ration	4
		* Population density	5
		* Death/Birth rate	4
		* Ethnic distribution	4
		* Migration	4
		* Religion	4
Health	Hospital/Rural Health Centres		3
	Diseases/Outbreaks		3
	Provision of Health Care		3
Education	Schools/Training Centres		4
	Level of education		4
Employment	Active Labour Force		4
	Unemployment Rate		4

Contd. Yable 7 Data/Information Needs for Future Planning

Income	Income		5
	Poverty		4
Tourism	Tourist Sites		5
	Potential Tourist Sites		4
Transport	Public Transportation		4
Trade	Growth Centres		5
	Markets		6
Infrastructure	Road Network/Port	* Road types	7
Resources		* Bridges/Ferries	6
		* Seaports/Airports	5
Energy	Power Plants/Lines		6
Communication	Overland Telephone Lines		5
Water	Industries	* Industrial estates	4
Supply/Sewage		* Timer processing zone	4
		* Industrial waste disposal	4
Urban/Rural	Settlement		6
Built-up	Waste Disposal		5
Land Division	Political/International/ State Boundaries		5
	Division/District Boundaries		6
Land Tenure	Timber License		2
	Mining License		2
	State Land Forest		5
	Permanent Forest Est.		5
	NCR Land		5
Protected Areas	High Biodiversity		6
	Ecological Sensitive		5
	Marine Sanctuaries		5
	Totally Protected		5
	Catchment/Watershed		6
General	Proposed Plans/	* Integrated Reg. Dev. Plan	5
References	Approved Plans	* Integrated Land Use Plan	6
Others:	Gov/Statutory Bodies		4
Location/Details	Research Stations		8
	Project Sites		8
	Pest/Disease Outbreaks		8

Table 8 **Data Availability versus Data Needs at DOA**

DOA GIS DATABANK				
Natural Resources	**Socio-economic Resources**	**Infrastructure Resources**	**Land Division**	**General References**
Agriculture	**Population**	**Road Network**	**Political Boundaries**	**General Map References**
*Suitable/Arable land	*Density/Age distribution	*Road types	*International/State	*Maps at scale 1:250,000
*Farming sustems	*Gender ratio	*Bridges/Ferries	*Divisional/District	*Maps at scale 1:50,000
*Land use change	*Death/Birth rate	*Seaports/Airports		*Landsat TM
*Agriculture Capability	*Ethnic distribution		**Land Tenure**	*Radar
*Integrated Agr.Dev. Plan	*Migration		*State land	*Aerial Photographs
*Crops Information	*Religion		*NCR land	
*Logistic Information				
Hydrology	**Health**	**Urban/Rural Built-up**	**Protected Areas**	
*River/Water bodies	*Hospital/Rural Health Cr.	*Settlement	*Totally Protected Area	
*Water quality	**Education**	*Industries	*Ecolog. Sensitive Area	
*Catchment areas	*Level of education	*Industrial estates	*Committed land use	
*Flood hazard				
Soils/Mineral Resources	**Employment**			
*Soils types	*Active labour force			
*Soi erosion	*Unemployment rate			
*Soil/Crop suitability	**Income**			
	*Income/Poverty			
Climate	**Trade**			
*Rainfall/Sunshine/Temp.	*Market Information			
Terrain	*Agricultural statistics			
*Elevation/Slope/Landform	*Cost/Return information			

Data in analogue format (Incomplete)
Data in analogue format

Table 9 Data Needs for Future Planning and GIS Applications

In-house	External
Existing crops distribution Existing commercial acquaculture farms Livestock distribution & concentration Suitable areas for mechanization Pests & deseases of crops/livestock/fish Availability of suitable land for crops/livestock/ acquaculture Settlement/villages/farm families Soil suitability Socio-economic profiles Crops/Agronomic information Cost/Return information Agric. offices/station Logistic information	Meterological and hydrological data Land Tenure Information Land Classification Information Infra-structure information Market information Vegetation and landuse change

3.2 TECHNOWARE

The 'Technoware' dimension of GIS refers to the physical set-up of GIS which include, among other things, equipment, software and office infra-struture. Technoware is considered the least complicated in the market terms of establishing as hardware and software are often readily available in the market. Other peripheral facilities can often easily be procured as long as fund is available. Several stages of sophistication for GIS in the Technoware Dimension are recognized (Traub, 1997). They are described in Table 10.

a. Technoware in DOA

A detailed description of the present stages of sophistication for GIS with specific reference to the GIS Hardware and Software at the Soils Branch was compiled and presented to the DGIS (Teng, 1997). The existing equipment which is used for the GIS related functions at the Soils Branch are summarized in Table 11.

The GIS hardware components comprises PC, digitizing table (48x36 cm), plotter and A4 printers. A Spatial Analysis System of SPANS/TYDIG Ver. 5.3 is presently the GIS Software used at the Soils Branch. It is a hybrid GIS raster/quadtree based software for integration, analysis and modelling of geographical data. The key features of this Raster Imaging GIS Software are described below.

Table 10 Technoware and Stages of Sophistication

Stages of Sophistication	Description	Remark
Analogue	Manual GIS operations by overlay on a light-table, pan-topographic rescaling, and etc.	Applied for soil & related themes
Computer-assisted	CAD & DTP used for digital mapping and visualization	None
Stand-alone PC GIS	GIS operation by GIS software	At early stage of development in Soils Branch
Local Area Network (LAN)	Several users practise file sharing in a server/client environment using a centralized DBMS	None
Workstations	Platform based on UNIX systems	None
Wide Area Network (WAN)	Interchange of data by network over district/Division/State	None

Table 11 Hardware and Software at the Soils Branch

Hardware	**Software**
1 x PC Pentium 1 x PC 486 DX4, 59 Mhz, 600 MB 1 x AO Digitising Table 1 x AP Pen Plotter 2 x A4 Printer	Window 3.11, OS/2, 1 x SPANS/TYDIG Ver 5.3 Window 3.11

i. Imaging GIS Software

* *Integrated image process*
* *GIS analysis*
* *Vector data*
* *Tabular data*
* *Digital photometry*
* *Data visualization*
* *Cartographic map creator*

ii. Image Visual GIS Features

* *Interactive movement through three dimensions*
* *Data manipulation*
* *Graphic querry*
* *Fly interactively or by swetting flight pattern*
* *Real time control of elevation, pitch azimuth*
* *Look angle*

b. DOA's GIS Sophistication in Technoware

The present GIS involvement of DOA is confined only to the Soil Information/Cartographic Unit of the Soils Branch where GIS activities were first started in tandem with the establishment of GIS at the State Planning Unit in the framework of the former CIDA-supported Integrated Agricultural Development Programme (SADP) in 1991.

The initial physical set-up of GIS at the Soils Branch was met with much disenthusiasm by certain Senior Agricultural Planner. It was commented that the level of sophistication for the GIS at the Soils Branch would not be able to meet the Department's needs. It was all very well said but only so in passing. There was no commitment whatsoever then as to suggest an alternative option to the kind of GIS and the level of GIS sophistication that the Department should procure for the Departmental use.

The implementation of GIS at the Soils Branch started in 1994 with the examination of data output requirements and the cost of acquiring reliable data for input to the system and how this information can be dessiminated rapidly for use within and ouitside the Department. A subsequently evaluation on basis of the prevailing financial and manpower constraints suggested that the Soil Branch could at best implement a GIS on *as hoc* basis. The financial allocation under the 1994 Special Expenditure to the Soils Branch was only sufficient for the purchase of GIS hardware. A supplementary allocation in 1995 was necessary for the procurement and installation of the SPAN/TYDIG Ver. 5.2 GIS software. The choice of this software was preferred to the others in order to benchmark against the GIS software at the State Planning where the same software was used then in computer-assisted mapping between 1991-1995. The SPANS software at the Soils Branch was subsequently upgraded from Ver. 5.2 to Ver. 5.3 in 1996.

At this present stage, GIS in Soils Branch takes the form of a stand-alone system which aims primarily at conversion of data from analogue to digital format and also for the digital preparation of soil resources maps. The system is presently developed to examine the graphical elements of the system. Data are usally selected to enable the graphics to be displayed in the correct form and the type of database is designed to optimize this feature. The level of DOA GIS sophistication is ranked low and has reached no higher than the ***"computer-assisted"*** stage of sophistication in the ***Technoware*** dimension (See Table 10).

3.3 ORGAWARE

The Orgaware dimension refers to the organizational framework and its network of linkages inside an outside the department. The level of sophistication of Orgaware can be categorized into five stages, starting from 'intra-institutional cooperation' up to 'GIS-based decision making' as described in Table 12.

Table 12 Orgaware and Stages of Sophistication

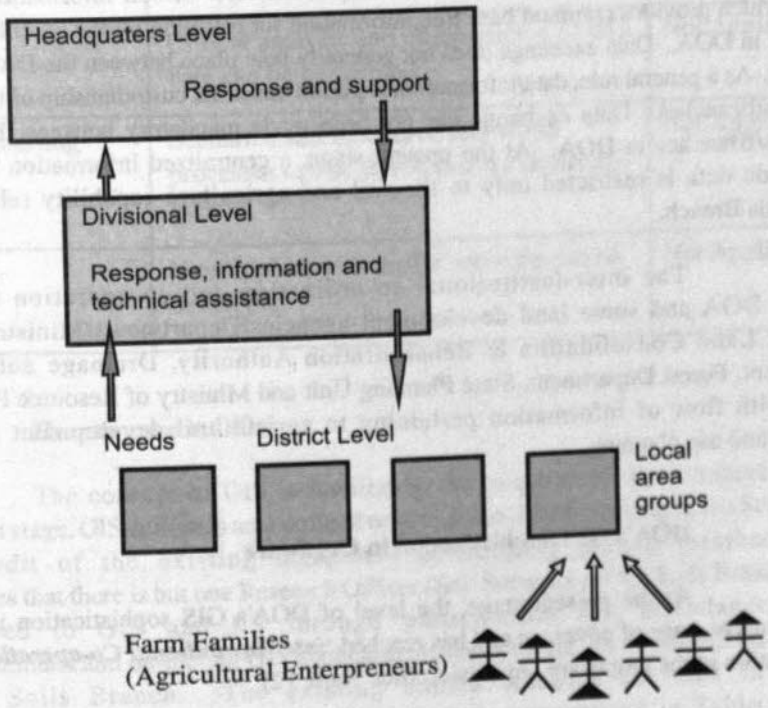
Stages of Sophistication	Description	Remark
Intra-institutional Co-operation	Different Divisions/Branches/Sections within an institution coordinate and cooperate regularly (internal linkages) with regard to data exchange	Applied in DOA
Inter-institutional Co-operation	Different institutions cooperate and interact on a case-to-case basis (external linkages) with regard to data exchange	Applied in DOA
Regular Information Flow and Exchange	A systematic and regular data sharing and exchange procedure is implemented	Not Applied
Central Information Pool	A host institute is mandated to be the central data depository	Not Applied
GIS-based Decision Making	Decision makers within an institution make decisions based on GIS output and products	Not Applied

a. Orgaware in DOA

The present Orgaware of DOA, Sarawak is shown in Fig. 1. The DOA is made up of six Divisions and three Branches and has three administrative levels, starting from the district to division and up to headquarters levels.

Agricultural development planning basically takes place simultaneously at the three different administrative levels. A major emphasis is put on agricultural development planning towards sustainable development which supposedly includes an integration of the resources, environment, social and economic issues. This planning process is conceived as an interactive process which can only be successful with a high level of commitment between the stakeholders/farm families and the planners/implementors at the three administrative levels, starting from district to headquarters as shown in Fig. 2.

Fig. 2 Demand Driven Interactive Development Planning in DOA



The intra-institutional planning in DOA starts by ways of generating and collecting data/information among the local area groups/villages at the district level. Data/information are processed and needs are identified. Information flow and exchange between the district and divisional levels are regulated and made mandatory. A systematic and regular data sharing and exchange is assured by formal procedure and presentation in monthly meeting. Issues relating to projects are resolved with response of information and action. Further technical assistance and needs are compiled which, after close scrutinization by the Departmental Action Committee Group headed by Divisional

Assistant Director of Agriculture are next to be submitted with recommendation in the forms of progress reports and Annual Reports to the Divisional Heads (Senior Assistant Director of Agriculture) at headquarters. The Headquarter Divisions, governed by the availability of fund and resources would respond accordingly by vetting and often with counter recommendations and exertion of control over the implementation of agricultural projects by formulation of formal guidelines and support; and 'modus operanti' for specific schemes and projects. The Departmental Steering Committee oversees the decision and policy-making matters at the headquarters level.

Information flow between the Headquarter Divisions is restricted to monthly financial return between the Planning, Administrative and Finance Divisions and all the six Divisions and three Branches at the Headquarter level. The intra-institutional cooperation or internal linkage is generally confined to one-way information flow between the Divisions or Branches. For example, the flow of soil information from Soils Branch which provides common base line information for planning by the other Divisions and Branches in DOA. Data exchange does not generally take place between the Division and the Branches. As a general rule, data/information is placed under the custodianship of the individual Divisions/Branches. Data exchange has not been made mandatory between the individual Divisions/Branches in DOA. At the present stage, a centralized information pool for the geographic data is restricted only to the soil and agriculture capability related themes at the Soils Branch.

The inter-institutional co-ordination and co-operation is common between DOA and some land development agencies/Departments/Ministries such as Sarawak Land Consolidation & Rehabilitation Authority, Drainage and Irrigation Department, Forest Department, State Planning Unit and Ministry of Resource Planning and others with flow of information pertaining to agricultural development zoning and regional land use planning.

b. DOA's GIS Sophistication in Orgaware

At the present stage, the level of DOA's GIS sophistication is ranked at comprehensive stage of coverage and has reached ***'inter-institutional Co-operation'*** stage of sophistication in the Orgaware Dimension (See Table 12).

3.4 Humanware

Humanware refers to the availability of human resources in the forms of personnel, expertise and skill in developing and oeprating geographical information systems. There are six different stages of sophistication in humanware for GIS. These are described in Table 13.

Table 13 Humanware and Stages of Sophistication

Stages of Sophistication	Description	Remark
Familiarisation	Concept of GIS is known and understood by the people involved	Applied in DOA
Operation	Off-the-shelf GIS software adopted and used; and standard GIS functions handled by the staff	Partly Applied at Soils Branch
Maintenance	The status quo of the GIS can be maintained without outside support	Not Applied
Analysis	Critical analysis and interpretation of GIS data can be performed	Not Applied
Models & Modelling	Scenarios and models of real world processes can be developed for decision-making	Not Applied
Development	New applications and/or software can be developed	Not Applied

a. Humanware in DOA

The concept of GIS is familiar to the majority of the members in DGIS. At this present stage, GIS activities are confined only to some digital mapping at the Soils Branch. A quick audit of the existing manpower particularly among members of the DGIS indicates that there is but one Research Officer (Soil Surveyor) at the Soils Branch who has been exposed to GIS and RS through participation and attendance of GIS workshops/seminars and on-the-job GIS application/training on the use of SPANS GIS Software within the Soils Branch. The existing human resource for GIS in DOA in person of this Research Officer (Soil Surveyor) is summarized in Table 14. It is envisaged that part of the existing human resource in the Cartographic Unit of the Soils Branch may be re-deployed to GIS Work Team, given the necessary training in GIS. Presently, members of the Cartographic Unit are doing manual drafting of maps and colour-processed mapping. They have been given a basic introduction to the SPANS GIS but are not using the software just yet.

Table 14 GIS Staff of DOA

Position	Main Task(s)	GIS Training Background
Research Officer (Soil Information Unit, Soils Branch)	General GIS related task(s)	* Workshop on GIS * Natural Resource Information Management (GIS/RS) * Basic Remote-Sensing Course * 2nd Regional RS Seminar on tropical eco-system management * Application of RS and GIS for urban planning * RS for marine studies * Quantitative methodology for explorary RS/GIS studies * Information Technology Management Programme

b. DOA's GIS Sophistication in Humanware

The level of sophistication of the human resource for GIS in DOA is drawn by a comparision of required GIS activities and actual situation at Soils Branch of DOA. The results were obtained by conduct of interview at the Soils Branch. These were described by Eller (per. comm. 1997) in Table 15. The level of sophistication of the human resource for GIS in DOA is low at no higher than a level of ***'familiarization'*** in the humanware dimension (See Table 13).

4. ESTABLISHMENT OF GEOGRAPHICAL INFORMATION SYSTEM (GIS) IN DOA, SARAWAK

4.1 Potential Areas of GIS Application in DOA

GIS as a planning and decision-support tool has in principal been recognized by the Department as useful for various applications relating to planning and management of resources for agricultural production. GIS technology in combination with remote-sensing application can be adopted, among others, for the zoning and development of suitable areas for cropping, acquaculture, livestock and also for citing of rural infrastracture projects such as rural project roads, market outlets and collection centres. GIS can be used as a tool in decision-support by ways of critical analysis and optimization of facilities/resources according to situation through simulation or GIS models. GIS can ultimately be employed to support the preparation of an integrated agricultural development plan for the State. The potential areas of GIS application by DOA are summarized in Table 16. First of all, GIS application starts with the development of Infoware Framework.

Table 15 Required GIS activities and actual situation at Soils Branch

Requirements	Actual Situation : + (carried out); 0 (partly carried out); - (not carried out)
OPERATION	*RATING*
* Acquision of data	+, in-house, external
* GIS/RS planning and design	-
* Development of applications	-
* Processing of satellite image	-
* Interpretation of image	+, aerial photographs
* Collection of field data (e.g. GPS)	+
* Preparation of map manuscripts	+, draft, tracing, colour-processed mapping
* Entering attribute data	-
* Retrieval of data	+
* Model spatial and non-spatial data	+, agriculture capability, potential suitability
* Plot/Print	+, ammonia-dyeline prints
* Output quality control	+, cross- checks (village data are outdated or cannot be properly validated)
* Develop and maintain GIS/RS databases	+, semi-standardized departmental system
* Ensure data integrity/security	+, but no back-up for digital data
* Enhance and optimize system	-
* Maintenance of hardware/software	0, by SAINS; 4 months interval on hardware only
* Document procedures	+
ADMINISTRATION	
* Plan work flow	+
* Control work flow	+, more difficult for extension
* Allocate and control resources	+
* Design actual work	+
* Contact users	+
* Elaborate projects	+
* General management activities	+
* Dessiminate outputs	+

Table 16 Potential Areas of GIS Applications in DOA

Integrated Agriculture Planning	Headqu'ter	Divisional	District
1. Planning & Development of Commercial Cropping			
2. Expected crop yields			
3. Agriculture capability			
4. Agro-climatic zonation			
5. Farm Mechanization Planning & Development			
6. Planning & Development of Market Infra-structure			
7. Planning & Development of Acquaculture			
8. Livestock Planning & Development			
9. Pests & Diseases Monitoring			
10. Planning & Distribution of Manpower			
11. Environmentally Sensitive Areas			
12. Objective land use planning			

Potential area of application

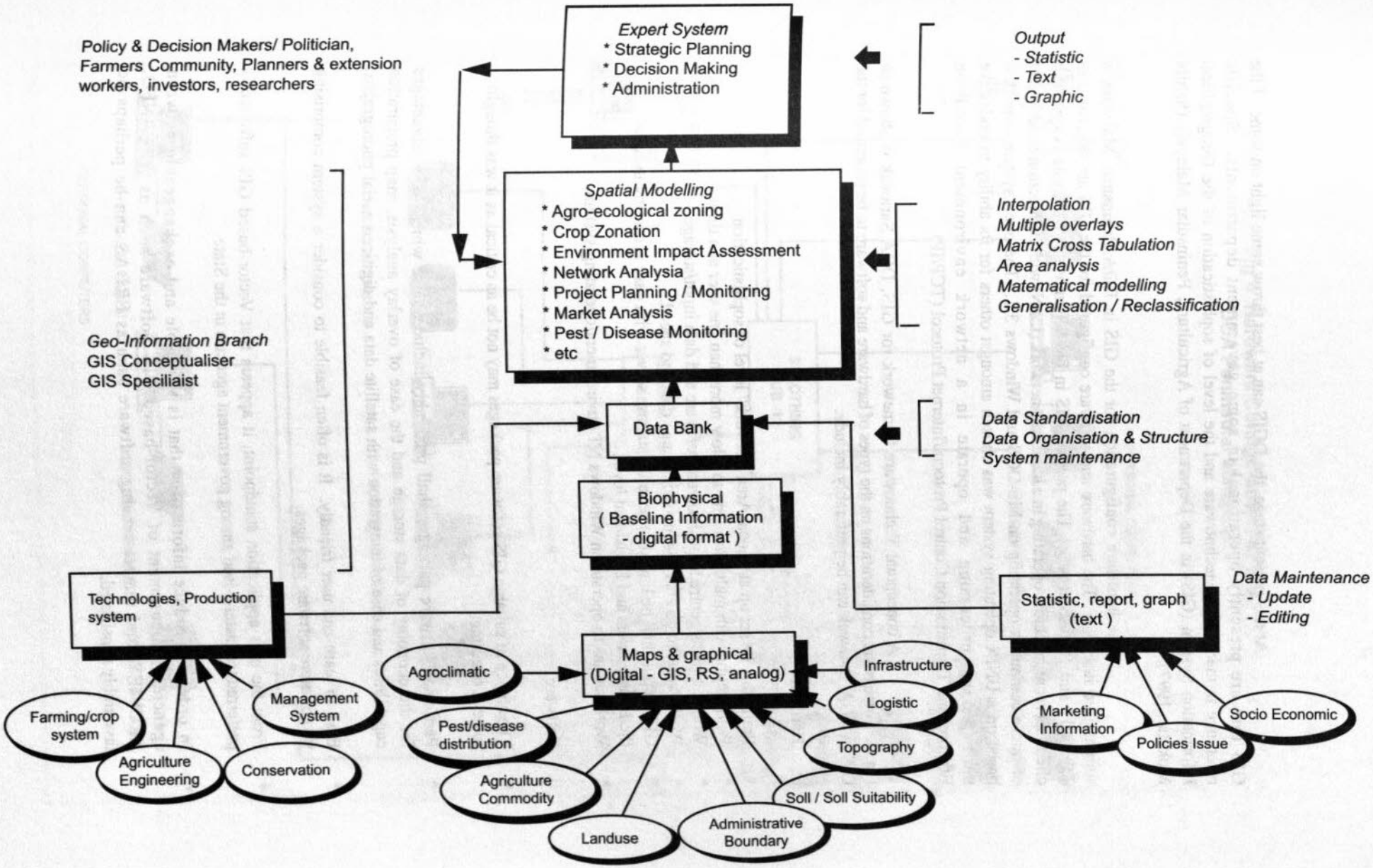
4.2 Suggested Infoware Framework for GIS, DOA

A conceptual GIS Infoware Framework for GIS, DOA is shown in Fig. 3. The Infoware Framework depicts, firstly, the need of data acquisition for GIS at the various levels in DOA. Secondly, it indicates that successful implementation of the departmental GIS can be categorically divided into two stages. The first stage, is basically the development of a Geographical Information System whereby data/information is collected and generated and GIS is used as a tool to store, process, manage and use the data for certain defined purposes. The second stage, is referred to as Executive Information System of Information Support System. By ways of intra- and inter-institutional data exchange and information flow and by manipulating the data or modelling the data into layers of intelligient information, Executive Information System can be used to serve the various co-ordination, co-operation and operational planning and management needs of the Department.

4.3 Suggested Technoware for GIS, DOA

The identification of appropriate hardware and software for GIS in DOA does not come under the TOR for the DGIS. The reason is simple as members of the DGIS do not have the expertise on hardware configuration neither do they have the technical knowledge on the selection of appropriate GIS software for GIS in DOA. It is suggested that identification of hardware and software should best be left to the expert or consultant. The engagement of a consultant to advise on the technoware for DOA can probably be incorporated as part of the GIS project requirement if the DOA were to proceed with the establishment of GIS.

Fig 3: Suggested Infoware Framework For GIS, DOA Sarawak



At this present stage, the DGIS can at best throw some light on some of the GIS that are presently operational in some government departments. Specific reference is made to the technoware and the level of sophistication of the Geographical Information System (GIS) in the Department of Agriculture, Peninsular Malaysia (Sahibi Mokhtar, 1997).

The hardware configuration for the GIS in DOA Peninsular Malaysia is summarized in Fig. 4. The hardware and software configured for the GIS are described in Tables 17 and 18 respectively. The present GIS in DOA Peninsular Malaysia is one of a client-server architecture operating in a local area network (LAN) with connection to a number of micro-computers operating on MS-DOS and Windows 3.1. The open system approach based on a UNIX operating system was chosen amongst others for its ability to undertake multi-tasking processing and operate in a network environment based on Ethernet and Transmission Control Protocol/Internet Protocol (TCP/IP).

A conceptual Technoware framework for GIS, DOA Sarawak is shown in Fig. 5. Some basic considerations on the types of hardware and software to be procured for the GIS in DOA, Sarawak can be preferably include:

i. Hardware

* Preferably be set up at "Local Area Network" level of sophistication.
* Workstation with multi-licensing to allow more than one user at a time.
* Workstation as centre to position the software and data input/storage.
* Workstation to do analysis involving huge data and speed.
* GIS output shall be linked to central database server with easy access by users at the Headquarters and Divisional level.
* Workstations to operate on Windows NT environment/operating system.

ii. Software

* The choice of suitable GIS software packages may not be as critical as it was thought to be at one time.

* Particular software packages shall preferably include those which have advantages for the economy of data storage and the ease of overlay analysis, map preparation capabilities and ease of integration with satellite data and digitized aerial photographs.

* Easy to learn and user friendly. It is often feasible to consider a system comprising two or more software packages.

* From the user application standpoint, it appears that Vector-based GIS software is preferred to Raster-based among government agencies in the State.

* In order to produce information that is shareable and exchangeable between agencies, procurement of Vector-based GIS Software such as ARC/INFO, ARCVIEW and remote-sensing software such as ERDAS can be perhaps be favourably considered.

Fig 4 Hardware Configuration For GIS
DOA Peninsular Malaysia

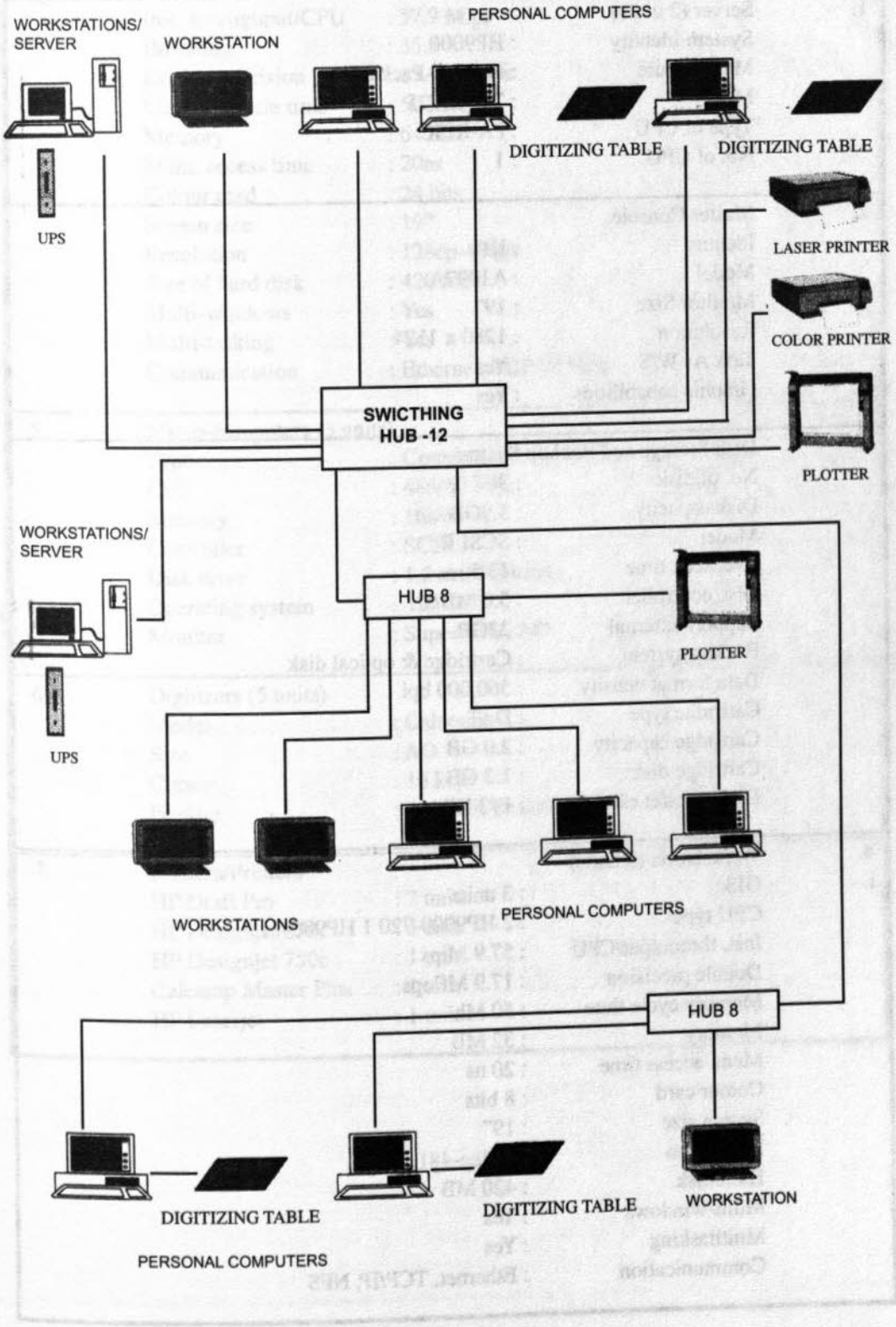


Table 17 Hardware Configuration for GIS, DOA Peninsular Malaysia

Hardware		
1.	Server (2 units)	
	System Identity	: HP9000
	Manufacture	: Hewlett-Packard
	Model	: 750 & 725
	Type of CPU	: PA-RISC
	No. of CPU	: 1
2.	Master Console	
	Identity	: HP
	Model	: A1097A
	Monitor Size	: 19"
	Resolution	: 1280 x 1124
	Task As W/S	: Yes
	Graphic capabilities	: Yes
3.	Disk Storage and Backup System	
	No. of disk	: 3
	Disk capacity	: 5.9GB
	Model	: SCSI II
	Ave. seek time	: 13.5 ms
	Disc controller	: 5.0 MB/s
	Support external	: 23GB
	Backup system	: Cartridge & optical disk
	Data format density	: 560,000 bpi
	Cartridge type	: DAT
	Cartridge capacity	: 2.0 GB
	Cartridge disk	: 1.3 GB
	Data transfer rate	: 173 KB/s
4.	Workstation (3 units)	
i.	GIS	: 3 units
	CPU type	: 2 HP9000-720 1 HP900-715
	Inst. throoutput/CPU	: 57.9 Mips
	Double precision	: 17.9 Mflops
	Memory cycle time	: 50 Mh
	Memory	: 32 MB
	Mem. access time	: 20 ns
	Colour card	: 8 bits
	Screen size	: 19"
	Resolution	: 128cp-481ps
	Hard disk	: 420 MB
	Multi-windows	: Yes
	Multitasking	: Yes
	Communication	: Ethernet, TCP/IP, NFS

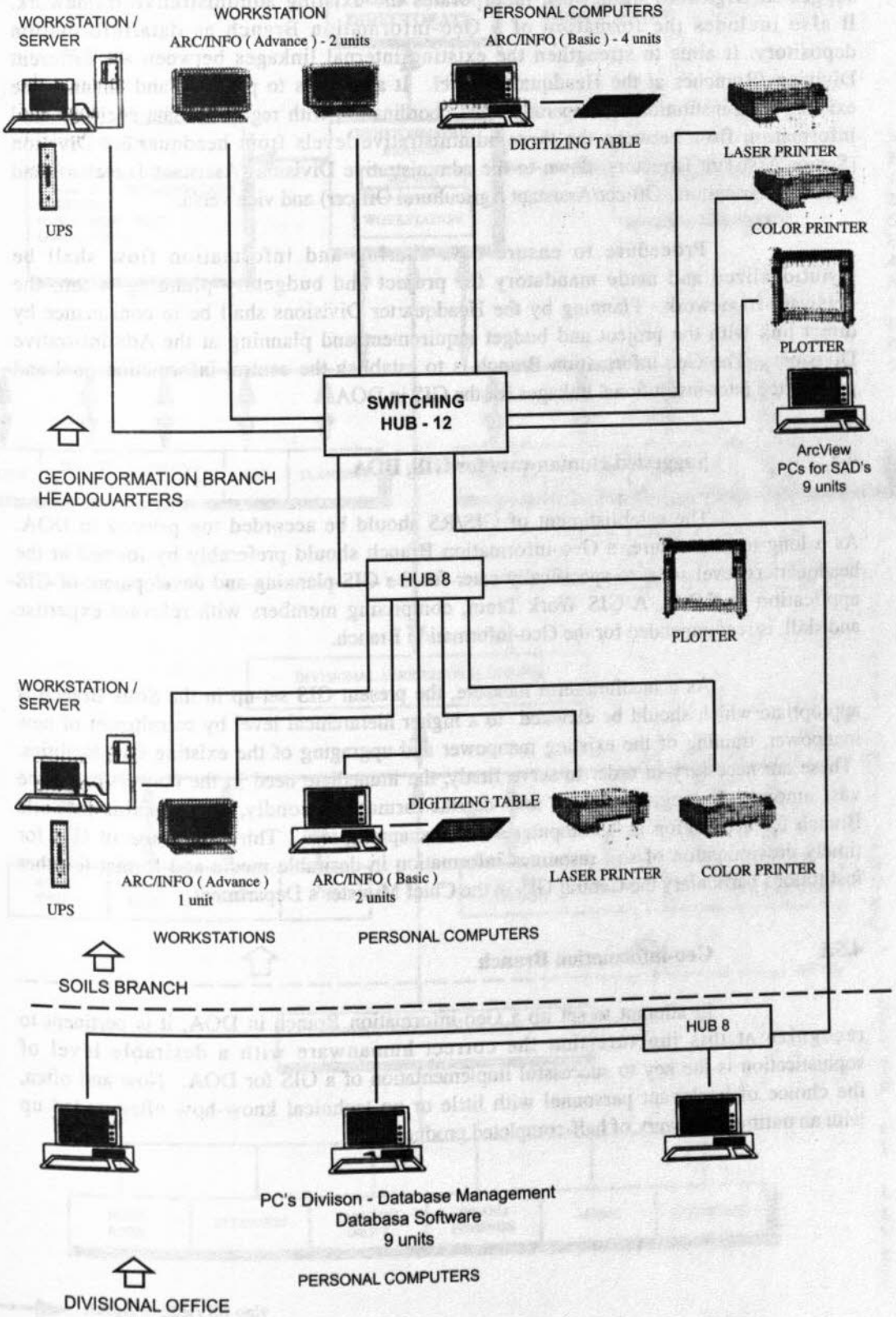
Contd Table 17 Hardware Configuration DOA, Peninsular Malaysia

ii.	Image Analysis (Remote-sensing)	
	CPU type	: HP9000-720
	Inst. throughput/CPU	: 57.9 Mips
	IM rating	: 35.5
	Double precision	: 17.9 Mflops
	Memory cycle time	: 50 MHz
	Memory	: 64 MB
	Mem. access time	: 20ns
	Colour card	: 24 bits
	Screen size	: 19"
	Resolution	: 128cp-481ps
	Size of hard disk	: 420 MB
	Multi-windows	: Yes
	Multi-tasking	: Yes
	Communication	: Ethernet, TCP/IP, NFS
5.	Micro-computers (3 units)	
	Type	: Compaq
	CPU	: 486/50 Mhz
	Memory	: 16MB
	Controller	: SCSI
	Disk drive	: 1.2 and 1.44 MB
	Operating system	: MS DOS
	Monitor	: Super VGA 14"
6.	Digitizers (5 units)	
	Model	: Calcomp
	Size	: AO
	Cursor	: 16 keys
	Feature	: 4 backlit 1 non-backlit
7.	Plotters/Printers	
	HP Draft Pro	: 2 units
	HP Designjet 650c	: 1 unit
	HP Designjet 750c	: 1 unit
	Calcamp Master Plus	: 1 unit
	HP Laserjet	: 1 unit

Table 18 GIS Software DOA, Peninsular Malaysia

SOFTWARE	ARC/INFO 7.0 for UNIX	
	CORE	: 1 license
	Floating licence	: 6
	Network modules	: 1
	DTM/TIN	: 1
	GRID/RASTER	: 1
	ARC/INFO 3.4 PC	: 5
	ARCVIEW 2.0 UNIX	: 1
	ARCVIEW 2.0 PC	: 5
	ARC/INFO DAK	: 2
	ERDAS/IMAGINE :	
	Spatial and spectral enhancement	
	Rectify image from SPOT, Landsat, radar & etc.	
	Assess accuracy of processed data	
	Overlay data of different resolution and size	
	Resample data from SPOT, Landsat etc and perform overlay	
	Perform querries from multiple files	
	Display at least three bands at a time	
	Display GIS Vector data and image	
	Performs Raster to Vector	
	Create and edit file including conversion and subsetting	
	Process unlimited file size and full screen	
	Classify more than 42 classes	
	Masking and clipping	
	Automatic contract stretching, screen mosaic, and enlargement/reduction	
	Supervised and unsupervised classification	
	Full screen parallel piped classification	
	Define training samples	
	Radiometric correction	
	Perform spatial analysis, editing and manipulation	
	Able to read LGSOWG (BSQ and BIL format)	
	Determine unknown format	
	DATABASE MANAGEMENT SYSTEM	
	ORACLE software consisting of	
	RDBMS kernet	: 1 unit
	Transaction processing	: 1 unit
	SQL * NET	: 4 units
	Network protocol	: 3 units
	SQL * PLUS	: 3 units
	SQL * FORMS	: 3 units
	SQL * Reportwriter	: 3 units
	Pro * C	: 3 units

Fig 5 Suggested Hardware Configuration For GIS, DOA Sarawak



4.4 Suggested Orgaware for GIS, DOA

The suggested Orgaware framework for GIS, ODA is shown in Fig. 6. The suggested Orgaware framework incorporates the existing administrative framework. It also includes the formation of a Geo-information Branch as data/information depository. It aims to strengthen the existing internal linkages between the different Divisions/Branches at the Headquarter level. It also aims to promote and enhance the existing intra-institutional co-operation and coordination with regard to data exchange and information flow between the three administrative levels from headquarters Division (Senior Assistant Directors) down to the administrative Division (Assistant Directors) and District (Agricultural Officer/Assistant Agricultural Officer) and vice versa.

Procedure to ensure data sharing and information flow shall be instutionalized and made mandatory for project and budgetary planning within the orgaware framework. Planning by the Headquarter Divisions shall be in consonance by direct link with the project and budget requirement and planning at the Administrative Divisions. The Geo-information Branch is to establish the central information pool and provide the inter-institutional linkages for the GIS in DOA.

4.5 Suggested Humanware for GIS, DOA

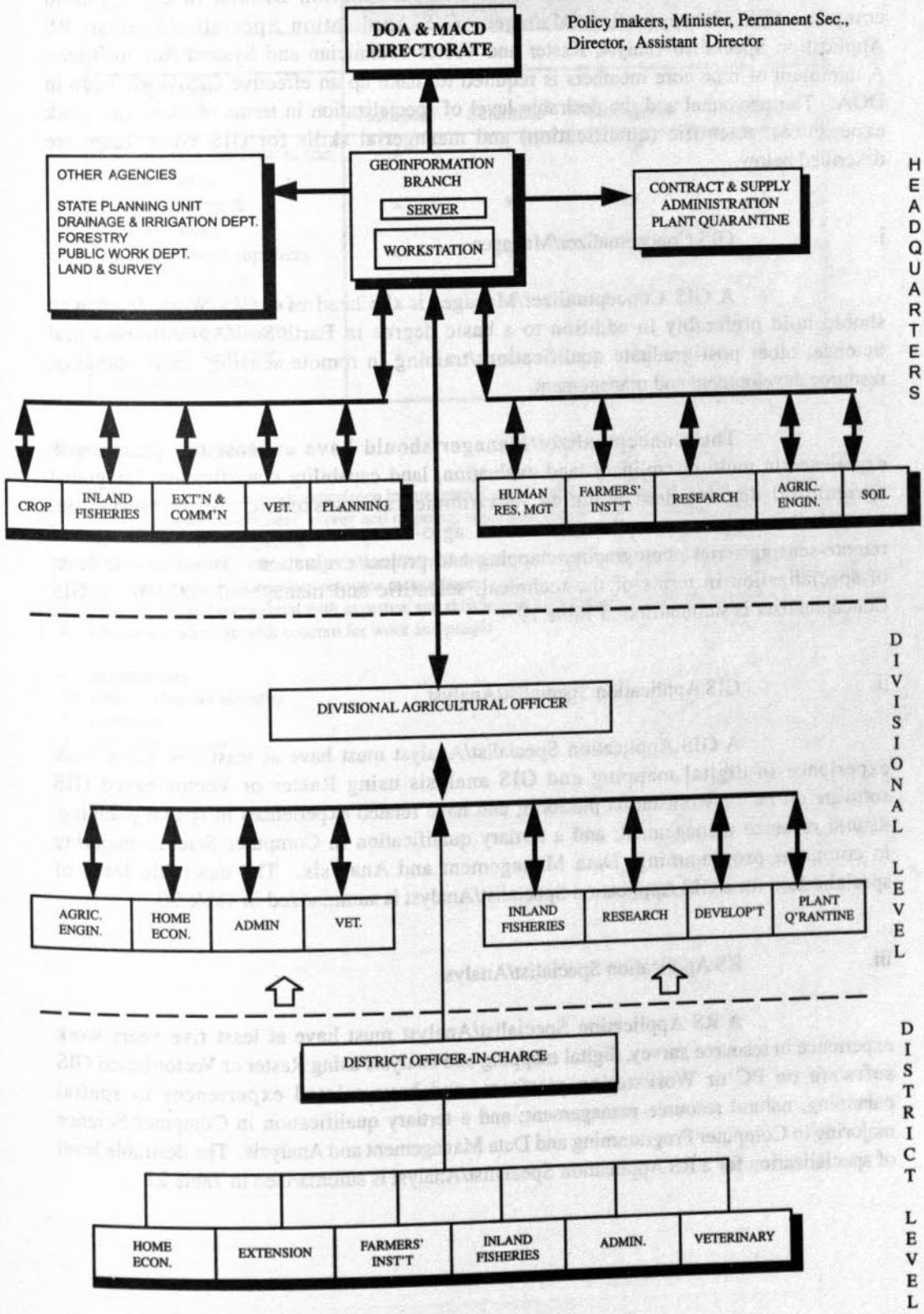
The establishment of GIS/RS should be accorded top priority in DOA. As a long-term measure, a Geo-information Branch should preferably by formed at the headquarters level so as to specifically cater for the GIS planning and development of GIS application in DOA. A GIS Work Team, comprising members with relevant expertise and skill, is recommended for the Geo-information Branch.

As a medium-term measure, the present GIS set-up in the Soils Branch is appropriate which should be elevated to a higher hierarchical level by recruitment of new manpower, training of the existing manpower and upgraging of the existing GIS facilities. These are necessary in order to serve firstly, the immediate need in the conversion of the vast amount of geographic data into digital format. Secondly, GIS remains in Soils Branch for application as a computer-assisted mapping tool. Thirdly, the use of GIS for timely dessimination of soil resources information in desirable media and format to other institutions particulary the Central GIS in the Chief Minister's Department.

4.5.1 Geo-information Branch

In attempt to set up a Geo-information Branch in DOA, it is pertinent to recognize at this juncture that the correct humanware with a desirable level of sophistication is the key to successful implementation of a GIS for DOA. Now and often, the choice of irrelevant personnel with little or no technical know-how often ended up with an untimely delivery of half-completed product.

Fig. 5 Suggested Orgaware Framework For GIS DOA, Sarawak



a GIS Work Team

A GIS Work Team for a Geo-information Branch in DOA should comprise GIS Conceptualizer/Manager. GIS Application Specialist/Analyst, RS Application Specialist/Analyst, Raster and Vector Technician and System Administrator. A minimum of nine core members is required to make up an effective GIS Work Team in DOA. The personnel and the desirable level of specialization in terms of technical (work experience), scientific (qualification) and managerial skills for GIS Work Team are described below.

i. GIS Conceptualizer/Manager

A GIS Conceptualizer/Manager is the head of a GIS Work Team who should hold preferably in addition to a basic degree in Earth/Soil/Agricultural/Rural Science, other post-graduate qualifications/training in remote sensing, rural planning, resource development and management.

The Conceptualizer/Manager should have at least ten years work experience in multi-disciplinary land evaluation, land capability classification, integrated agricultural development planning, environmental assessment, soil conservation, watershed management, soil conservation, agro-ecosystem assessment, appliation of remote-sensing/aerial photography, mapping and project evaluation. The desirable level of specialization in terms of the technical, scientific and managerial skills for a GIS Conceptualizer is summarried in Table 19

ii. GIS Application Specialist/Analyst

A GIS Application Specialist/Analyst must have at least five years work experience in digital mapping and GIS analysis using Raster or Vector-based GIS software on PC or Workstation platform; and have related experiences in spatial planning, natural resource management; and a tertiary qualification in Computer Science majoring in computer programming, Data Management and Analysis. The desirable level of specialization for a GIS Application Specialist/Analyst is summarized in Table 20.

iii. RS Application Specialist/Analyst

A RS Application Specialist/Analyst must have at least five years work experience in resource survey, digital mapping and analysis using Raster or Vector-based GIS software on PC or Workstation platform, and have related experiences in spatial palanning, natural resource management; and a tertiary qualification in Computer Science majoring in Computer Programming and Data Management and Analysis. The desirable level of specialization for a RS Application Specialist/Analyst is summarized in Table 21.

Table 19 GIS Conceptualizer

Personal	**GIS Conceptualizer**			
No. required	1 (one)			
GIS Operation	Technical[1]	Scientific[2]	Managerial[3]	Liaison[4]
* Planning work flow in the organization	+	+	x	-
* GIS planning & development	x	+	x	x
* Contacts with suppliers of data & clients	+	+	x	x
* Contacts with hardware & software suppliers	x	x	x	+
* Contracts with other mapping agencies	+	x	x	+

Explanation of symbols:

1 With at least ten years work experience in Integrated Land Use Planning, land evaluation, environmental assessment, survey and mapping, soil conservation, water catchment and agro-ecosystem management
2 With tertiary qualification in Agricultural/Rural Science, Soil/Earth Science majoring in Land Use Planning, remote sensing, resource management
3 Professional and managerial with expertise and skill in project management and evaluation
4 Dynamic leadership with concern for work and people

\- not necessary
(+) desirable but not essential
\+ necessary
x absolutely necessary

Table 20 GIS Application Specialist

Personnel	GIS Application Specialist			
No. required	1 (one)			
GIS Operation	Cost	Technical	Scientific	Managerial
* Off-line digitizing on micro computer	low/mod	-	-	(+)
* On-line digitizing on inter-active graphic system	high	+	-	(+)
* Off-line scanning (high quality) & vector conversion	Very high	+	-	(+)
* Entering in ASII files	low	-	-	(+)
* Building topological networks in database	low/mod	x	-	(+)
* Linking graphic & non-graphic data	low	+	-	(+)
* Inputting satellite images	low/high (software/ hardware)	+	-	(+)
* Checking database & archiving	low/mod	+	(+)	+
* Simple data retrieval	low	-	-	(+)
* Using a relational DBMS	high	x	+	(+)
* Interactive graphic system	high/v.high	+	-	(+)
* Interpolation and contouring	mod/high	+	+	(+)
* Map overlay	mod/high	+	+	(+)
* Statistical analysis	low/mod	(+)	x	(+)
* Raster processing for image analysis	mod/high/v.high	+	x	(+)
* Digital terrain models	mod/high	+	x	(+)
* Special software/software libraries	low/mod/high	+	x	(+)

Explaintion for symbols:

- Not necessary
(+) Desirable but not essential
+ Necessary
x Absolutely necessary

Table 21 GIS Application Specialist

Personnel	RS Application Specialist			
No. required	1 (one)			
		Level of Specialization		
GIS Operation	Cost	Technical	Scientific	Managerial
* Off-line digitizing on micro computer	low/mod	-	-	(+)
* On-line digitizing on inter-active graphic system	high	+	-	(+)
* Off-line scanning (high quality) & vector conversion	Very high	x	-	(+)
* Entering in ASII files	low	-	-	(+)
* Building topological networks in database	low/mod	+	-	(+)
* Linking graphic & non-graphic data	low	+	-	(+)
* Inputting satellite images	low/high (software/ hardware)	+	-	(+)
* Checking database & archiving	low/mod	+	(+)	+
* Simple data retrieval	low	-	-	(+)
* Using a relational DBMS	high	x	+	(+)
* Interactive graphic system	high/v.high	+	-	(+)
* Interpolation and contouring	mod/high	+	+	(+)
* Map overlay	mod/high	+	+	(+)
* Statistical analysis	low/mod	(+)	x	(+)
* Raster processing for image analysis	mod/high/v.high	+	x	(+)
* Digital terrain models	mod/high	+	x	(+)
* Special software/software libraries	low/mod/high	+	x	(+)

Explaintion for symbols:

- Not necessary
(+) Desirable but not essential
+ Necessary
x Absolutely necessary

iv. Raster/Vector Technician

A Raster/Vector technician must be a cartographer of good skill and experience who is also trained and competent in GIS digitizing work. The desirable level of specialization for a Raster/Vector technician is summarized in Table 22.

v. System Administrator

A System Administrator must have at least five years work experience in planning, design and developing of an efficient and task oriented DBMS, and with good knowledge of hardware architecture in a GIS/RS software environment, general house keeping of hardware and software installation, configuration and maintenance; and in regular updating of all GIS and related databases. He should also hold a tertiary qualification in Computer Science or related field in Information Technology. The desirable level of specialization for a System Administrator is summaried in Table 23.

b. Staffing of Geo-information Branch and Scheme of Service

Manpower audit of DOA was carried out in response to the State GIS Technical Committe's directive (Minit Mesyuarat "Jawatankuasa Pelaksanaan Pusat GIS Negeri, (25) dlm. UPN/S/909/1/2 dated 6.2.1998) to form a Geo-information Branch within the availability of own resources in the Department.

The manpower audit in respect of officers in the Professional and Managerial and Support Groups of DOA, be they Agricultural Officers, Research Officers, Veterinary Officers, Fishery Officers, Agricultural Economists and others indicates that they all have the expertise in the work areas of their respective discipline but lack generally the technical expertise and skill in GIS planning, design and developing GIS application. In short, there is no personnel in DOA who can do the job as prescribed for the Geo-information Branch neither is there any extra manpower to spare for the Geo-information Branch.

The set-up of a Geo-information Branch is quite beyond the available resources within the Department. It has to be taken as synonymous to starting everything anew. New intake by recruitment to make up the work team for a Geo-information Branch is deemed necessary. Job offer may have to be made attractive with better career prospect and the Geo-information Branch is to be instated to the status of a full Branch, if not a Division in the DOA's Organizational Structure. The suggested scheme of service and Grade for the core members of the Geo-information Branch is described in Table 24.

Table 22 Raster/Vector Technician

Personnel	Raster/Vector Technician		
No. required	2 and 3		
GIS Operation	Technical	Scientific	Managerial
* Off-line digitizing on micro-computer	x	-	(+)
* On-line digitizing on inter-active graphic system	x	-	(+)
* Off-line scanning (high quality) & vector conversion	x	-	(+)
* Entering in ASII files	+	-	(+)
* Building topological networks in database	x	-	(+)
* Linking graphic & non-graphic data	+	-	(+)
* Inputting satellite images	(+)	-	(+)
* Checking database & archiving	(+)	-	(+)
* Simple data retrieval	+	-	(+)
* Using a relational DBMS	+	(+)	(+)
* Interactive graphic system	+	-	(+)
* Interpolation and contouring	x	(+)	(+)
* Map overlay	x	(+)	(+)
* Statistical analysis	(+)	(+)	(+)
* Raster processing for image analysis	(+)	(+)	(+)
* Digital terrain models	(+)	(+)	(+)
* Special software/software libraries	(+)	-	(+)

Explanation for symbols:

- \- Not necessary
- (+) Desirable but not essential
- \+ Necessary
- x Absolutely necessary

Table 23 System Administrator

Personnel	System Administrator		
No. required	1 (one)		
GIS Operation	Level of Specialization		
	Technical	Scientific	Managerial
* Planning, design and development of an efficient and task oriented DBMS	x	-	(+)
* Controlling integrity and quality of databases	x	+	(+)
* Advising users on available archived data	+	-	(+)
* Documenting database structure and query procedure	x	+	(+)
* Writing monthly computer hardware and software status reports	+	-	(+)
* Installation and configuration of software and hardware	x	+	(+)
* Regular maintenance of hardware and software and network	+	+	(+)
* System enhancement and optimization	+	+	(+)
* Ensuring data security and regular backups		+	(+)
* Liaise eith vendors on technical support	+	-	(+)
* Performing other tasks as required	+	-	(+)

Explanation for symbols:

- Not necessary
(+)
+ Necessary
x Absolutely necessary

Table 24 **Suggested Scheme of Service for core members of Geo-information Branch, DOA**

Designation	Scheme of Service	Grade	Sub-total
GIS Conceptualizer/Manager	Professional & Managerial	G1 or Q1	1
GIS Application Specialist	Professional & Managerial	G3/G2 or Q3/Q2*	1
RS Application Specialist	Professional & Managerial	G3/G2 or Q3/Q2*	1
Raster Technician	Support	G5	2
Vector Technician	Support	G5	3
System Administration	Professional & Managerial	G3/G2 or Q3/Q2	1
* *Promotional post*			

4.5.2 GIS in Soils Branch

The Gis Unit was set up within the organizational framework of the Soil Information Unit in the Soils Branch which consists of one Research Officer (Grade 3 Scale), two Pembantu Pertanian (Grade 8), seven Juruteknik Ukur (J 8/9 Scale) and one P.R. Awam Khas (R 10). The work focus of the Soil Information Unit or formerly known as the Cartographic Unit, prior to the set-up of GIS, covered primarly manual drafting and colour-processed mapping and production of maps.

The present GIS activities come under the work purview of the Soil Information (Cartographic) Unit. It is envisaged that the focus of work shall eventually be on GIS activities. The GIS shall be applied in thematic mapping of soils, land sue, agro-climate; terrain analysis and land cover change for the generation of erosion risk map, and crop zoning on basis of the differences in bio-physical and socio-economic factors. GIS shall be applied to improve and expedite information output in desirable format and media.

a. GIS Work Team for Soils Branch

The core members of a GIS Work Team for the Soil Branch are identified as shown in Table 25. In line with the State GIS/RS Technical Committee's directives of setting up a GIS within own resources, the manpower for the GIS Work Team for Soils Branch is partly resolved by international appointment/re-deployment of the existing staff from the Cartographic Unit to the GIS Work Team. However, re-deployment does not and cannot overcome the shortage of skilled manpower for GIS neither can it solve the GIS related problems thereto in the Soils Branch. A combination of internal appointment/re-deployment and recuitment of certain key GIS personnel is obligatory to form a GIS Work Team for the Soils Branch. This is described below.

Table 25 GIS Work Team for Soils Branch

GIS Work Team	Recruitment	Inter. appoint/ re-deployment	Sub-total No.
GIS Conceptualizer	0	1	1
GIS Application Specialist	1	0	1
RS Application Specialist	0	1	1
Raster Technician	1*	1	1
Vector Technician	1*	3	3
System Administrator	0	1	1
* On contract			

i. GIS Conceptualizer and Level of Specialization

One of the key GIS personnel who can probably be filled by internal appointment is GIS Conceptualizer. At this present stage, GIS Conceptualizerr can perhaps be appropriately assigned to Head of Soils Branch in person of Assistant Director of Agriculture (SOILS). In addition to his present duties and responsibilities, AD (SOILS) is expected to expand his job role to include that of a GIS Conceptualizer. The curriculum vitae in respect of Teng Chin Siong, Assistant Director of Agriculture (SOILS) is summarized and annexed in Appendix II.

ii. GIS Application Specialist and Desirable Level of Specialization

The present GIS in the Soils Branch is not operational as it should due to the lack of personnel who has the technical-know how to operate the GIS. Officers had been given the opportunities to attend course/seminar/workshops on GIS. However, it was found out that this kind of on-the-job trainings/exercises through courses/seminars/workshops has not been adequate at all as to produce the required GIS Application Specialist for the Soils Branch.

Invariably, recruitment of a GIS Application Specialist is one surest way of making the GIS operational in the Soils Branch. Recruitment requirement of GIS Application Specialist in terms of scientific qualification and technical work experience are summarized in Table 20.

iii. RS Application Specialist and Level of Specialization

By internal manpower audit and combined with the staff's literacy level in computer useage and special aptitudes for information technology, one Research Officer (Soil Surveyor) who is also the present head of the Soil Information Unit shall be assigned to take up extra duties and responsibilities as RS Application Specialist.

The level of specialization for RS in respect of the Research Officer in person of En. Ngab Dollah Salam is summarized and annexed in Appendix III.

iv Raster/Vector Technicians

A combination of recruiment and re-deployment of the support staff to form the Raster/Vector Technician Group is anticipated. With the great contrast of differences in skill between the cartographic and Raster/Vector technician, recruitment of one RS and one Vector Technician is pertinent in support of an operational GIS for the Soils Branch.

Intake of Raster/Vector Technicians by recruitment or on contract should preferably only include Diploma graduates in Computer Science with at least five years work experiences in digital mapping and GIS analysis using Raster and /or Vector-based GIS software on PC or Workstation platform. The skill of Raster/Vector Technicians shall then be passed on to the other on the other members in the same Work Team. Four members of the support staff shall be selected to form Raster/Vector Technician Group upon expiry of the contract Raster/Vector Technicians. The level of their technical skill shall be appropriately upgraded from time to time by formal and on-the-job trainings/exercises.

v. System Administrator

A System Administrator is necessary for the GIS Work Team at the Soils Branch. With the vast amount of data/information that has been generated or collected for GIS Application, System Administrator is to plan, design and develop an efficient and task orient DBMS which can be integrated with GIS/RS environment. The desirable level of specialization in respect of System Administrator for the Soil Branch is as described in Table 23. With the recruitment of a System Administrator for the Geo-information Branch at the headquarters level, it is suggested that the work duties of the System Administrator shall be extended to cover the work related to GIS at the Soils Branch as well.

b. Suggested Hardware Configuration for GIS, Soils Branch

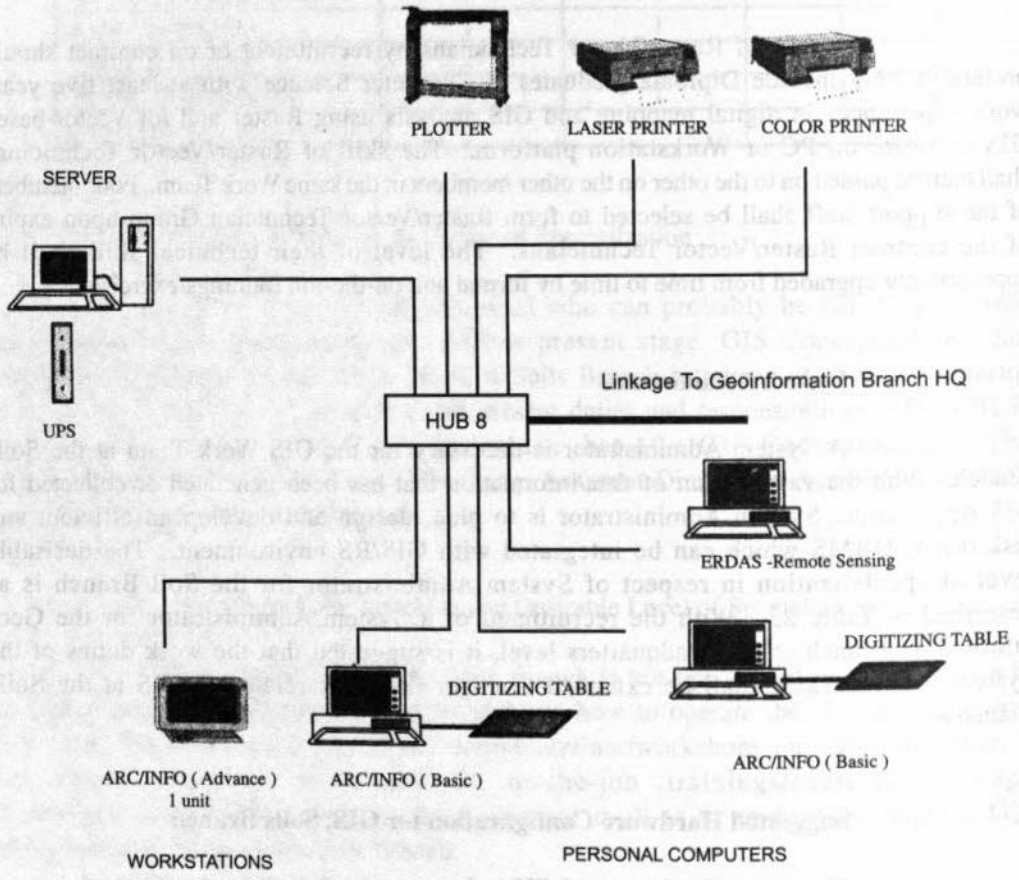
The present hardware and GIS software at the Soils Branch consist of

Hardware:
1 x PC Pentium
1 x PC 486 DX4, 59 Mhz, 600MB
1 x AO digitizing table
1 x AP pen plotter
1 x A4 printer

Software:
Windows 3.11,OS/2, 1xSPANS/TYDIG Ver.5.3
Windows 3.11

The existing GIS shall be upgraded to a Workstation as shown in Fig. 7. The upgrading shall include the procurement of one unit of Workstation server, 3 units of PC, 1 unit of ARC/INFO (advance), 2 units of ARC/INFO (basic) and one unit of ERDAS to operate on Windows NT environment.

Fig 7 Suggested hardware Configuration and Software For GIS Soils Branch



5. FINANCIAL RESOURCE REQUIREMENT FOR GIS IN DOA

The financial resource requirement for the the establishment of GIS in DOA includes the cost for the purchase and installation of hardware and software as well as the personal emolument and the annual operating cost for operating and maintenance of Geographical Information System. Breakdown of the cost for the hardware and software is based on the suggested technoware and orgaware framework for GIS, DOA as shown in Fig. 6 and 7 respectively. Estimates on the cost of hardware and software, personal emolument and annual operating cost are summarized in Table 26.

The total estimate for the establishment of GIS, DOA for the first year is RM1,170,800.00 which includes the cost of hardware and software, personal emolument and the cost for operating and maintenance. After the initial establishment, the annual recurrent expenditure is estimated at RM448,880.00 which includes personal emoluments and the cost for operating and maintenance of GIS. In line with the state GIS/RS Technical Committee's directive, DOA shall submit request and bid through the annual budgeting process on the financial requirement for the establishment of GIS, DOA in 1999.

Table 26 Financial Resource Requirement for GIS, DOA

Description	Station	Cost per unit (RM)	Sub-total (RM)	Total (RM)
Hardware & Software	**Geo-Information Branch**			
	1. 1 unit Workstation Server	25,000.00	25,000.00	
	2. 2 units workstation NT4.0	20,000.00	40,000.00	
	3. 3 personal computers	5,000.00	15,000.00	
	4. 1 unit digitizing table	16,000.00	16,000.00	
	5. 1 unit AO plotter	20,000.00	20,000.00	
	6. 1 unit A3 colour printer	5,000.00	5,000.00	
	7. 1 unit AO colour printer	5,000.00	25,000.00	
	8. 1 unit A4 laser printer	5,000.00	5,000.00	
	9. 1 unit Window NT (float licence)	10,000.00	10,000.00	
	10. 1 unit PC ARC/INFO for Workstation NT	30,000.00	30,000.00	
	11. 8 units ARCVIEW	6,500.00	52,000.00	
	12. 1 unit ERDAS NT	20,000.00	20,000.00	
	13. 3 units AutoCAD	6,000.00	18,000.00	
	14. 2 units HUB (8 ports)	1,500.00	3,000.00	
	15. 1 unit HUB (12 ports)	3,000.00	3,000.00	
	* 1 unit UPS	5,000.00	5,000.00	
	* 1 unit Scanner>1000 dpi	5,000.00	5,000.00	
	* 1 unit CD-Read/Write Drive	5,000.00	5,000.00	
	* 1unit MO Drive	5,000.00	5,000.00	
	* Cabling	5,000.00	5,000.00	
	* Training for 6 officers	5,000.00	30,000.00	
	* Office furniture	30,000.00	30,000.00	
				372,000.00

	Soils Branch			
	1. 1 unit Workstation Server	25,000.00	25,000.00	
	2. 1 unit Workstation for Window NT	20,000.00	20,000.00	
	3. 4 personal computers	5,000.00	20,000.00	
	4. 1 unit ARC/INFO for Worstation Window NT	70,000.00	70,000.00	
	5. 1 unit ERDAS	20,000.00	20,000.00	
	6. 1unit ARCVIEW	6,500.00	6,500.00	
	7. 2 units AutoCAD	6,000.00	12,000.00	
	8. 1 unit AO colour printer	25,000.00	25,000.00	
	9. 1 unit HUB (8 ports)	1,500.00	1,500.00	
	10. 1 unit UPS 1,000.00	1,000.00	1,000.000	
	11. 1 unit Scanner>1000 dpi	5,000.00	5,000.00	
	12. 1 unit CD-Read/Write Dr	5,000.00	5,000.00	
	13. 1 unit MO Drive	5,000.00	5,000.00	
	14. Cabling	5,000.00	5,000.00	
	15. Training for 5 officers	5,000.00	25,000.00	
	16. Office Furniture	12,000.00	12,000.00	
	17. 1 unit AO Photocopier	50,000.00	50,000.00	
	18. Satellite Images	42,000.00	42,000.00	
				350,000.00
Personal Emolument	**Geo-information Brach**			
	*1 GIS Conceptualizer	5000/mth	60,000.00	
	*1 GIS App. Specialist	1900/mth	22,800.00	
	*1 RS App. Specialist	1900/mth	22,800.00	
	*1 Raster Technician	1200/mth	14,400.00	
	*1 Vector Techinician	1200/mth	14,400.00	
	*1 System Administrator	1900/mth	22,800.00	
				157,200.00
	Soils Brach			
	*1 GIS App. Specilaist	1900/mth	22,800.00	
	*1 Raster Techician@	1200/mth	14,400.00	
	*1 Vector Techinician@	1200/mth	14,400.00	
				51,600.00
Annual Operating Cost	**Geo-information Branch**			
	* Hardware/software licensing & maintenance		50,000.00	
	* Analogue-digital conversion (HQ & Admin. Divisions)		30,000.00	
	* Draughting/printing		20,000.00	
				100,000.00

	Soils Branch			
	* Hardware/software licensing & maintenance	2000/map (Estimated 20 maps/yr)	50,000.00	
	* Analogue-digital conversion (210 soils Maps 1:50,000)		40,000.00	140,000.00
	* Printing/draughting		20,000.00	
	* Satellite images		30,000.00	
Total				**1,171,800.00**

Explanation of symbols: @ on annual contract

6. CONCLUSION

The present trend in agricultural development and land use planning is to move towards optimizing the use of resources by integrated land use approach which is often multi-disciplinary and complex. It includes integration of the resources, environment and socio-economic issues. A fast and accurate information support system is pertinent in decision-support.

The Department of Agriculture Sarawak recognizes the importance of Geographical Information System (GIS) application in spatial planning and decision making for improved sustainable managemnet of natural resources for agricultural production. The results of needs analysis for GIS, DOA indicates that the level of GIS sophistication in the Department of Agriculture, Sarawak is low and ranked below a comprehensive stage of coverage in respect of the Inforware (existing and availability of data), Technoware (hardware and software), Orgaware (intra- and inter-institutional collarboration, cooperation and linkages) and Humanware (Personnel and manpower resources) respectively.

As a long-term measure, a Geo-information Branch should preferably be formed at the headquaters level so as to specifically cater for the GIS planning and development of GIS application in DOA. The correct humanware with the a desirable level of specialization is, among other things, the critical success factor to the establishment of GIS in DOA. The present manpower in DOA does not have the GIS expertise and skill neither is there any manpower to spare. Recruitment of a nine-member GIS Work Team viz., GIS Conceptualizer, GIS Application Specialist, RS Application Specialist, Raster and Vector Technicians and System Administrator is mandatory for the establishment of GIS, DOA at the headquarters level.

As a medium-term measure, the present GIS set-up in Soils Branch shall be appropriately maintained and upgraded. The GIS which, as a computer-assisted mapping tool, improves and ensures timely dessimination of information in desirable format and media. The GIS shall also be used in research-oriented application such as terrain analysis and land cover change for the generation of erosion risk map, agro-climatic classification and mapping and crop zoning on basis of the differences in bio-

physical and sicio-economic factors. The present GIS Work Team is formed within own manpower resource by internal appointment and redeployment. It is necessary to be further strengthened. Recruitment of a GIS Application Specialist, Raster and Vector Technicians are essential to make the GIS operational in Soils Branch.

Suggested Infoware for GIS, DOA includes data needs for future planning. Potential areas of GIS application are identified. Suggested Orgaware framework incorporates the present organizational linkages with the insertion of Geo-information Branch at the headquarter levels as data/information depository. Basic considerations on hardware configuration and software for the GIS, DOA are highlighted. The set-up of hardware at "Local Area Network" level of sophistication for GIS, DOA is preferred. Two units of GIS Workstation operating on Windows NT environment complete with perpherals are suggested. ARC/INFO and ARCVIEW GIS Software and ERDAS RS software are suggested for favourable consideration.

The estimate of financial resource requirement for the establishment of GIS, DOA includes the hardware and GIS/RS software, person emoluments and operating cost. The estimate for the establishment of GIS, DOA is RM1,170,800.00 during the initial year. Of which the cost for the suggested hardware and software is RM722,.000.00. The total personal emolument is RM208,800.00 per annum. The annual operating cost is RM240,000.00 covering multi-licensing and maintenance, analogue-digital conversion and dessimination of information.

Reference

Elke Eller (1997) Workshop Documentation at the Department of Agriculture, Sarawak in conjunction with the Project on the Establishment of a State Geographic Information System Sarawak
State Planning Unit, Chief Minister Department, Sarawak

Sahibi Moktar (1997) Geographical Information System (GIS) Department of Agriculture, Peninsular Malaysia 1981-1997
Dept. of Agriculture, Peninsular Malaysia

Teng C.S. (997) Status Report on the Establishment of Geographical Information System (GIS) in Soils Branch, Department of Agriculture, Sarawak
Dept. of Agriculture, Sarawak

Traub, K. P. (1997) The Four Dimensions of GIS
GIS Asia Pacific 1/97 Singapore

APPENDIX

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Appendix 1

EXISTING INFORMATION, DOA Sarawak

Type of information/Data (Existing)	Scales	Format (Hardcopy / softcopy)	Validity	Remarks
Research Branch				
Experimental Data on crops	NR	H/S		Crop yield, material inputs, soils agric, practices
Processed of compiled data	NR	H/S		Tech. leaflets, bulletin, papers
Other data collection	NR	H/S		Observation plots
General Databases	NR	H/S		Inventory of equip., book, tech publication etc.
Other Databases	NR	H/S		Germplasm database (pepper)
Human Resource Management				
Computer Training	NR	MS Access 2.0	30.4.97	
Staff Traning	NR	MS Excel 2.0		
Computer Inventory	NR	MS Access 2.1	30.4.97	
TQM	NR	MS Powerpoint (Report)		
MWP amd Deskfile	NR	MS Powerpoint (Report)		
AIMS	NR			
Commodity and Ext. Division				
DOA Annual Report	NR	H/S		
Agric. Advisory Booklet	NR	H/S		
Planning, Admin. & Finance				
Agric. Statistic Of Sarawak	NR	H/S		
Production Handbook (partial)	NR	H/S		
Budget crops, livestocks, fishery	NR	H/S		

EXISTING INFORMATION, DOA Sarawak

Type of Information/Data (Existing)	Scales	Format(Hardcopy/softcopy)	Validity	Remark
Veterinary Division				
Annual Livestock Statistic	NR	MS Excel 4.0	1994	
Soils Branch				
Land Based Information				
Soil of Sarawak	1:500,000	H(map)	1960	
Soil of Sarawak	1:50,000	H(map)		
Agriculture Capability	1:125,000	H(map)	1993	
Crop Suitability	1:500,000	H(map)	1994	
Technical Papers				
Soil Mem. of West Sarawak	1:125,000	Report/Map	1972	
Soil Mem. of Central Lowland Sarawak	1:125,000	Report/Map	1985	
Soil Mem. of Northern Interior Sarawak	1:125,000	Report/Map	1982	
Semi-detailed Report	1:2,000-1:10,000	Report/Map		
Organic Soils (Tie)-Tech. Paper No. 4	NR	Report	1979	
Cap. Classification (Maas)-Tech. Paper No. 5	NR	Report	1986	
Soil Classification(Tie)-Tech. Paper No. 6	NR	Report	1982	
Key to Soil Classification S'wak (Teng)-Tech. No. 10	NR	Report	1993	
Soil Resource Agric. Cap. & Landuse (Teng) -Tech. No. 11	NR	Report	1994	
Soil Profile database	NR	SD2-VER. 2.0 (SRIC)		

EXISTING INFORMATION, DOA Sarawak

Type of Information/Data (Existing)	Scales	Format (Hardcopy/softcopy)	Validity	Remark
Farmers Organisation				
INSTITUTIONAL MANAGEMENT DATA				
FO Membership	NR	H		
FO Registration	NR	H		
FO Office Bearer	NR	H		
FO Election	NR	H		
FO Statutory Meetings	NR	H		
FO Authorised Capital	NR	H		
FO Farmers Units	NR	H		
Farm Families	NR	H		
FO Personnel	NR	H		
FO Profit Appropriation	NR	H		
BUSINESS INFORMATION DATA				
FO Fixed Assets	NR	H		
FO Current Assets	NR	H		
FO Paid -up capital/shares	NR	H		
FO Investment-Equity	NR	H		
FO Special Reserves	NR	H		
FO Business Volume	NR	H		
FO Profile/Loss	NR	H		
REPORTS:				
Audit Report	NR	H		

EXISTING INFORMATION, DOA Sarawak

Type of Information/Data (Existing)	Scales	Format(Hardcopy/softcopy)	Validity	Remarks
Inland Fishery				
Areas and no. of fish pond constructed annually under constructed FPSS by Division	-	Hard copy	Updated annually	
Area and no. fish pond constructed annually under FPSS by District	-	Hard copy	Updated annually	
No. of fishery distributed by species	-	Hard copy	Updated annually	
No. of applicant issued with fish fry by Division	-	Hard copy	Updated annually	
Annual report from the Division, District and Station	-	Hard copy	Updated annually	

Appendix II

Data/Information Needs - Department of Agriculture Sarawak

	Plan. Admin. & Fin. Div.	Veterinery Div.	Farmers Inst. Div.	Research Div.	Inland Fisheries Div.	Commodity & Ext.	Human Res. Mg't Br.	Agriculture Eng. Br.	Soils Br.
Land based Resources									
Agriculture									
Arable Land	*		*	*		*		*	*
Farming System	*		*	*		*		*	*
Landuse Change	*	*	*	*	*	*		*	*
Land Capability	*	*	*	*	*	*		*	*
Integ. Agric. Dev. Plan	*	*	*	*	*	*		*	*
Forestry									
Forest Type	*		*		*	*			*
Forest Cover Change detect.	*		*		*	*			*
Forest Mg't Unit	*		*						*
Integ. Forest Dev. Plan	*		*		*	*			*
Hydrology									
Water Bodies	*		*		*	*		*	*
Water Quality	*		*		*	*		*	*
Coastal Zone	*		*		*	*		*	*
Major Catchment Areas	*	*	*		*	*		*	*
Flood Hazard Zone	*	*	*		*	*		*	*
Soils/Mineral Resources									
Soils Types	*	*	*	*	*	*		*	*
Soils Erosion	*		*	*	*	*		*	*
Geological Features	*				*	*		*	*
Mineral Resources	*				*	*			
Off-shore Exploration	*					*			
Climate									
Rainfall Distribution	*	*	*	*	*	*		*	*
Wind Speed/Wind Direction	*			*	*	*		*	*
Temperature	*		*	*	*	*		*	*

Appendix II (cont.)

Data/Information Needs - Department of Agriculture Sarawak

	Plan. Admin. & Fin. Div.	Veterinery Div.	Farmers Inst. Div.	Research Div.	Inland Fisheries Div.	Commodity & Ext.	Human Res. Mg't Br.	Agriculture Eng. Br.	Soils Br.
Terrain									
Contours	*	*	*	*	*	*		*	*
Elevation	*		*	*	*	*		*	*
Slope	*		*	*	*	*		*	*
Digital Terrain Model	*					*		*	*
Social-economic Resources									
Population									
Age distribution	*		*		*	*			
Gender ration	*		*		*	*			
Population density	*		*	*	*	*			
Death rate	*		*		*	*			
Birth date	*		*		*	*			
Ethnic distribution	*		*		*	*			
Migration	*		*		*	*			
Region	*		*		*	*			
Health									
Hospitals/rural health centred	*				*	*			
Diseases/Outbreaks	*				*	*			
Provision of health care	*				*	*			
Education									
Schools/Training Centres	*		*		*	*			
Level of education	*		*		*	*			
Employment									
Unemployment rate	*		*		*	*			
Active labor force	*		*		*	*			
Income									
Income	*		*	*	*	*			
Poverty	*		*		*	*			

Appendix II (cont.)

Data/Information Needs - Department of Agriculture Sarawak

	Plan. Admin. & Fin. Div.	Veterinery Div.	Farmers Inst. Div.	Research Div.	Inland Fisheries Div.	Commodity & Ext.	Human Res. Mg't Br.	Agriculture Eng. Br.	Soils Br.
Tourism									
Tourist sites	*	*	*		*	*			
Potential tourist sites	*		*		*	*			
Transport									
Public Transportation	*		*		*	*			
Trade									
Growth centres	*	*	*		*	*			
Markets	*	*	*	*	*	*			
Infrastructure Resources									
Road Network (include. Ports)									
Road types	*		*	*	*	*		*	*
Bridges/Ferries	*		*	*	*	*		*	
Sea-Airports	*		*		*	*		*	
Energy									
Power plants/Power lines	*	*	*		*	*		*	
Communications									
Overland telephone lines	*		*		*	*		*	
Water Supply/ Seawage									
Industries									
Industries estates	*		*		*	*			
Timber processing zones	*		*		*	*			
Industrial waste disposal	*		*		*	*			
Urban/Rural Build-Up									
Settlement	*	*	*		*	*		*	
Waste disposal	*		*		*	*		*	

Appendix II (cont.)

Data/Information Needs - Department of Agriculture Sarawak

	Plan. Admin. & Fin. Div.	Veterinery Div.	Farmers Inst. Div.	Research Div.	Inland Fisheries Div.	Commodity & Ext.	Human Res. Mg't Br.	Agriculture Eng. Br.	Soils Br.
Land Division									
Political bound									
International/State b.	*				*	*		*	*
Divisional/District b.	*		*		*	*		*	*
Land Tenure									
Timber license b.	*				*				
Mining license b.	*				*				
State Land Forest	*		*		*	*			*
Perm. Forest Estates	*		*		*	*			*
NCR Land	*		*		*	*			*
Protected Areas									
Areas of High Biodiversity	*		*	*	*	*			*
Ecological Sensitive Areas	*		*		*	*			*
Marine Sanctuaries	*		*		*	*			*
Totally Protected Areas (TPA)	*		*		*	*			*
Catchment/watershed areas	*	*	*		*	*			*
General References									
Sheet Index 1:250,000	*	*			*	*		*	*
Sheet Index 1:50,000	*	*			*	*		*	*
Landsat TM									*
Landsat MSS									*
SPOT									*
Radar									*
IRC (Indian Research Sat.)									*
Earthwatch									*
Space Imaging									*
Aerial Photos					*	*			*
Planning Results									
Proposed Plans									
Integr. Reg. Dev. Plan	*		*		*	*			*
Integr. Landuse Plan	*		*	*	*	*			*

Appendix II (cont.)

Data/Information Needs - Department of Agriculture Sarawak

	Plan. Admin. & Fin. Div.	Veterinery Div.	Farmers Inst. Div.	Research Div.	Inland Fisheries Div.	Commodity & Ext.	Human Res. Mg't Br.	Agriculture Eng. Br.	Soils Br.
On-going Project 1	*								
On-going Project 2	*								
On-going Project 3	*								
On-going Project 4	*								
Others :									
(Location / Details of)									
Gov't./statutory bodies offices	*		*			*	*		
Research Station / Exp. Plot	*	*	*	*	*	*		*	*
Project Sites	*	*	*	*	*	*		*	*
Data on computerisation							*		
Pest/Disease outbreak	*	*	*	*	*	*		*	*

Appendix IIIA

CURRICULUM VITAE - TENG CHIN SIONG FROM 1974-1997

1. PERSONNEL DETAIL

Name	:	Teng Chin Siong
NRIC	:	490520-13-5369 (K141317)
Date of Birth	:	20.5.1949
Staff File No.	:	E9951844-09
Pay No.	:	028553
Address	:	Department of Agriculture Soils Branch Jalan Badruddin 93400 Kuching

2. PRESENT SCHEME OF SERVICE

2.1 Name and Grade

Name of Post	:	Senior Soil Surveyor (1.12.1991 - 30.3.1994) Assistant Director of Agriculture (SOILS) 1.4.1994 -
Name of Scheme	:	Penyelidikan dan Pembangunan
Present Grade	:	Q2P2T4
Date of Confirmation	:	1.12.1991

2.2 Post and Department

Name of Post	:	Research Officer
Grade	:	A20 (Q3)
Name of Department	:	2.7.1974
Date of Appointment	:	2.7.1974
Date of Confirmation	:	20.5.1977

2.3 Previous and Present Appointment

* 1974-1990 Research Officer (Soil Surveyor), A20
* 13.7.1987 - 26.8.1987 Acting Senior Soil Surveyor, A10
* 1.12.1987 - 9.1.1988 Acting Senior Soil Surveyor, A10
* 2.10-1989 - 2.11.1989 Acting Senior Soil Surveyor, A10
* 18.12.1989 - 6.2.1989 Acting Senior Soil Surveyor, A10
* 1.9.1990 - 30.11.1991 Acting Senior Soil Surveyor, A10
* 1.12.1991 - 31.3.1994 Senior Soil Surveyor, A10
* 1.4.1994 Assistant Director of Agriculture, (SOILS)

3. ACADEMIC QUALIFICATIONS

Bachelor of Agricultural Science
(Massey University, New Zealand, 1974)

Master of Soil Science (Distinction)
(State University of Ghent, Belgium, 1981)

4. CERTIFICATES OF ACHIEVEMENT/ATTENDANCE

* Program For Development Managers
Asian Institute of Management, Eugenio Lopez Foundation -
An affliliate of Ateneo De Manila University and De La Salle University
in cooperation with the Ministry of Agriculture and Community Development,
Sarawak, 1985

* Software Appreciation Course
Informatics, Kuching 1989

* Pengurusan Prestasi Perkhidmatan Awam
Centre for Modern Management in collaboration with Institut
Tadbiran Awam Negeri (INTAN), Kuching, 1994

* Kemahiran Kaunseling Untuk Pengurus
Centre for Modern Management in collaboration with Institut Tadbiran
Awam Negeri, Kuching, 1994

*Total Quality Management - QCC
Centre for Modern Management, Kuching, 1994

* Isu-isu Kritikal Dalam Pengurusan
Centre for Modern Management in collaboration with Institut Tadbiran
Awam Negeri (ITAN), Kuching, 1995

* Geographical Information System
Malaysian-German Technical Cooperation Project - FOMISS, 1995

* Total Wellness Programme
Centre for Modern Management, Kuching, 1995

* Team Development Programme
Centre for Modern Management, Kuching, 1996

* Occupational Safety & Health Act (OSHA 1994)
Centre for Modern Management, Kuching, 1996

* Strategic Planning
Centre for Modern Management, Kuching, 1996

* The Art of Total Wellness (Chapter 2)
Kuching 1-3 April, 1997

* Managerial Grid Seminar
Kuching, 27-30 October, 1997

* National Workshop on Malaysian AIRSAR PACRIM Programme
Malaysian Centre for Remote Sening (MACRES), Kuala Lumpur 4-6 June, 1997

* Workshop on Using Arc/Info GRID for Surface and Erosion Risk Modelling
ESRI Training Centre, Petaling Jaya, 22-24 July, 1997

5. ASPEK ASPEK PROFESIONALISM

5.1 Published and Unpublished Technical Reports, Papers, Thesis, Information Papers and Feasibility Studies as from 1978-1997

a. Published Technical Reports - Soil Survey and Land Evaluation Reports

Level of Survey	Survey Area	Report No./Year	Remark/Contribution
Reconnaissance	Saribas-Layer	185/1978	To precede semi-detailed soil survey and land evaluation for Kalaka-Saribas IADP
	Pakan	194/1978	Land evaluation for rural agricultural projects in RASCOM Areas
	Batang Ai	206/1979	Land evaluation for resettlement of Batang Ai people
	Sg. Sebeliau	Misc. 110/1979	Land evaluation for resettlement of people affected by Batang Ai Hydro-electric Project
Semi-detailed	Saratok	192-1978	Land evaluation for rural agricultural projects and DID schemes
	Jualau	200/1980	Land evaluation for agricultural projects in RASCOM Areas
	Sebuyau-Sebangan	228/1982	Appraisal of soil resources in the Coastal Zone for plantation development
	Tarat	240/1984	Master Plan for Tarat Planting Material Production Centre of DOA
	Betong-Engkarangji	241/1984	Land Evaluation for SALCRA Land Development Scheme
	Lubok Piasau	Misc. 85-1/1985	Appraisal of soil resources for fruits and vegetables targetted for Brunei market
	Ng. Pais	Misc. 86-1/1986	Master Farm Plan for ADP village
	Sebat-Sebako	266-1987	Land evaluation for SALCRA cocoa plantation
	Kabuloh Agr. St.	Misc. 87-1	Satation Master Station Plan for planting materials and crop research

Serian	237/1988	Land evaluation for cocoa and oil palm Scheme
Sedarat-Selopong	Misc. 88-1/1988	Feasibility study of padi land for Batang Ai HEP settlers
Krokong	256/1989	Land evaluation for SALCRA cocoa scheme
Kuala Tatau	268/1989	Appraisal of soil resources in the Coastal Zone
Sungai Aran	274/1989	Land evaluation for SALCRA Scheme
Batu Bungan	279/1989	Village Farm Plan for Penan Settlement
Sungai Tepus	282/1990	Land Evaluation for SALCRA Scheme
Sungai Siru	285-1990	Land Evaluation for SEDC Mulberry Project
Sadong-Simunjan River Basin	Misc. 259-1990	Land Evaluation for regional land use planning
Oya-Balingian River Basin	Misc. 360-1990	Land Evaluation for regional land use planning
Sungai Nowang	290/1991	Land Evaluation for DID Padi Scheme
Ukong Agr. St.	291/1992	Station Master Plan for crop research and mitigation measures for drainage Improvement
Tg. Embang	295/1992	Station Master Plan for livestock production of DOA
Telaga Air	301/1994	Feasibility Study for Telaga Air RGC SPU Inhouse Consultant Report
Sungai-Jangkar-Pasir	304/1994	Feasibility Study for the development of highland agriculture (Gunong Pueh)
Sadong-Simunjan River Basin	308/1996	Land Evaluation for regional landuse planning
Long Bemang	310/1996	Feasibility Study for Integrated Agric. Station

Footnote: Miscellaneous reports on soils and land suitability for plantation crops as requested by SEDC, LCDA, SALCRA and FELDA are not included in Table 1.

b. Published Technical Papers

No.	Title	Source of Information
1.	A Comparative Study (Micromorphology, Mineralogy and Genesis) of some Gley Soils of the Floodplains in Sarawak, Malaysia	M. SC. Thesis; University of Ghent, 1981
2.	A Numeric-Parametric Approach in Assessing Soil Suitability for coconut Seed Station in Sarawak.	22nd Research Officers' Conference, Dept. of Agriculture, Sarawak, 1984
3.	Crop zonation on the basis of land evaluation and capability for the development of modern agriculture	Proc. 28th Annual Research Officers' Conference, Dept. of Agric. Sarawak(in press).
4.	Shifting cultivation of hill padi - a traditional method of utilizing and managing natural soil fertility for rice production in Sarawak	Malaysia Country Report for Workshop on Indigenous Conservation Farming Practices, Goroka, Papua New Guinea5-7 Dec 1990. In ASOCON Report No.7
5.	Soils, agricultural capability and current status of land use in the coastal zone of land use in the coastal zone of Sarawak	Proc. 29th Annual Research Officers' Conference, 30 Nov-1 Dec 1992, Kuching 8-36
6.	Experiences on shifting cultivation in Sarawak	Proc. Workshop on Guidelines for Agricultural Activities on Steeplands in Malaysia, 5-8 Jul 1993, Cameron Highlands (in press)
7.	Preliminary observation on agricultural activities and their contributory effects on land and degradation in Sarawak	Presented for inclusion in Malaysia Country Report entitled "The Collection Analysis of Land Degradation Data in Malaysia" under the joint authorship of Aminuddin Yusoff,Teng C.S. and Deratil Boaklam; Asia Network on Problem Soils; Oct 1993.
8.	Keys to Soil Classification in Sarawak	Proc. 30th RO Conference, Kuching 25-26 Oct 1993
9.	Soils Resources, Agriculture Capability and landuse in Sarawak	Bengkel Sains Tanah di-Malaysia, Tahun 2020, 11-12 Jan 1994, Universiti Pertanian Malaysia, Serdang
10.	Soils Land Capability and Crop Zone Classification for Land use Planning in Sarawak	Seminar on Agroclimatic and Crop Zone Classification in Malaysia; 6th September 1994, Petaling Jaya, K.L.
11.	COMSSSEM National Soil Correlation Bulletin	National Soil Correlation in Sarawak; November 1996

12.	A Tentative Landform Classification System	Committee for the Standardization of Soil Survey & Evaluation, Malaysia, 1997
13.	Soil Resources, Agriculture Capability and Land Use Planning in the Coastal Zone of Sarawak (Revised)	Integrated Coastal Zone Management Committee (ICZM), State Planning Unit, 1997

c. PUBLISHED NON-TECHNICAL PAPERS

1.	Reorganization of the Soils Branch Dept. of Agriculture, Sarawak	Dept. of Agriculture, Sarawak 1992
2.	Perspective Plan of the Soils Branch of the Department of Agriculture	Dept. of Agriculture, 1994
3.	Future Plan and Directions of Soils Branch in the 7MP	Dept. of Agriculture, 1995
4.	Soil Resources Information - Classification and Access	Dept. of Agriculture, 1996
5.	Research and Development Programmes of the Soils Branch	Dept. of Agriculture, 1996
6.	Master Plan - Setting up a soil laboratory in Soils Branch of DOA	Dept. of Agriculture, 1996
7.	A Profile of the Soils Branch in DOA	Dept. of Agriculture, 1996
8.	A Status Report on the Establishment of Geograhic Information System in the Soils Branch of DOA	Dept. of Agriculture, 1996

d. Unpublished Technical Papers

1.	A Review of the Crystallogy, Morphology and Genesis of Gypsum in Acid-Sulphate Soils	Post-graduate Project at University of Ghent, 1981
2.	Soils for Rubber Cultivation in Sarawak	Incorporated in the Dept. paper for LCDA Seminar, 1982
3.	Description and Characterization of a Potential Acid-Sulphate Soils in Sarawak	Dept. of Agriculture, 1997
4.	Contribution towards a better understanding of a calcareous marine gley soil in Sarawak	Extract from M. SC. Thesis
5.	Soils and Climate for Flue-cured Tobacco Cultivation in Sarawak	Submitted to MACD, 1988
6.	Soils and Climate for Burley Tobacco Cultivation in the Highlands of Sarawak	Submitted to MACD, Sarawak 1988
7.	Definition, Classification and Characterization of Organic Soils in Sarawak.	Submitted to National Working Group on Agroclimatic Mapping; 1991

Appendix IIIB

Curriculum Vitae

En. Ngab Dollah Salam
Research Officer, Soils Branch, Department of Agriculture, Sarawak

Academic *Background*

University of Malaya - *Applied Geology, Second Class Lower, BSc. (Hons)*

* Final year thesis - General Geology Of Southern Niah Area: emphasis on the study of sedimentology, stratigraphy, micropaleontology / fossil and stuctural geology and subsurface interpretation

Work Experience

1. Research Officer - *Dept. Of Agriculture Sarawak, Soils Branch (Sept. 1989 -)*
   Present Main Task:

* Responsible to AD (SOILS) on all matters relating to soil information, GIS, Remote Sensing and cartographic drafting and production of maps; and maintenance of GIS and RS hardware and software and IT facilities to a certain extent.

* Conduct soil survey / field investigation work at semi-detailed and reconnaissance level.
* Conduct topographical surveys for commercial/rural agricultural projects (IRAD) projects
*
* Conduct lectures on Soil Science Land Surveying & Topographic Survey at the Agriculture Insitute Semongok.
* Advise and produce report on land and soil suitability on plantation development
* Update Landuse Map at 1:500,000.

Other Under Graduate Projects

* General mapping (estimation of rock volume) - (Tangkak, Negeri Sembilan)
* Underground water survey (Selangor)
* Structural geology survey / mapping (Tanjung Kempit, Johor)
* Soil mechanic analysis (samples taken from Karak Highway, Pen. M'sia)

Other specific committment

* Attached to the CIDA Group (Feb. 1991 -1Feb. 1993) as counterpart to the CIDA Landuse Planner cum GIS conceptualiser.
* Member of an inhouse consultant group for Lower Rajang Feasibility Study
* Task Force Group - Integrated Rural Agriculture Development Project - MACD
* Aerial Survey - Coconut Leaf Miner Outbreak (conduct aerial survey and mapped the severity of infestation and furthur planned for aerial spraying)
* Departmental GIS workgroup - secretary
* Departmental Commercial Project Workgroup

2. Drilling Data Engineer - *Geoservices Eastern Cooperation (Jan. 1989 - Aug. 1989)*
Main Task:

* Incharge of the overall system and manpower of the drilling control unit.
* Supervisor to the exploration geologist and subordinate crew.
* Monitored drilling parameters on total control computerised system - Weight on bit (WOB), standpipe pressure, drilling fluid pump pressure, drilling rotation, torque, drilling fluid propeties and volumes, subsuface formation pressure analysis (based on "leak off test"), D'exponent log, hydrolic report, drill bit report, drill hole cavity and drilling fluid loss monitoring, daily drilling progress and parameters report.
* System layout, sensors installation and maintenace.

3. Mudlogging Geologist - Geoservices Eastern Cooperation *(Jun. 1987 - Dec. 1988)*
Main task:

* Lithological classification and crude oil indicator test from the bore hole samples (drilled, core and side wall samples).
* Hydrocarbon and toxic gas monitoring (chromatographer and special sensors)
* Well correlation based on wireline log (sonic, resistivity, gamma ray log) and masterlog.
* Daily drilling progress report.

Workshops Seminars Courses Attended

* Workshop On Gender Analysis - A Framework For Development Programming. MACRES, 16-18th July 1991

* Workshops On GIS-MACRES, 2-14th Sept. 1991

* Short Course on Natural Resources Information Management (GIS/RS), Asian Inst. of Technology, 11th May - 14th Aug, 1992

* Basic Remote Sensing Course - MACRES & New South Wales Uni., 22-27th Feb. 1993.

* Management Development Course - DOA & INTAN, 12 - 24th April 1993

* The 2nd Regional Remote Sensing Seminar on Tropical Eco-System Management - AIT MACRES, NASDA, UN, ESCAP, 8 - 14th Sept. 1993.

* Workshop On the Integration Of Remote Sensing & GIS-MACRES & New South Wales Uni., 6-23th. Dec. 1993.

* Workshop On Application of Remote Sensing and GIS for Urban Planning - MACRES & New South Wales University.

* Workshop On Remote Sensing For Marine Studies - MACRES & Peking Uni., 1 - 6th. Aug. 1994

* Quantitative Methodology for Exploratory Land Use Studies - MARDI & Wageningen Agric. Uni., 5-16 June 1996.

* I.T Management Programme - Sarawak Information System Sdn. Bhd (SAINS) and CMM 24-26th March 1997.

* ISO 9000 : Quality Awareness & The 20 Elements Programme - CMM, 8-10th July, 1997.

* National Workshop On M'sian AIRSAR PACRIM Programme - MACRES, UNSW, Australia 4-6th June 1997.

* Workshop On ArcInfo GRID for Surface and Erosion Risk Modelling - ESRI South East Asia, Petaling Jaya, 22-24th July 1997.

* SPANS 6.0 and Spatial Analysis Training - UPM & TYDAC Canada, 18-22th Aug. 1997

* Exploring ENVI and Foundations for IDL Programming - MACRES & Research System, Inc. USA, 6-13th December 1997.

* Workshop On Airborne Radar/Microwave Remote Sensing - MACRES, JPL USA, 15-20th December 1997.