Japan International Cooperation Agency (JICA)

Survey Department, Ministry of Forestry

The Study on
The Establishment of Geographic Database for
National Rehabilitation and Development Programme
In The Union of Myanmar

GIS Guideline

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ASIA AIR SURVEY CO. LTD.
AERO ASAHI CORPORATION

Preface

GIS (Geographic Information System) is a system to manage information according to add location information to collected information. In applying GIS, it is possible to perform spatial analysis such as recognizing current condition by spatial distribution of information, analyzing data overlaid condition of two seasons and performing simulation by these datasets. Besides, GIS is also applied for support of development planning and tool of decision making. GIS is introduced in many organizations because of such characteristics.
However, it is often the case that the evaluation introduced GIS actually is no so sufficient.

In order to build GIS, hardware and software should be introduced and furthermore geographic information database should be prepared. It is very expensive to build GIS because of such reasons. Above all, it is often the case that GIS have built by involuntary data, because it is very expensive to prepare high quality geographic information database. Even though spatial data framework in the name of National Spatial Data Infrastructure (NSDI) shall be maintained by nations, initial cost investment is reduced and dissemination of GIS will be spread.

Therefore, JICA in cooperation with Survey Department (SD) prepared spatial data framework. Any other organizations can build GIS by less cost in using this spatial data framework and furthermore they can share geographic database because they prepared them base on the same spatial data framework.

This guideline is arranged items to comply with the aim of sharing geographic information database. Organizations intended to build GIS can prepare high cost effective geographic information database by using this guideline. Besides, database prepared based on spatial data framework performed interoperability in many organizations, according to build GIS by many organizations based on this guideline.
Consequently, dissemination of GIS will be spread in Myanmar.

July 16, 2004

Contents

■ Appendices

1. Building of GIS

GIS is the information system managing information with location related to the earth. Therefore, both definitions of information and maps to plot information are necessary. **The organization to build GIS should make clear how to collect any information, how to plot them on any map, how to manage them.**

1.1 Issues to build GIS

GIS is applied to many kind of work. In order to introduce GIS and to get easily approval from many persons, sometimes many objectives are added. It is important to clear objective to introduce GIS.

While the price of hardware and software is expensive, cost to prepare GIS database is also very much expensive. It is said that cost to prepared database is 60 to 80 percents of total expense to build GIS. Therefore it is very useful to apply existing database. In this point of view, it is valuable to maintain spatial database by SD as spatial data infrastructure. If spatial data framework is arranged, GIS will be popularized in Myanmar. **Therefore it is necessary that true objective should be clear to introduce GIS.**

The following examples of objective to build GIS are considering.

1) Facility management
2) Support to prepare development plan
3) Management of land information
4) Management of urban information
5) Information system for decision making

1.2 Selection of GIS Software

When GIS is built, it is very important to select applied software and **it should be selected the system that many engineers want to operate.** The price is also one criteria to select the software. The system in which a lot of function are installed basically should be selected. If the function installed is low, some application software have to be developed by oneself. However high price software has so many functions, many of them are not used usually. It is very difficult to select the suitable GIS software.

And, it is also important points to maintain and manage GIS. In consideration of data exchange, information exchange of operation and solution of troubles in operation, the software to get easily in a market should be selected.

GIS software getting in the market are introduced.

1) Arc/INFO（ESRI, USA）
2) Arc/View（ESRI, USA）
3) TNTmips（Micro Image, Canada）
4) GeoMedia（Intergraph, USA）
5) GeoConcept（IGM, France）
6) MapINFO（MapINFO, USA）

GIS has 4 functions represented in Fig. 1. Selected GIS should have these 4 functions basically.

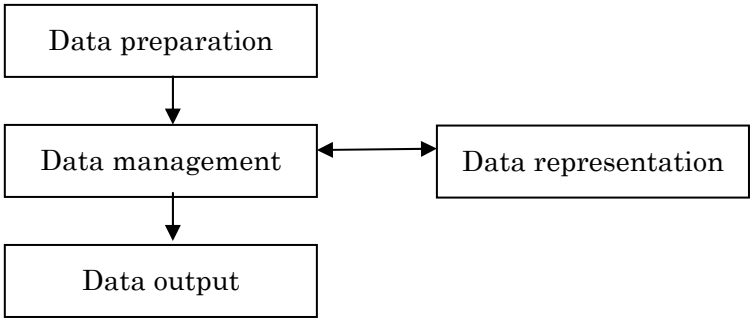


Fig.1 Composition of GIS function

1) Data preparation function
   - To prepare graphic data such as point, line and polygon
   - To import numerical data prepared by different system
   - To give attribute information to acquired graphical data
   - To move, delete, modify and amend graphic data
   - To move, delete, modify and amend attribute data
   - To generate and compile DEM and TIN

2) Data management function
   - To operate both graphic and attribute data simultaneously
   - To operate point data, line data and polygon data independently
   - To manage database

3) Data representation function
   - To generate contour lines from digital elevation model (DEM)
   - To draw map using map represent function

- To represent list from attribute database
- To draw map using map symbols and adding marginal information
- To represent stereoscopic view and to acquire 3D data from it by manual or automatically

4) Data analysis function

- To have graphical process function
- To have buffering function of graphical data
- To have polygon analysis function.
- To convert geographic coordinates to plane coordinates, vice versa.
- To convert to coordinates system each other in different Map projections.

1.3 Required Hardware and peripheral Instruments

The GIS system is composed of following hardware generally. **High performance equipments should be selected.**

- Personal Computer
- Display
- Plotter
- Printer
- CD-RW
- Network Server
- UPS
- Scanner

Sample of specifications is shown appendices.

1) Personal computer

Instrument to process numeric and character data. To select newest computer with much memory and high speed processor.

2) Display

Device to represent results on monitor.

Large format and high resolution type display is recommended.

3) Printer

Device for data output. This device is used to make document, numerical data and table.

A3 or A4 type device is recommended.

4） Plotter

Device of data output. A0 type of plotter is recommended in order to plot large map.

5） Network server

It is necessary to manage large volume of data, when GIS system will be built to compose many data acquisition system, data compilation system, and data management system.

The volume of memory size should be designed depend on dimension of built GIS.

6) UPS (Uninteruptable Power Supply)

This is necessary for protection of data to supply stable power and to prevent power cut.

7) CD-RW

Device to read or write large volume of data on CD-ROM. New device to read or write more large volume of data calls DVD but this is not popular yet.

8) Scanner

Device to input data. Numerical data are prepared from paper based materials such as maps and photographs ,using this device. There are two types color or black and white. Large format of A0 type is recommended.

2. Application of topographic data

Topographic data is indispensable to prepare topographic map. It is also necessary to build GIS as basic GIS data which is called spatial data framework. The value of topographic data will increase more and more to apply GIS.

2.1 The detail of topographic data to be prepared in this Study

Topographic data composed of both topographic dataset and metadata. Topographic dataset are prepared in unit of sheet or zone.

Topographic dataset is prepared usually to divide in each sheet.

In order that the study area contains two zones of UTM projection which are zone 46 and 47, two datasets of spatial data framework were produced in the study.

(1) Geodetic elements

Geodetic elements based on Myanmar datum 2000 are adopted in the study.

Table 2.1 Adopted Geodetic elements

Elements	Description
Reference Ellipsoid	Everest 1830
Horizontal Datum	Horizontal location Of Kaynathpo
.Vertical Datum	Mean sea level Of Andaman Sea
Map Projection	UTM

(2) Metadata

a set of seamless database should be prepared by unifying all datasets.

Metadata is a description file which includes following items.

- Name of dataset
- Objectives to prepare dataset
- Application field
- Name of produced organization, address and its contact
- Acquired geographic features
- Data structure
- Data format

The detail of Metadata is explained in the document of ISO/DIS 19115 and sample of Metadata is attached in appendix

2.2 Interoperability of GIS

Topographic dataset prepared in this Study can also use another system. There is no problem to use soon in the same system which is TNTmips. However, when different system are used to operate them, sometimes the problem occurs. If the TNTmips has transformation software(so called export) for another system, there is no problem. Even though the TNTmips has not transformation software to one system, exchange format should be selected which is used usually dxf or dwg of AutoCAD drawing format as defact standard.

(1) Transformation of format

Topographic dataset prepared in this Study is applied on TNTmips system. Therefore topographic dataset must transform to different format of other system.

Table 2.2 List of application and exchange format

Import data format	Export data format	Name of system
TNTmips .RVC	.SHP	ArcINFO, ArcView
	.MIF	MapINFO
	.DGN	GeoMedia
	.GC	GeoConcept

2.3 Expansion of database

(1) Addition of another topographic feature data

Additional data with specified code or data structure will be acquired, and added these new data to old database.

(2) Addition of attribute data

If additional attribute data are necessary to add old database, data of additional attribute should be added in the new additional field of attribute one by one using GIS software.

If new attribute data are tabulated by software as Excel, attribute data are imported in the attribute field correspond to geographic feature by investing function of attribute.

2.4 Unification and deviation of topographic feature data

(1) Unification of topographic data prepared by same specifications

These datasets can be unified easily. In case that some features divided into two by neat

line, these are unified one by one.

(2) Unification of dataset prepared different specifications

The topographic features catalogue will be prepared after refer topographic feature catalogue, confirm definition of feature and obey new specifications. Then topographic feature catalogue will be updated and prepared new catalogue according to old feature catalogues.

Table 2.3 Unification of dataset prepared different specifications

New catalogue Code	Old catalogue Code1	Old catalogue Code2
1011	1111 1121	2101
1012	1112	2102 2103
1013	1113	2104
1014	1114	2105

(3) Division of dataset

A part of dataset is quarried out from original dataset and compiled based on new specifications.

(4) Unification of between different scale of topographic data

For instance, small scale topographic data are compiled to unify both small scale topographic data and compiled topographic data from large scale topographic data using digital compilation system.

(5) Compilation from small scale topographic data to large scale topographic data.

Small scale topographic data are not able to use large scale topographic data generally. A part of topographic dataset such as existence of feature, annotation and attribute information and so on, are able to use. But, graphical data should be updated to compile the original materials again.

3. Application of topographic data

The study area is planned to develop and rehabilitate in the near future. The following topographic data were needed to make these plans. It is very useful to maintain topographic data because duplicated investment to avoid which different organizations prepare topographic data or maps independently.

To make a plan to develop land, some spatial data are necessary. Essential spatial data are introduced in this table.

Area development / Spatial data		Road	Agri culture	Indus try	Marine Industy	Hous-ing	Sight sea ing	Disas-ter	Envi-ron-ment
	Administration	○		○		○	○		
	Road, Railway	○	○		○	○	○	○	○
	Coastal line	○	○	○	○				○
	River, Lake	○	○		○		○	○	
	Toponomy	○	○	○	○	○			
	Control Point	○				○			
	Vegetation				○		○		○
	Public facility					○		○	
	Place name						○	○	
	Land use	○	○	○		○		○	○
	Land condition	○	○	○		○		○	
	Soil		○						
	Geology	○		○				○	
	Disaster	○				○	○	○	

4. Maintenance and management of applied GIS

To apply advanced GIS, the following items should be maintained and managed GIS.

4.1 Security of budget

Minimum budget should be secured to manage GIS

(1) Maintenance fee of GIS

Upgrade or version up of instrument, hardware and software

(2) Update of data

Expansion for scope of study area or update

(3) Consumption goods

Purchase of consumption goods

4.2 Arrangement of GIS engineers

(1) Staff members

To apply GIS, staff members should be arranged to operate GIS, update data and so on.

(2) Developing engineers

To develop new application software and update applications, developing engineers should be arranged.

4.3 Education and promotion of GIS

(1) Promotion by seminar

Technical information concerning GIS will be exchanged through seminar periodically. And operation of GIS will be spread by Seminar.

(2) Promotion of operation technique for computer

To promote personal computer technology, training should be executed by using computers procured by JICA. Every staff should be able to operate computers.

(3) Training of information technology engineers

To establish high information procession, engineers should be employed or trained.

(4) Training of engineers for developing GIS software

To develop sophisticated GIS software, GIS engineer should be trained.

(5) Training of engineers for system maintenance

System engineers should be trained to manage and maintain GIS system.

5. Products of the JICA Study

Following results were produced in the study on the establishment of geographic database for national rehabilitation and development programme.

(1) Aerial photographic image data

Aerial photographs were convert to raster data at resolution of 20 micron which means 1 meter on the ground. Memory size of one photo is 192MB.

(2) Geodetic control data

Location and description of geodetic control points such as GPS point and benchmark were filed. __points of ground control were stored.

In the study area, these geodetic control data will be used as control points when new project will start.

(3) Final adjustment result data of aerial triangulation

Results of aerial triangulation in the study area were record on CD-ROM.

If different scale of maps are required to produce, new maps will be prepared by using aerial photograph image data and aerial triangulation

(4) DEM data

Digital elevation data at 100 meters interval lattice were prepared in whole study area.

These DEM will be used geomorphological analysis. Memory size is 192MB.

(5) Orthophoto image data

Orthophoto image data were produced in each map sheet. Resolution of image is 2 meters on the ground. Memory size of one sheet is 192MB.

(6) Photo album of field survey in the study area

Many photographs were taken in the field. The photo album was prepared.

(7) Topographic data

Topographic data were prepared in each map sheet. These topographic data were used as a resource of spatial data frame and print maps

(8) Spatial data framework

Spatial data framework used as a resource of GIS were prepared. Two sets of spatial data framework were prepared because the study area is covered with 2 zones in UTM projection.

(9) Land use data

Land use data were prepared on 11 sheets of map in the Yangon metropolitan and vicinity. Land use was classified 23 categories.

(10) Topographic map drawing data

Topographic map is easily output by plotter device

6. Application of GIS

In the JICA study, a lot of kinds of Geographic information were produced. In this chapter, some of them are introduced. The user will be able to perform spatial analysis, and create new geographic information by using these data,

5.1 Aerial photo management system

Aerial photos are found easily in the shelf of CD-ROM by using aerial photo management system. (See Appendix A)

5.2 Ground control point Management system

Ground control points are found easily in the shelf by using ground control point management system. (See Appendix B)

5.3 GIS database management system

One example of GIS application was applied in Yangon area using GIS database produced by the Study. (See Appendix C)

5.4 GIS application in Myanmar

Spatial analysis of selected social function in Okkalapa Township, Yangon city was investigated by the geography department of Yangon university. (See Appendix D)

5.5 Topographic analysis

Topographic analysis was carried out using DEM produced by the Study. In this chapter, examples of Bird view, Gradient tint map, Counter map and topographic profiles were presented. (See Appendix E)

5.6 Education CD and Reference Books

Some CD for education and reference books were collected in the Study. Those who are interested in GIS can learn by themselves using these education CD and reference books. (See Appendix F, G)

5.7 Metadata

Sample of metadata of spatial data framework was presented. Besides explanation of metadata entities was attached which is defined in ISO/TC211. (See Appendix H)

No.	Item	Specification
1	Workstation computer	***Dell Precision 340MT Workstation with***
		- INTEL PENTIUM4 PROCESSOR 1.7GHz
		- INTEGRED 256KB ON-DIE L2 CACHE
		- ON-BOAD SOUND, 16-BIT
		- INTEGRATED NETWORKING 10/100MB/S 3COM FAST
		ETHERLINK XL WITH ACPI & WUOL
		- MEMORY: 1024 MB(2x512MB), PC800 ECC RIMM(RAMBUS)
		- HDD: 120GB ULTRA ATA, 1.0″ 7200RPM
		- VGA: 32MB Nvidia Quadro 2 EX, MT
		- FLOPPY DRIVE: 1.44MB,3.5″
		- CD-ROM: 48x Variable EIDE
		- SOUND CARD: Creative Sound Blaster Live
		- KEYBOAD: 104 Keys (English)
		- MOUSE: Microsoft Intellimouse, PS/2, 2BTNs + SCRL
		- OS: MICROSOFT WINDOWS2000 PROFESIONAL, SP 2,
		ENGLISH DELL ENHANCEMENT SOFTWARE, VERSION 2.0
		- HARD DRIVE FORMAT:FILE SYSTEM FORMAT(NTFS)
		- SPEAKER:HARMAN KARDON, HK395 STEREO,240B/50H
		- SHIPPING DOCUMENT/POWER CORD:
		Document, English Power Cord, 220V,UK,User
		Quick Reference Guide, DELL MOUSE PAD
2	MINITOR	**CRT TRINITORON FLAT DISPLAY 21″(19.8″ v.i.s)**
		MIDNGHT GREY, EQUAOR ZONE
		Horizontal/Vertical Refresh rate>120MHz, for Dual Monitor System
3	SOFTWERE	**TNTmips Map and Image Processing System with**
		- TNTmips full module
		- Plotter/Printer Module
		- TNTedit Module
		- Manual
		- Software Key(Parallel)

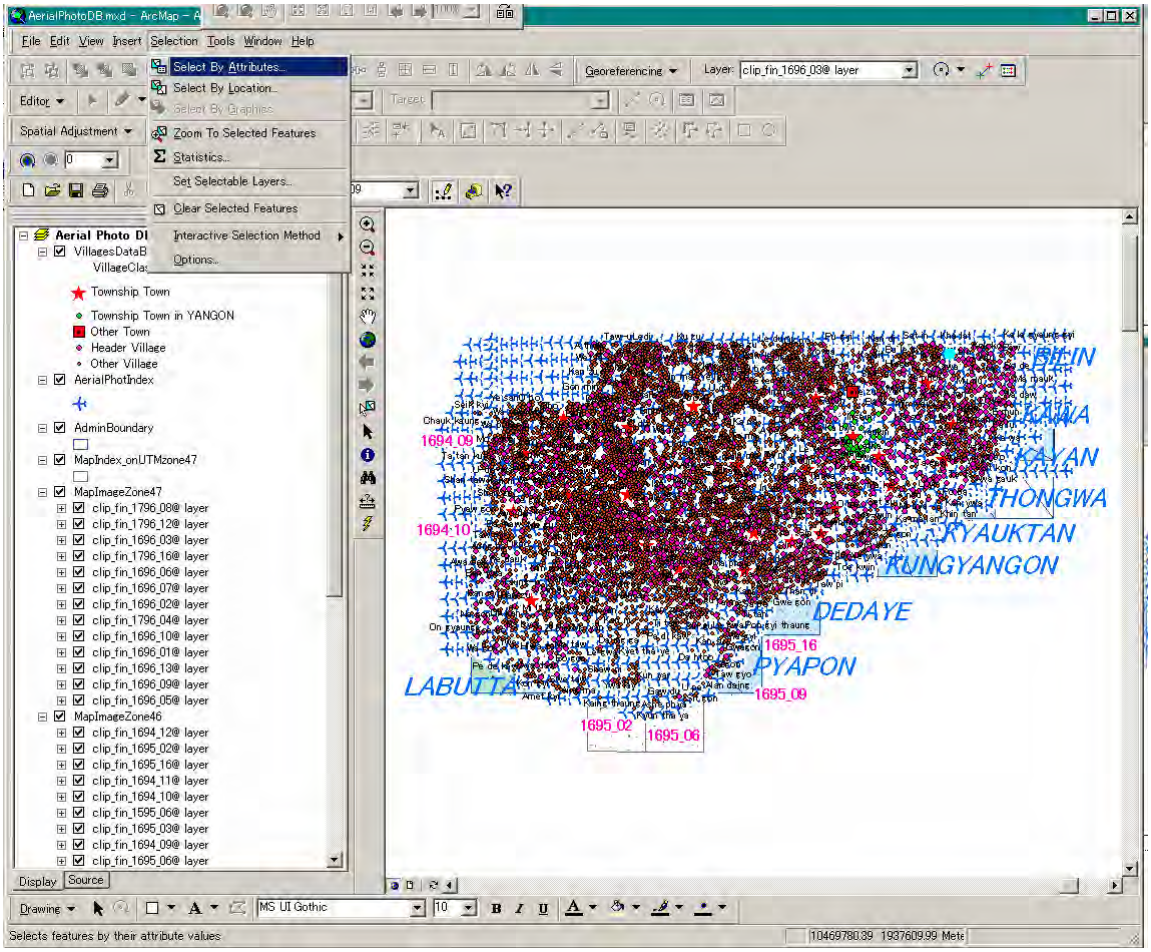
No.	Item	Specification
1	Data Server computer	***Dell Precision 340MT Workstation with***
		- INTEL PENTIUM3 PROCESSOR 1.13GHz
		- INTEGRED 512KB ON-DIE L2 CACHE
		- INTEGRATED INTEL PRO 10/100 NETWORK CARD
		FO, SERVER IDENTIFIER
		- RAID CONTROLLER: RAID 5, PERC3/SC,(MIN3HD),32MB
		1 INTERNAL CHANNEL DOCUMENT
		DISK KIT, PERC3/DI, ENGLISH
		- IDE CONTROLLER: CERC ATA 100,4CH,DOCUMENT, DISK KIT,ENGLISH
		- CHASSIS OPTION;TOWER ORIENTTATION,6U
		- MEMORY: 1024 MB(2x256MB), DIMM
		- FLOPPY DRIVE: 1.44MB/BOOT
		- HDD: 120GBX4 UNITES, E-IDE, 1″ 7.2K, RPM
		- VGA: BULT IN TNTEGRATED
		- CD-R-RW: 20x10X40 CD-R-RW E-IDE
		- SOUND CARD: Creative Sound Blaster Live
		- KEYBOAD: 104 Keys (English)
		- MOUSE: DELL mouse, (LOGITECH),MIDNIGHT GREY
		- OS: MSOFT WIN2000 ADVANCED SERVER,SP2,D,25 USER FI
		(DEFAULTED WITH 8GB B/PARTITION)
		- HARD DRIVE FORMAT:FILE SYSTEM FORMAT(NTFS)
		- SHIPPING DOCUMENT/POWER CORD:
		- POWER CORD:P4600,220V, 4, UK
		- POWER SUPPLY/AC TRABSFER SWITCH: REUNDANT 300W
		- TAPE BACKUP SOFTWARE: SERVER PRO EDITTION, VERITAS
		BACKUP EXEC FOR NW 8.5/NT/W2K8.6,NFI
		- TAPE BACKUP DDS4 INTERNAL: TAOE BACKUP DDS4,0/40 GB
		INTERNAL WITH
		CABLE,DATA,SCSI,FOR INTERNAL DDS4 TAPEBACKUP
		TAPE CARTIDGE DDS4, 20/40 GB 5 UNITS
		CLEANING TAPE CARTORDGE, DLT1/DLTVS80, 2 PACK
2	MINITOR	**CRT TRINITORON FLAT DISPLAY 21″(19.8″ v.i.s)**
		MIDNGHT GREY, EQUAOR ZONE
3	NETWORKING SYSTEM	BACKBONE(16)PORT SWITCH With UTP Cat5
		Cable
		RJ-45 Sockets, Face Plate Complete
4	Data Server configulation	Accessories
		Primary Domain Server Configulation
		System Configuration
		Raid System Configuration
		Network System Management

Appendix A: Aerial Photo Management System

This Data Base is consisting of below Layer.

- Viilage DB
- Aerial Photo Index DB
- AdminiBoundary DB
- Map sheet Index
- 1/50,000topographic Map Image File.

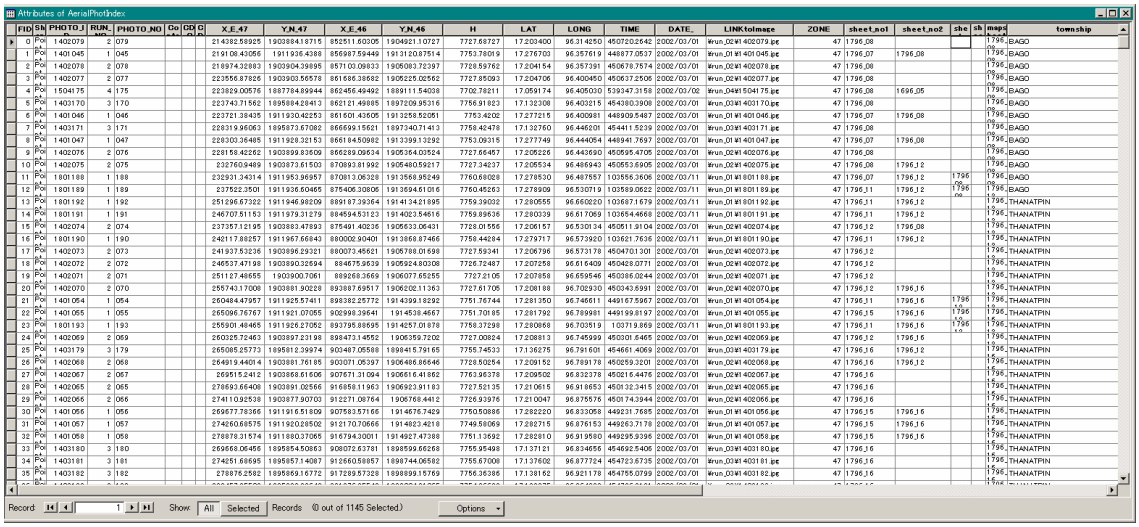
User can search aerial photo Image by using some query and browse image
This example is using “select attribute function” for finding aerial photo.



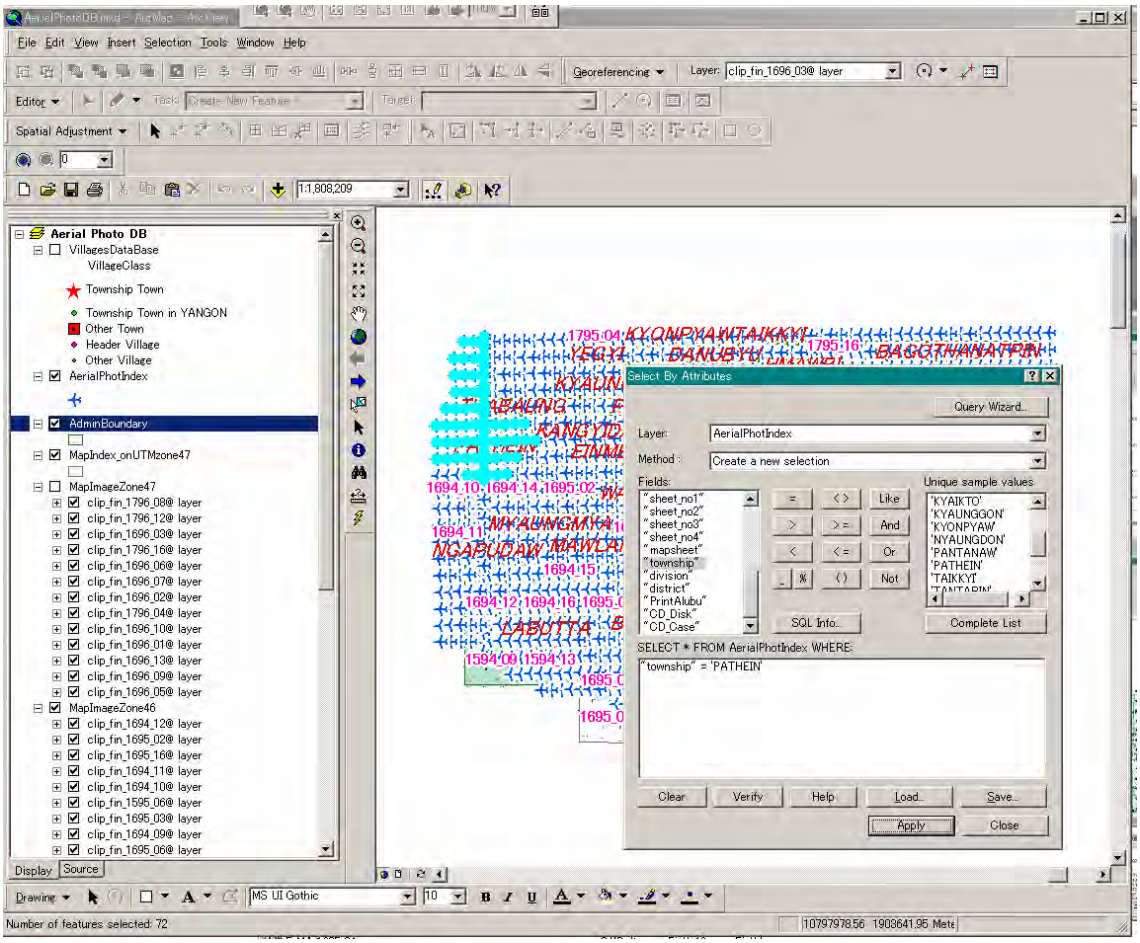
Example 1 Searching aerial photo by township name.

Attribute table of Aerial photo index layer has some field,

Run_NO
Photo_ID
PhotoNo.
Coodinate
TIME time of the aerial photo was taken.
Date date of the aerial photo was taken
Link Hyper link pass to Image file
Zone UTM zone No,
Sheet No, Covering 1/50,000map sheet ID for the each photo
Township Covering township name for each photos
Division
District



Below case select the aerial photo which covers Pathein township area from township field
Search from “township” field of “Aerial PhotoIndex” layer



Example 2 Searching aerial photos using attribute of village database layer

User can search the aerial photograph using list of village names and map.
Original data of Village database layer is annotation data of 1/50,000 scale topographic map.
This village database is **"Gazetteer"** of mapping area.
Attribute table of this village database is including following field.

+Name of town or village
+Classification of town or village
-Township town, -Other town, -Header Village, -Other village
+Division name of the town or village
+District name of the town or village
+UTM Grid letter for position of the town or village
+1/50,000 Map sheet No. the town or village covers
+Latitude
+Longitude

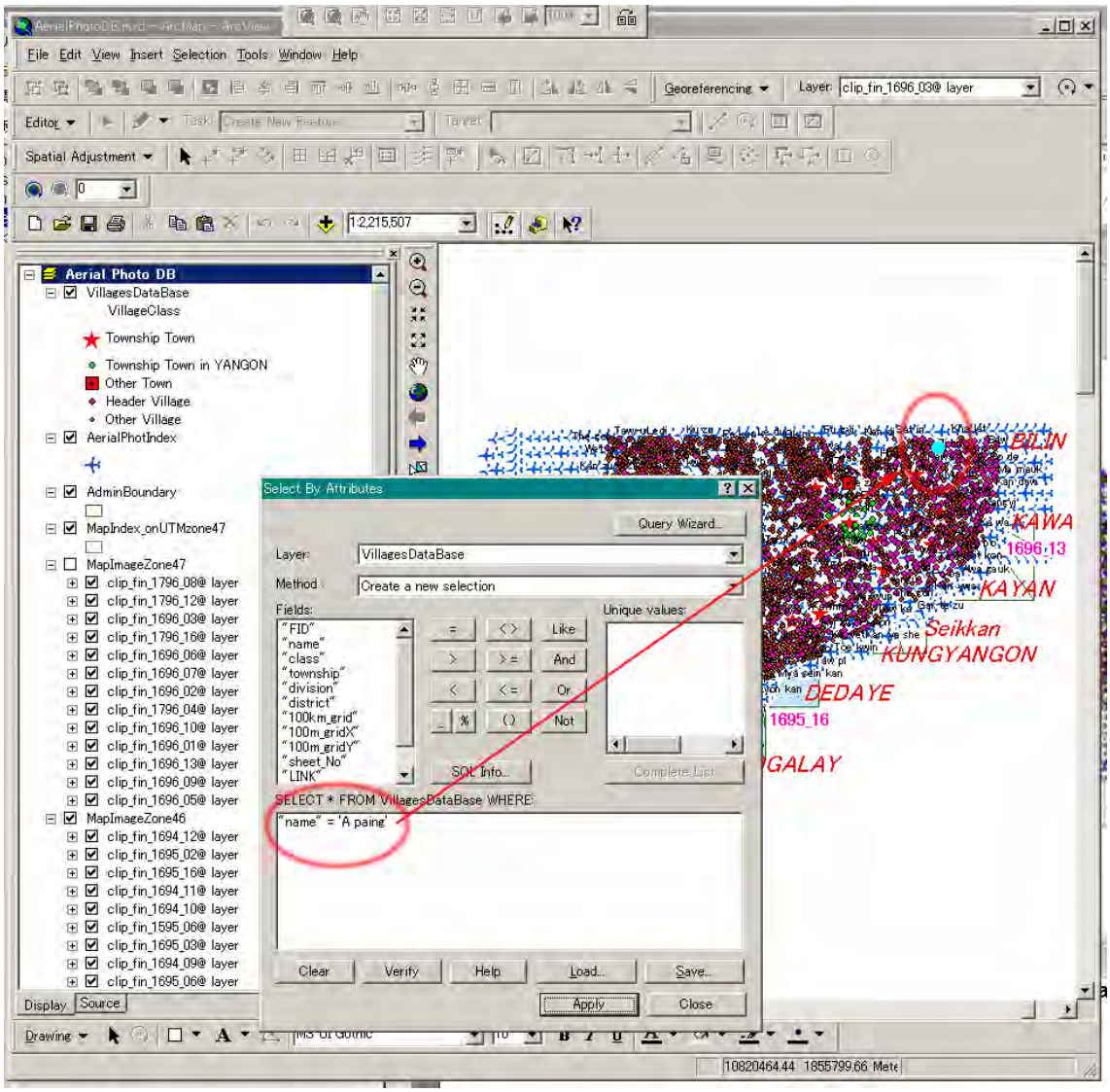
User can search name and location of villages from **"Gazetteer"** and search the aerial photos covering the village.

Attributes of VillagesDataBase

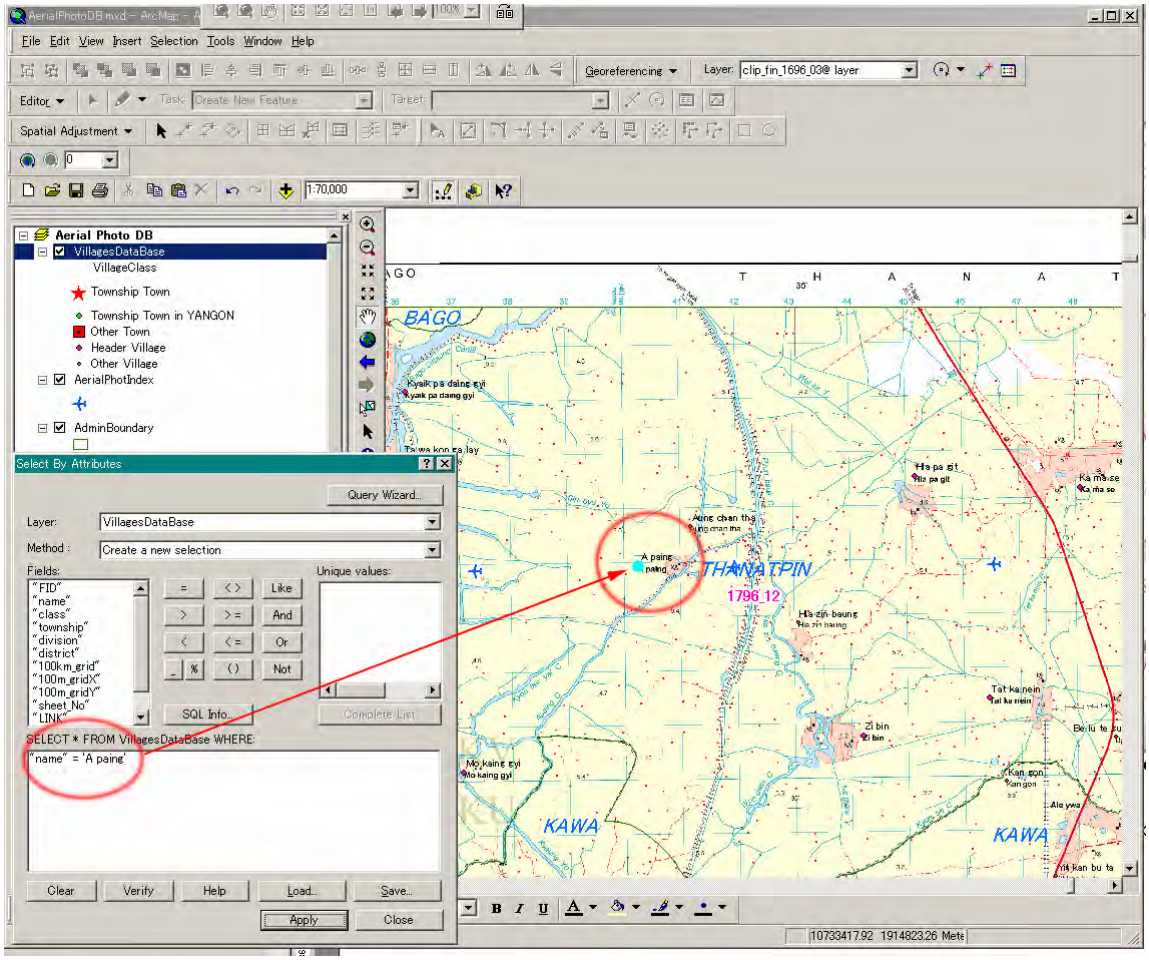
FID	Shap	name	VillageClass	township	division	district	100km_grid	100m_gridX	100m_gridY	sheet_No	LINK	LAT	LONG
6314	Point	A chan	Other Village	PYAPON	AYEYAWADY	PYAPON	GN	800	971	1695_12	¥run_15¥1515	16.240530	95.620480
8058	Point	A chan	Other Village	KYAIKLAT	AYEYAWADY	PYAPON	GP	804	189	1695_11	¥run_12¥1712	16.436875	95.626726
8071	Point	A chan gyaung	Other Village	KYAIKLAT	AYEYAWADY	PYAPON	GP	860	245	1695_11	¥run_12¥1712	16.487257	95.679441
3224	Point	A date	Other Village	MAUBIN	AYEYAWADY	MAUBIN	GP	915	586	1695_09	¥run_08¥1708	16.793743	95.735556
3475	Point	A don	Other Village	WAKEMA	AYEYAWADY	MYAUNGMYA	GP	416	463	1695_06	¥run_09¥1509	16.688958	95.266150
226	Point	A du ka la zu	Other Village	KAWA	BAGO	BAGO	KU	510	992	1796_12	¥run_03¥1403	17.165476	96.659131
8741	Point	A dun	Header Village	TWANTE	YANGON	SOUTHERN YANGON	HP	042	495	1695_14	¥run_09¥1509	16.710037	95.853827
5801	Point	A dut taw	Other Village	KYAUKTAN	YANGON	SOUTHERN YANGON	KU	113	433	1696_06	¥run_10¥1710	16.656019	96.293942
892	Point	A hta ysung	Other Village	TAIKKYI	YANGON	NORTHERN YANGON	GQ	902	043	1795_12	¥run_02¥1402	17.207329	95.729244
897	Point	A hta ysung	Other Village	NYAUNGDON	AYEYAWADY	MAUBIN	GQ	910	032	1795_12	¥run_02¥1402	17.197316	95.736482
8571	Point	A ka la	Other Village	TWANTE	YANGON	SOUTHERN YANGON	HP	045	327	1695_14	¥run_11¥1711	16.558663	95.853726
8685	Point	A kauk yone	Other Village	Seikkyikanaungdo	YANGON	SOUTHERN YANGON	JU	898	539	1696_02	¥run_31¥18N	16.749764	96.091070
6059	Point	A ke chaung wa	Header Village	DEDAYE	YANGON	PYAPON	HN	031	936	1695_16	¥run_16¥1616	16.205548	95.835531
6068	Point	A ke ywa ma	Other Village	DEDAYE	YANGON	PYAPON	HN	036	949	1695_16	¥run_15¥1515	16.217637	95.841016
1549	Point	A kwi	Other Village	PANTANAW	AYEYAWADY	MAUBIN	GP	628	941	1795_08	¥run_03¥1403	17.118095	95.471104
1580	Point	A kwi angu lay	Other Village	PANTANAW	AYEYAWADY	MAUBIN	GP	640	937	1795_08	¥run_03¥1403	17.114725	95.481762
1581	Point	A kwi ashe	Other Village	PANTANAW	AYEYAWADY	MAUBIN	GP	636	942	1795_08	¥run_03¥1403	17.119017	95.478081
665	Point	A Kyaw	Header Village	DANUBYU	AYEYAWADY	MAUBIN	GQ	693	069	1795_12	¥run_01¥1401	17.233367	95.533664
6388	Point	A kyi kayin zu	Other Village	PYAPON	AYEYAWADY	PYAPON	GP	840	042	1695_11	¥run_14¥1614	16.304195	95.658308
6409	Point	A kyi wa	Header Village	PYAPON	AYEYAWADY	PYAPON	GP	850	037	1695_11	¥run_14¥1614	16.299615	95.667767
3133	Point	A lan	Other Village	MAUBIN	AYEYAWADY	MAUBIN	GP	840	635	1695_09	¥run_07¥1807	16.838971	95.666135
3480	Point	A lan	Header Village	WAKEMA	AYEYAWADY	MYAUNGMYA	GP	372	412	1695_02	¥run_09¥1509	16.643554	95.224880
8057	Point	A lan dut	Other Village	KYAIKLAT	AYEYAWADY	PYAPON	GP	820	208	1695_11	¥run_12¥1712	16.453689	95.641951
847	Point	A lan gon	Other Village	NYAUNGDON	AYEYAWADY	MAUBIN	HP	008	889	1795_16	¥run_04¥1504	17.066562	95.827116
4122	Point	A lan lay	Other Village	KANGYIDAUNG	AYEYAWADY	PATHEIN	GP	112	626	1694_13	¥run_07¥1807	16.838696	94.982701
6002	Point	A le gon	Other Village	DEDAYE	YANGON	PYAPON	HN	194	973	1695_16	¥run_15¥1515	16.237448	95.988170
998	Point	A le se	Other Village	NYAUNGDON	AYEYAWADY	MAUBIN	HP	000	846	1795_16	¥run_04¥1504	17.027664	95.818382
1585	Point	A le su	Other Village	KYAUNGGON	AYEYAWADY	PATHEIN	GP	473	879	1795_08	¥run_04¥1504	17.064065	95.324037
1441	Point	A le zu	Other Village	KYAUNGGON	AYEYAWADY	PATHEIN	GP	334	828	1795_04	¥run_04¥1504	17.019151	95.193699
1471	Point	A le zu	Other Village	KYAUNGGON	AYEYAWADY	PATHEIN	GP	375	892	1795_04	¥run_04¥1504	17.076750	95.232428
4683	Point	A le zu	Other Village	KYAUNGGON	AYEYAWADY	PATHEIN	GP	248	784	1695_01	¥run_05¥1505	16.980103	95.112529
830	Point	A lein a le	Header Village	TANTABIN	YANGON	NORTHERN YANGON	HP	115	944	1795_16	¥run_03¥1403	17.114509	95.928377
5216	Point	A lut wa	Other Village	PANTANAW	AYEYAWADY	MAUBIN	GP	410	716	1695_05	¥run_06¥1406	16.917046	95.263174
7511	Point	A mat ga lay	Other Village	LABUTTA	AYEYAWADY	MYAUNGMYA	FN	985	891	1694_16	¥run_16¥1516	16.176024	94.857113
7510	Point	A mat wa	Other Village	LABUTTA	AYEYAWADY	MYAUNGMYA	FN	978	888	1694_16	¥run_16¥1516	16.172965	94.851163
573	Point	A mauk we	Other Village	TANTABIN	YANGON	NORTHERN YANGON	HQ	118	016	1795_16	¥run_02¥1402	17.180206	95.932178
5634	Point	A maung	Other Village	THONGWA	YANGON	SOUTHERN YANGON	KU	500	543	1696_09	¥run_08¥1808	16.760160	96.654828
1570	Point	A nauk kon	Other Village	PANTANAW	AYEYAWADY	MAUBIN	GP	470	921	1795_08	¥run_03¥1403	17.102073	95.321696
1597	Point	A nauk kon	Other Village	PANTANAW	AYEYAWADY	MAUBIN	GP	490	828	1795_08	¥run_04¥1504	17.017512	95.339598
1605	Point	A nauk su	Other Village	PANTANAW	AYEYAWADY	MAUBIN	GP	528	892	1795_08	¥run_04¥1504	17.075120	95.376462
6191	Point	A nauk su	Other Village	DEDAYE	YANGON	PYAPON	GN	945	975	1695_16	¥run_15¥1515	16.242492	95.755776
7097	Point	A nauk su	Other Village	BOGALAY	AYEYAWADY	PYAPON	GP	708	138	1695_11	¥run_13¥1613	16.391801	95.536385

Record: 0 Show: All Selected Records (1 out of 8775 Selected.) Options

View of Village database table

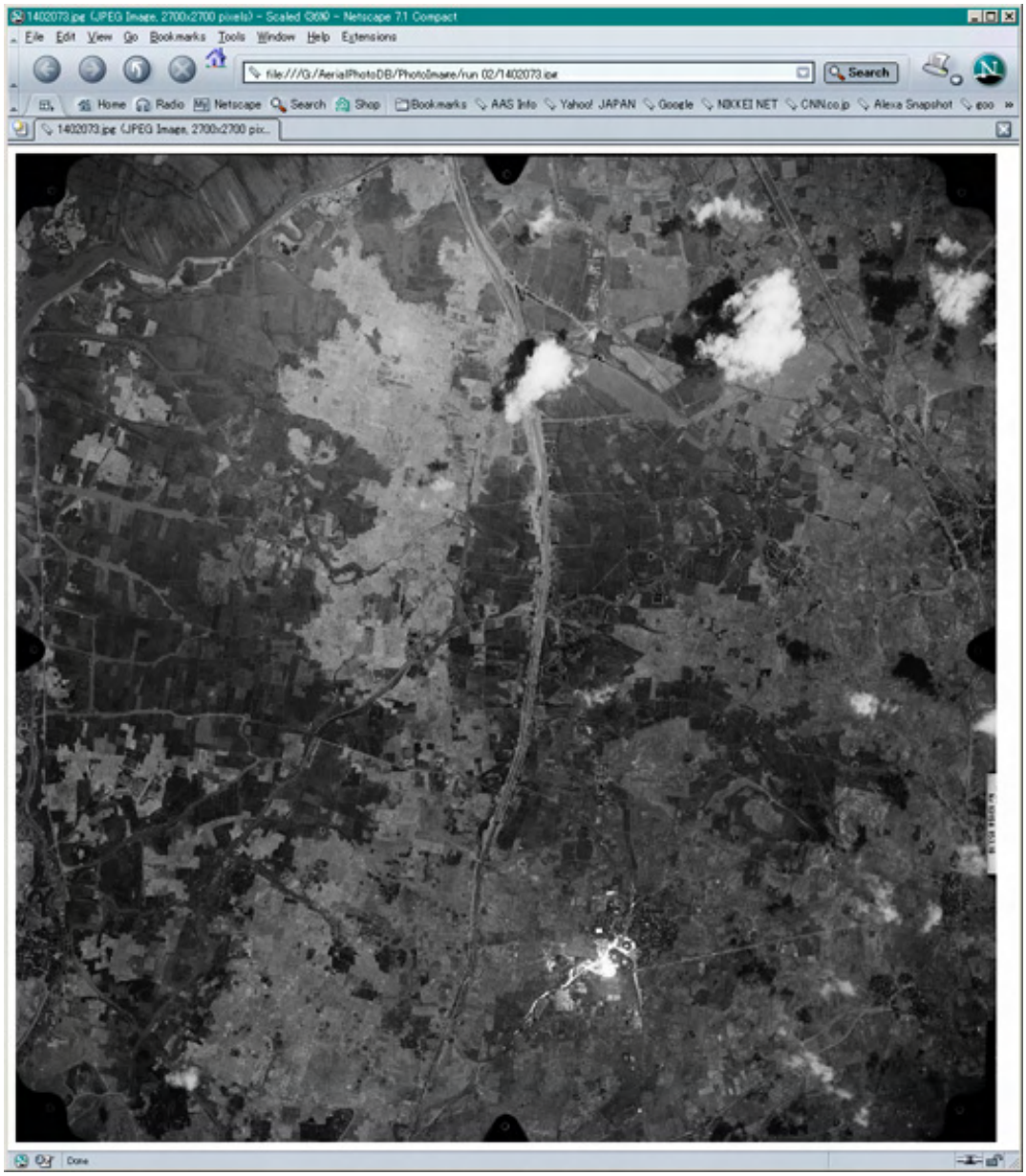


Search from village name which user wants see the aerial photo.



Zoom to location of the village which user searched and confirm the ID of the aerial photo which cover objective area.

Click the hyper link icon for aerial photograph, user can browse aerial photograph image which cover object area. (Next Page)


1402073.jpg (JPEG Image, 2700x2700 pixels) - Scaled (69%) - Netscape 7.1 Compact
File Edit View Go Bookmarks Tools Window Help Extensions
file:///G:/AerialPhotoDB/PhotoImage/run 02/1402073.jpg
Search
Home Radio Netscape Search Shop Bookmarks AAS Info Yahoo! JAPAN Google NIKKEI NET CNN.co.jp Alexa Snapshot goo
1402073.jpg (JPEG Image, 2700x2700 pix...
Done

Appendix B: Ground control point management system

1. Outline

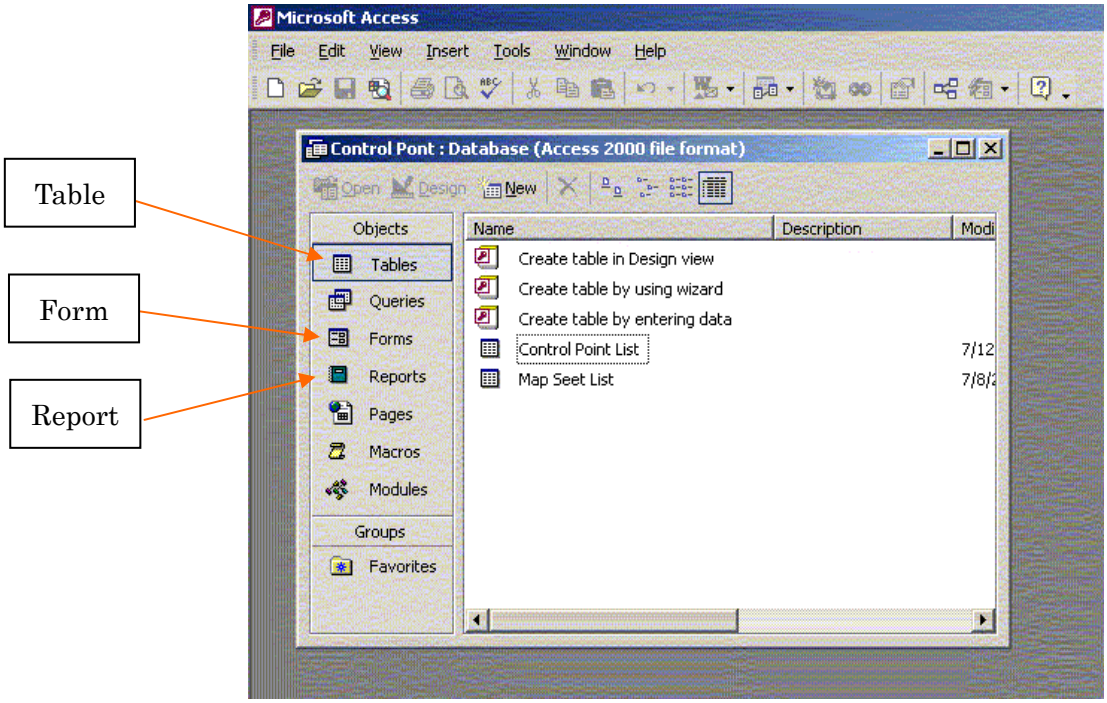
This system consists of three objects as “Table”, “Form” and “Report”.

“Table” is the place in which the data is stored.

“Form” is the graphical interface by which data is input visually.

“Report” is the function to print the data.

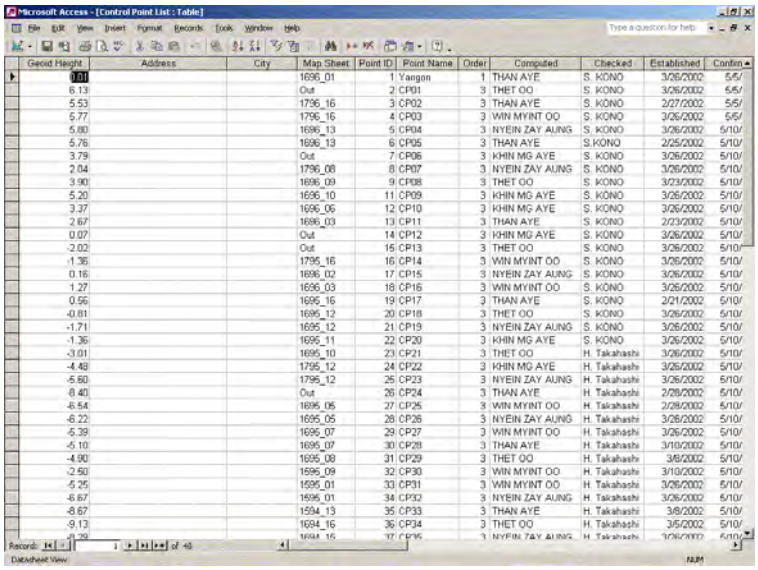
All of them have two types of mode, “Design” and “View”.



1-1. Table

Table looks like to Excel Work Sheet. All geodetic data are stored in the Table. Two tables, “Control Point List” and “Map Sheet List”, are prepared in this system.

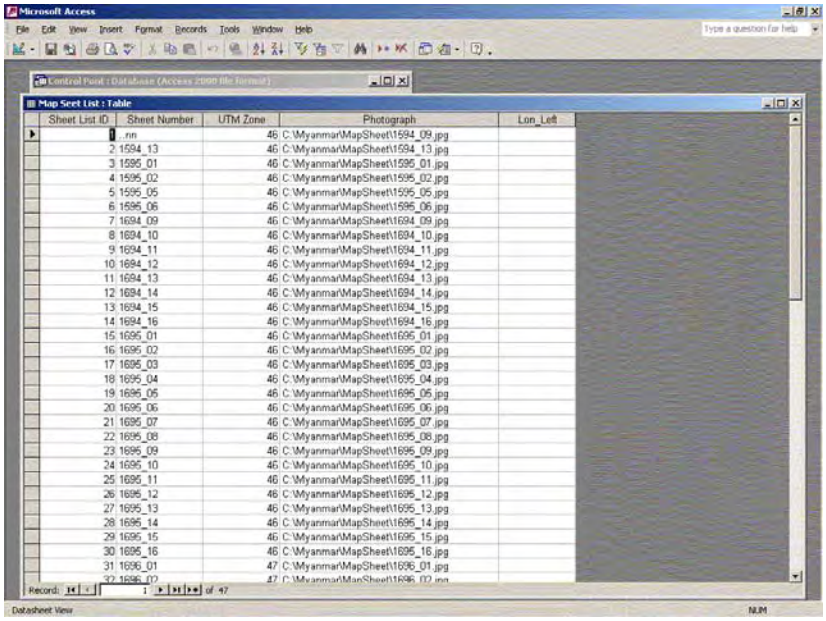
Control Point List



Items of data in Control Pont List are as follows.

1) Point ID
2) Name of point
3) Order of point
4) Map sheet number
5) Address
6) Date of establishment
7) Date of recent confirmation
8) Name of the person who computed
9) Name of the person who checked
10) Actual condition of point
11) Geographical coordinate (Longitude and Latitude)
12) Plane coordinate (Northing and Easting)
13) Elevation
14) Geoid height
15) Meridian convergence
16) Scale factor
17) Location map
18) Field photograph
19) Note

Map Sheet List



Items of data in Map Sheet List are as follows.

1) Sheet ID

2) Sheet number
3) UTM Zone
4) Image of sheet

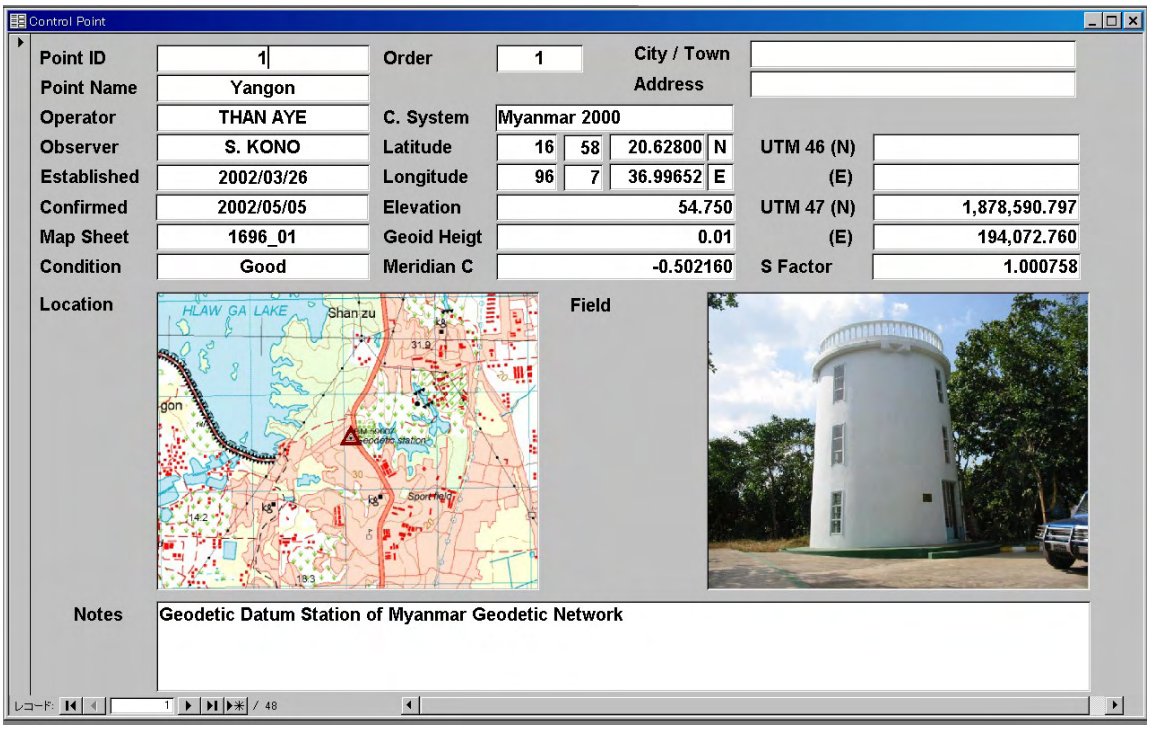
Data can be sorted, retrieved and replaced in the Table.
Column can be moved anywhere in the table.

A point to notice is the difference between Access and other applications of MS Office. When the data are input in Access, the file is modified in that moment. Contrarily in case of other applications, the data is not stored while the file is not saved.

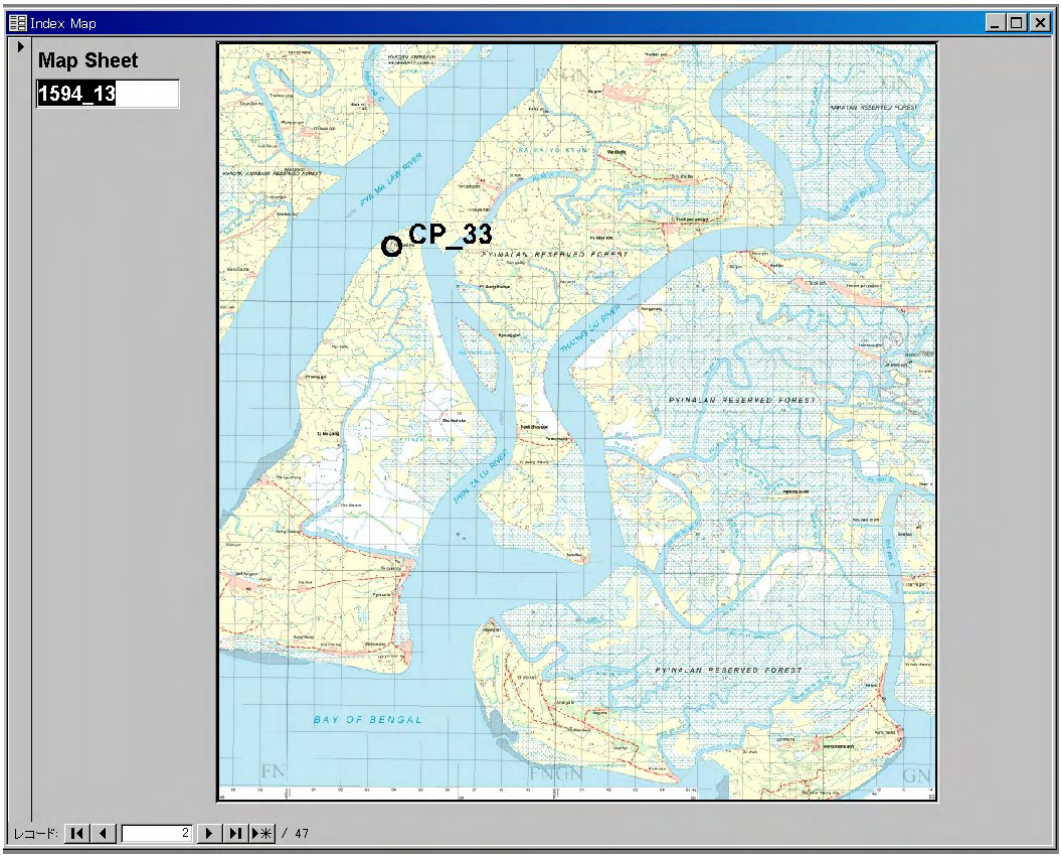
1-2. Form

Form is the interface to input data visually.
Two forms, “Control Point List” and “Map Sheet List”, are prepared in this system.
The items in these table are as same as the items of tables.

Control Point List



Map Sheet List



1-3. Report

Description of Control Point

Point ID	4		Order	3
Point Name	CP03		1/50,000 Sheet	1796_16
Location				
Date of Establishment	3/26/2002	Computed by	WIN MYINT OO	
Recent Confirmation	5/5/2002	Checked by	S.KONO	
Condition	Good			
Latitude	17 _ 6 _16.33948		N(46)	
Latitude	96 _ 49 _54.8389	UTM	E(46)	
Elevation	6.44		N(47)	1,892,251.477
Geoid Height	5.77		E(47)	269,334.568
Meridan Convergence	-0.3816643	S Factor	1.0002581	
Location Map		Field Photograph		
				
Note				

Report is the function by which the Description of Point is printed. The print out form of description can be designed easily.

It is possible to select some control points and print them by using parameter query.

2. Table

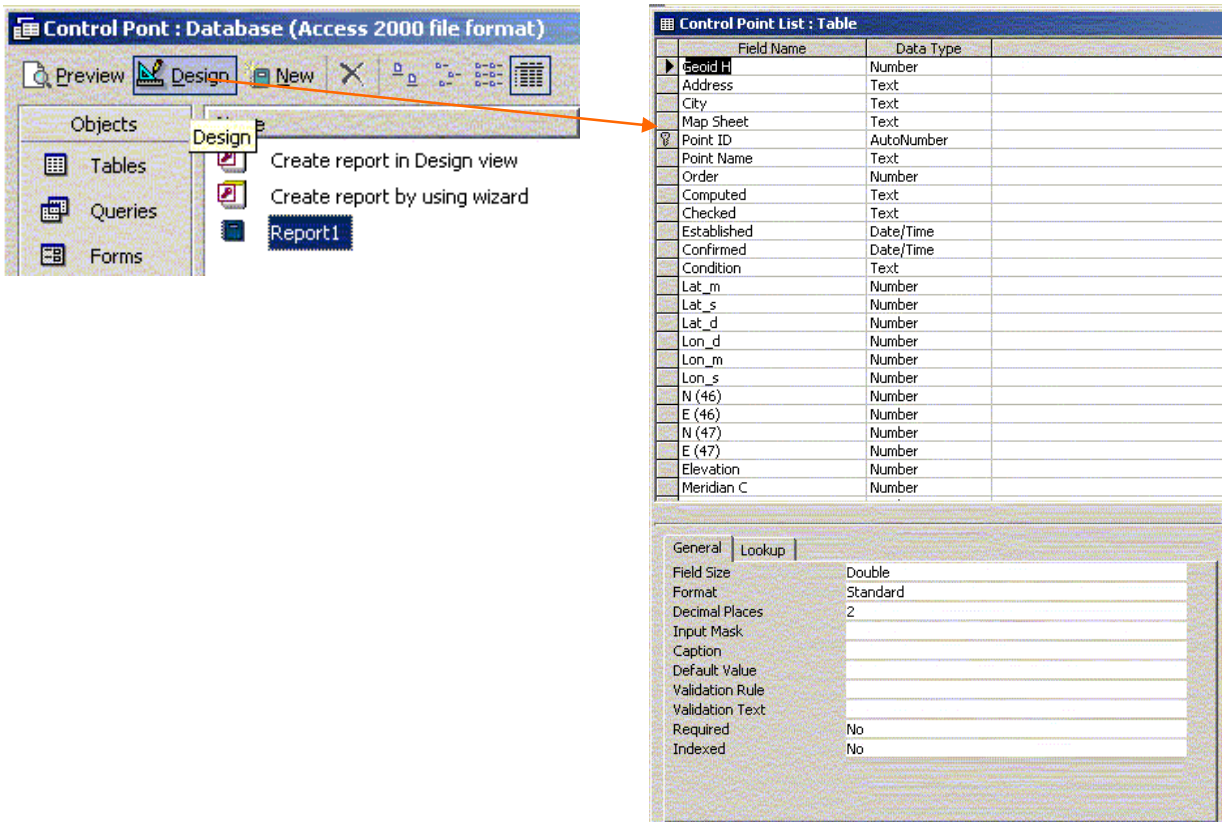
Using this object “Table”, data can be input and modified.

2-1. Property

Property is the definition of character of fields. Main item of property is as follows;

1) Field Name
2) Data Type
3) Field Size
4) Format
5) Input Mask
6) Caption
7) Default Value
8) Validation Rule

Design mode is used to modify the Property.

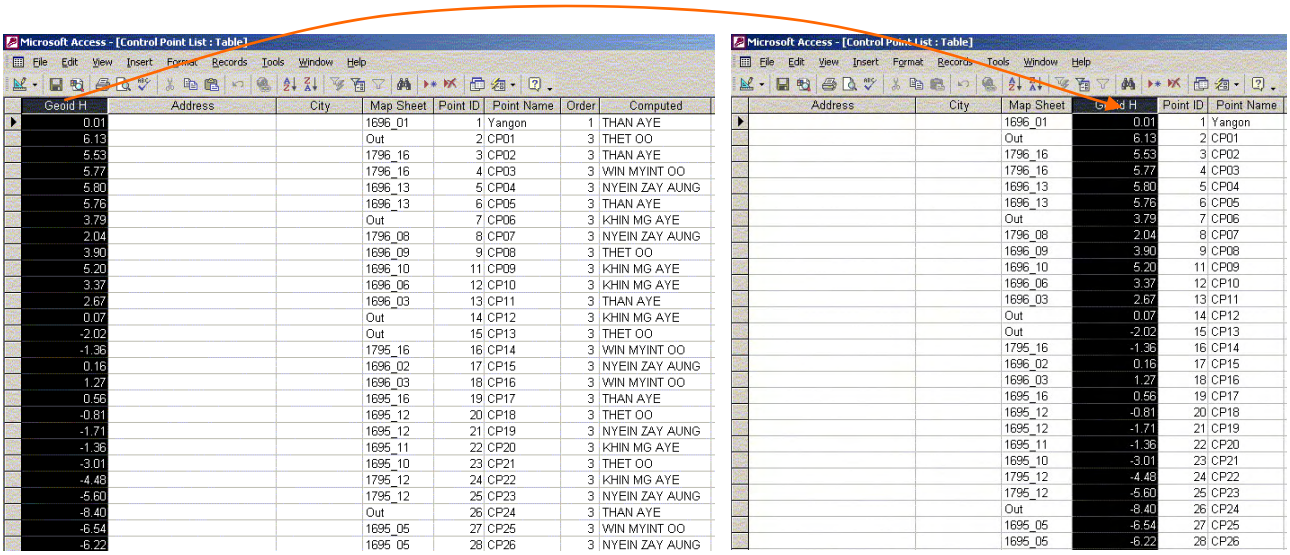


Property of each item will be as follows:

Item	Data Type	Field Size
Point ID	Number	Long Integer
Point Name	Text	
Order of point	Number	Integer
Map sheet number	Text	
Address	Text	
Date of establishment	Date/Time	
Date of recent confirmation	Date/Time	
Name of the person who computed	Text	
Name of the person who checked	Text	
Actual condition of point	Text	
Geographical coordinate (Longitude and Latitude)	Number	Double
Plane coordinate (Northing and Easting)	Number	Double
Elevation	Number	Double
Geoid height	Number	Double
Meridian convergence	Number	Double
Scale factor	Number	Double
Location map	Text	
Field photograph	Text	
Note	Memo	

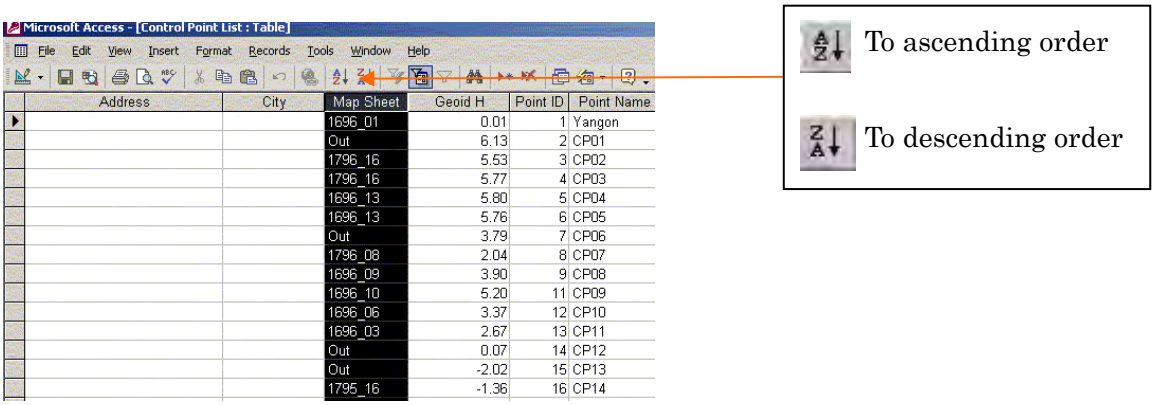
2-2. Column

Column can be moved to any position easily.



2-3. Sorting

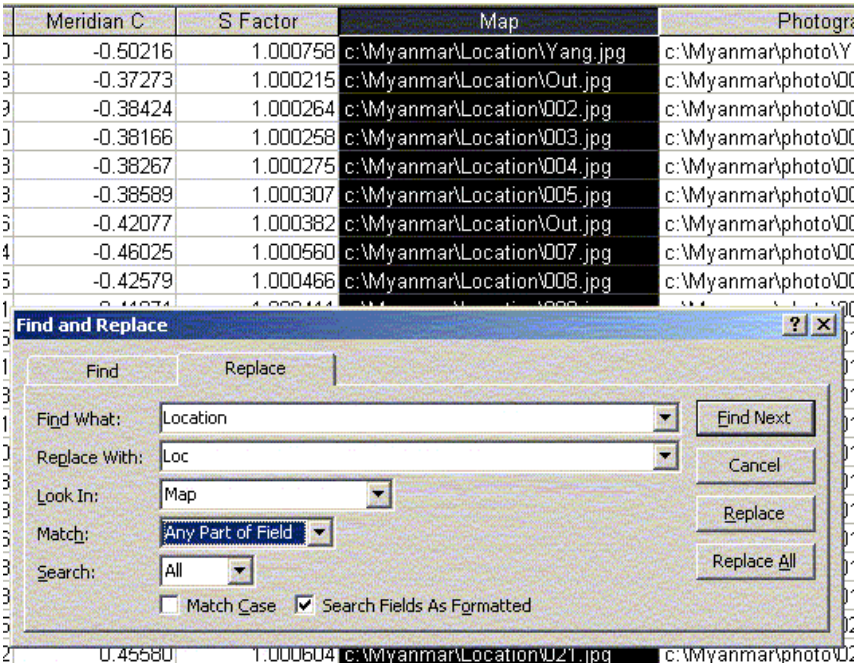
Data can be sorted. Now, let's sort them by sheet number.



Address	City	Map Sheet	Geoid H	Point ID	Point Name
		1696_01	0.01	1	Yangon
		Out	6.13	2	CP01
		1796_16	5.53	3	CP02
		1796_16	5.77	4	CP03
		1696_13	5.80	5	CP04
		1696_13	5.76	6	CP05
		Out	3.79	7	CP06
		1796_08	2.04	8	CP07
		1696_09	3.90	9	CP08
		1696_10	5.20	11	CP09
		1696_06	3.37	12	CP10
		1696_03	2.67	13	CP11
		Out	0.07	14	CP12
		Out	-2.02	15	CP13
		1795_16	-1.36	16	CP14

2-4. Find and Replace

Data that the user wants to replace can be and replaced.



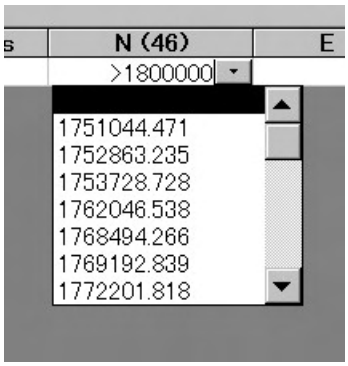
2-5. Filter

Any condition of data that the operator needs can be searched by the "Filter" function.

Now, let's search the control point which northing is larger than 1800000 in the zone 46.

1) At first clear the former condition.

2) Input the condition ">1800000" in the cell of "N(46)".



3) To search.

 ← Click this to searvh

4) Result.

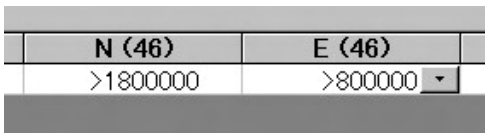
N (46)	E (46)
1,911,394.980	814,446.733
1,884,359.546	816,880.384
1,850,361.086	823,343.421
1,815,907.440	824,046.520
1,800,231.592	788,672.718
1,842,873.858	784,937.212
1,885,410.923	781,848.585
1,908,810.044	776,125.393
1,912,062.432	740,820.076
1,879,359.753	754,733.737
1,853,594.080	764,499.368
1,823,954.027	744,662.676
1,800,477.913	741,866.068
1,801,555.406	701,183.395
1,836,101.813	705,792.323
1,876,706.283	711,004.164
1,908,654.768	712,250.695
1,881,983.381	691,493.278
1,878,837.985	656,185.242
1,858,625.899	659,435.719
1,829,321.369	680,799.740
1,906,372.840	823,670.532
1,867,951.532	818,145.262
1,832,846.904	820,725.259

Control points with the northing larger than 1800000 are selected.

5) Multi condition (1)

Now, let's search the control point which northing is larger than 1800000 and easting is lage than 800000 in the zone 46.

Condition



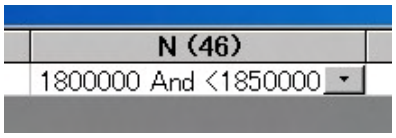
Result

N (46)	E (46)
1,911,394.980	814,446.733
1,884,359.546	816,880.384
1,850,361.086	823,343.421
1,815,907.440	824,046.520
1,906,372.840	823,670.532
1,867,951.532	818,145.262
1,832,846.904	820,725.259

6) Multi condition (2)

Now, let's search the control point which northing is larger than 1800000 and smaller than 1850000.

Condition



Result

N (46)
1,815,907.440
1,800,231.592
1,842,873.858
1,823,954.027
1,800,477.913
1,801,555.406
1,836,101.813
1,829,321.369
1,832,846.904

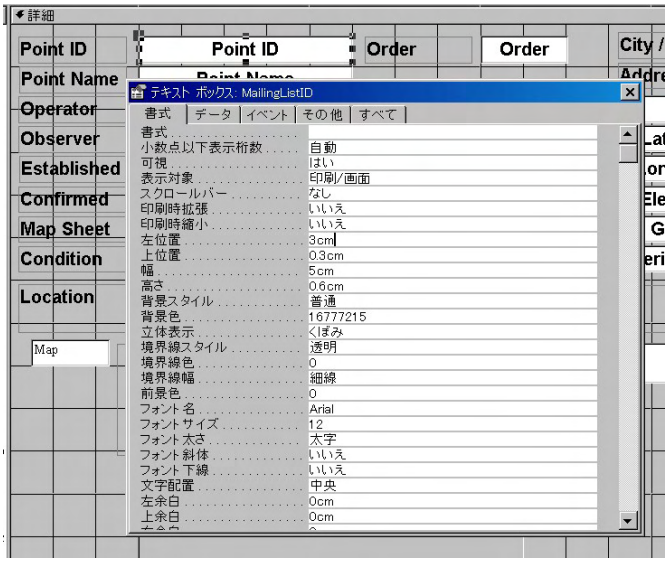
Many conditions can be setup simultaneously.

3. Form

Using this object "Form", data can be input and modified visually. The data entered from "Form" is stored in the "Table".

3-1. Property

By the "Design View" mode each object can be designed defining the property.

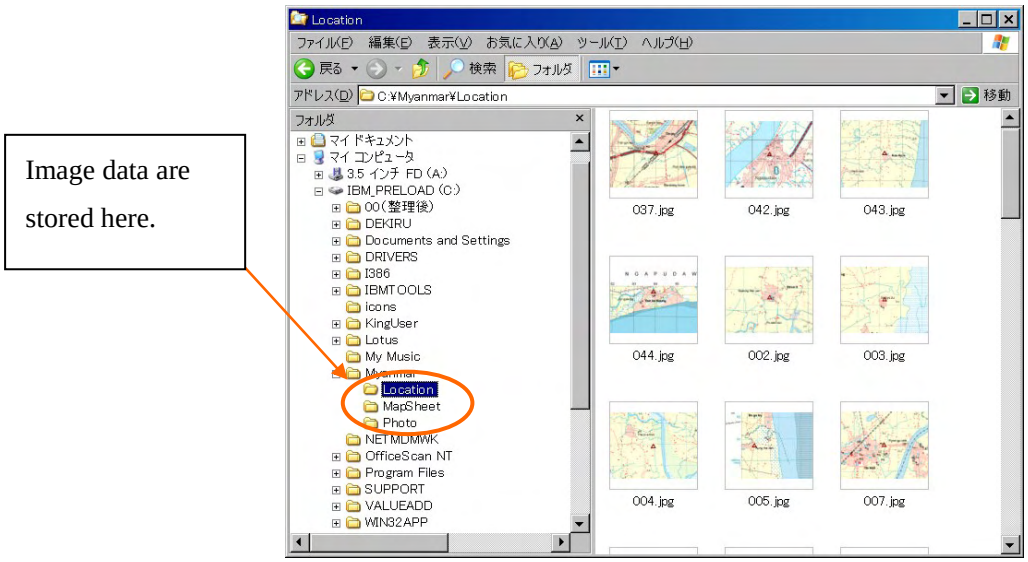


3-2. Image data

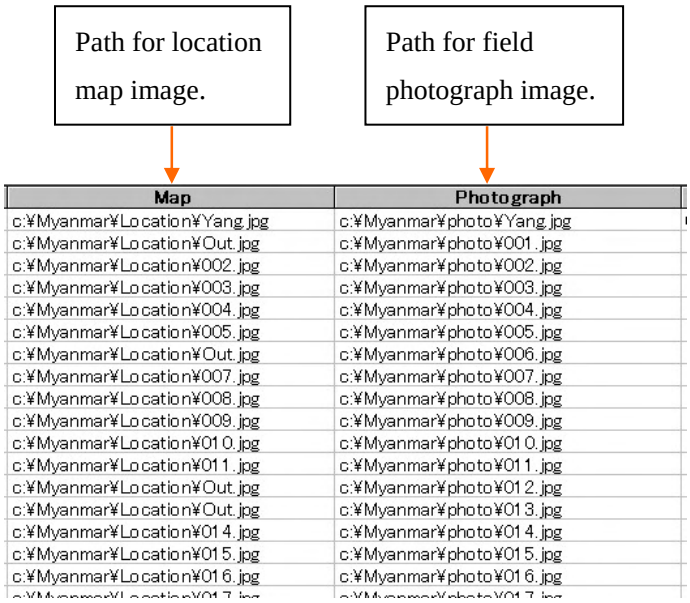
Image type data as the location map, field photograph and map sheet, are expressed in the object "Image" linked by path.

1) Path

Path is the Place where the image data is stored. In this system, image data are stored in the drive c:, folder Myanmar.



The path data is in the field “Map” and “Photograph” in the table.



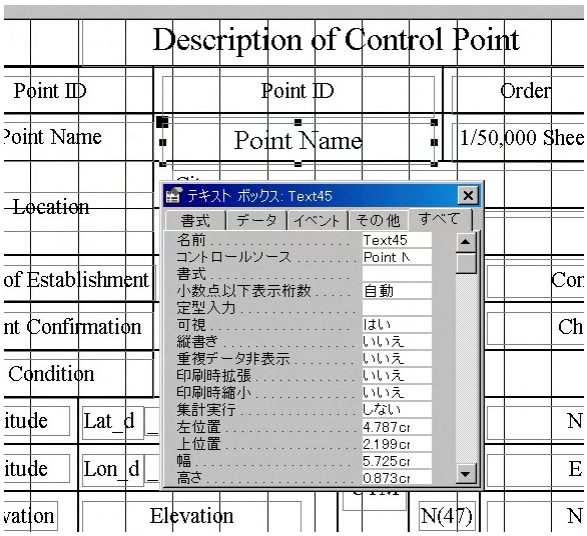
Map	Photograph
c:¥Myanmar¥Location¥Yang.jpg	c:¥Myanmar¥photo¥Yang.jpg
c:¥Myanmar¥Location¥Out.jpg	c:¥Myanmar¥photo¥001.jpg
c:¥Myanmar¥Location¥002.jpg	c:¥Myanmar¥photo¥002.jpg
c:¥Myanmar¥Location¥003.jpg	c:¥Myanmar¥photo¥003.jpg
c:¥Myanmar¥Location¥004.jpg	c:¥Myanmar¥photo¥004.jpg
c:¥Myanmar¥Location¥005.jpg	c:¥Myanmar¥photo¥005.jpg
c:¥Myanmar¥Location¥Out.jpg	c:¥Myanmar¥photo¥006.jpg
c:¥Myanmar¥Location¥007.jpg	c:¥Myanmar¥photo¥007.jpg
c:¥Myanmar¥Location¥008.jpg	c:¥Myanmar¥photo¥008.jpg
c:¥Myanmar¥Location¥009.jpg	c:¥Myanmar¥photo¥009.jpg
c:¥Myanmar¥Location¥010.jpg	c:¥Myanmar¥photo¥010.jpg
c:¥Myanmar¥Location¥011.jpg	c:¥Myanmar¥photo¥011.jpg
c:¥Myanmar¥Location¥Out.jpg	c:¥Myanmar¥photo¥012.jpg
c:¥Myanmar¥Location¥Out.jpg	c:¥Myanmar¥photo¥013.jpg
c:¥Myanmar¥Location¥014.jpg	c:¥Myanmar¥photo¥014.jpg
c:¥Myanmar¥Location¥015.jpg	c:¥Myanmar¥photo¥015.jpg
c:¥Myanmar¥Location¥016.jpg	c:¥Myanmar¥photo¥016.jpg

4. Report

Using this object “Report”, description of control point is printed.

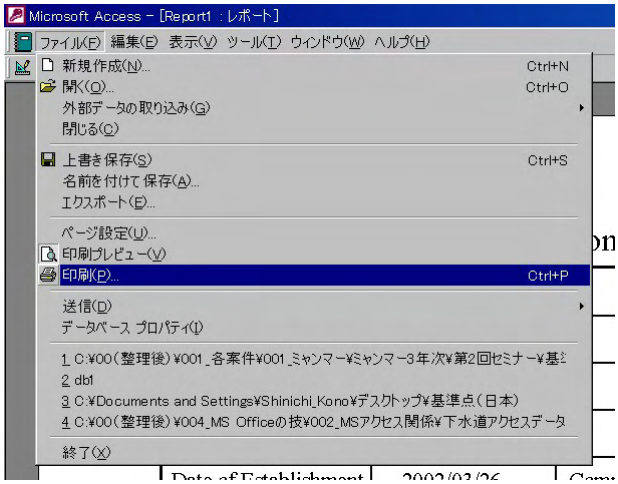
4-1. Property

By the “Design View” mode each object can be designed defining the property.



4-2. Printing

The process to print the description is same as it of other applications.



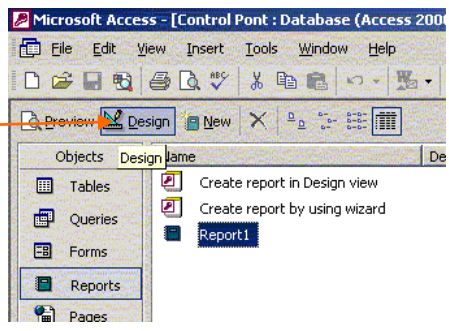
Selection of required description

The weak point of Access is to print the selected page that the user needs. If the volume of data is big and the user selects a page in the latter half of the data, system may stop. The reason is the load to express the image data.

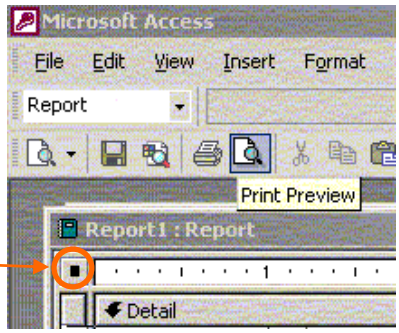
So it is desirable to select the required pages before printing.

1) Open the “Report” by design mode.

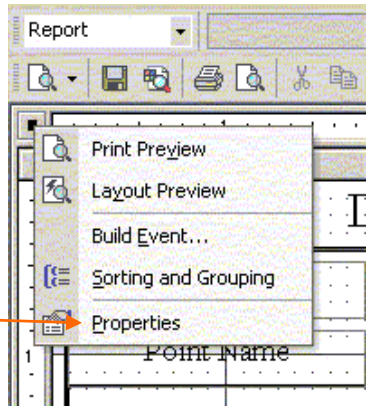
Open the Report by design mode.



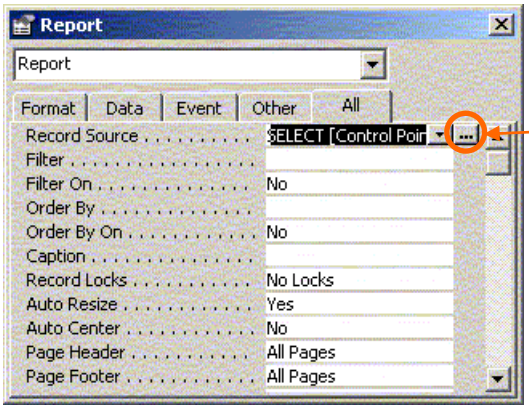
2) Open the property box.



1. Right click here.



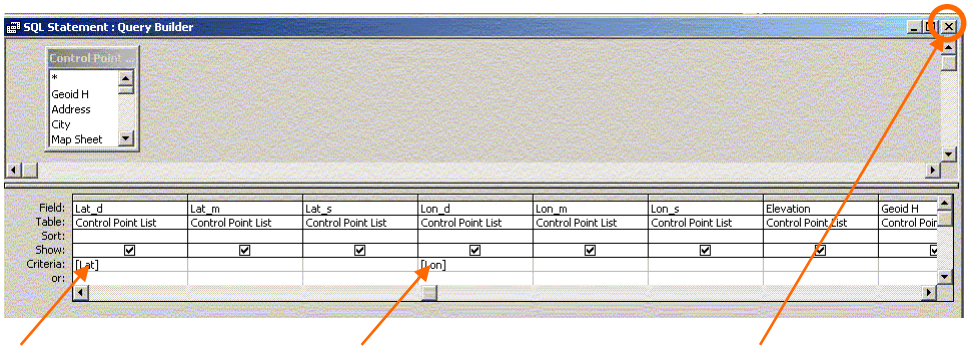
2. Click here.



3. Click here.

3) Select the item to setup.

In this example, let's select the control points above the latitude of 17 degrees and longitude of 96 degrees.

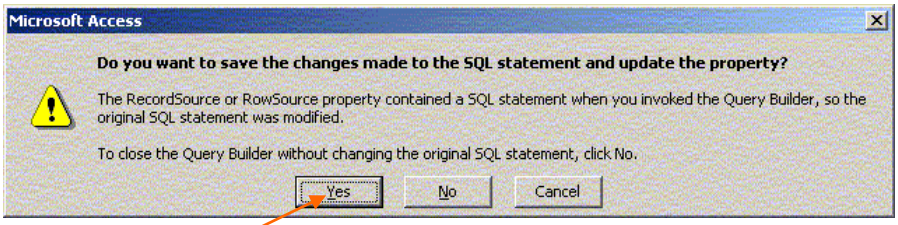


1. Put here [Lat].

2. Put here [Lon].

3. Close.

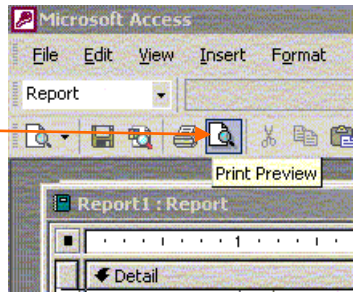
The word in [ ] can be any word. In this case, let's put "Lat" and "Lon" to be identified easily

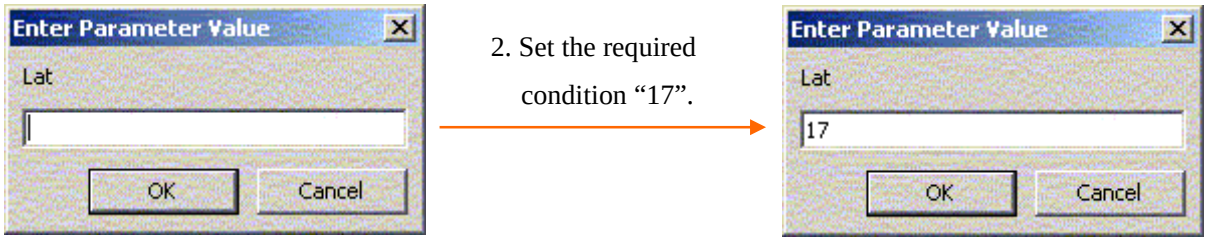


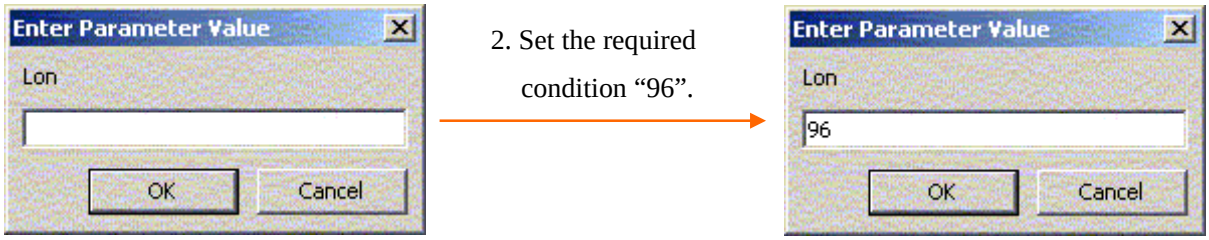
4. Click "Yes".

4) Preview

1. Click here.







5) Result

The control po¥ints that meet the condition are selected. In this case, seven control points meet the required codition.

Appendix C: GIS and its application

1. Introduction of GIS

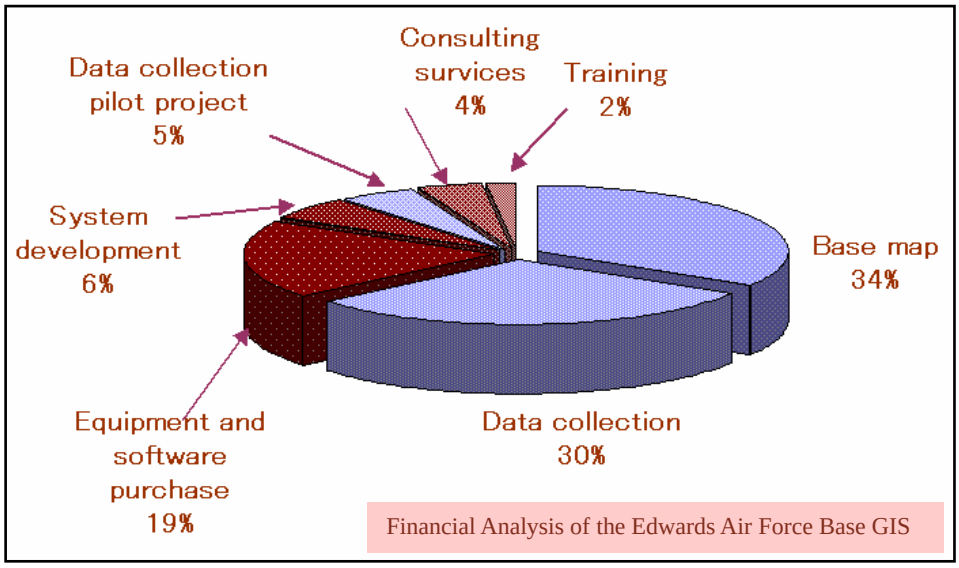
Geographic information systems are tools used to organize and display spatial information and analyze the spatial impacts of alternative decisions.
GIS is a tool for managing information of any kind according to where it is located. Their power lies in their ability to manage spatial relationships over time. GIS helps managers conceive of and implement management alternatives.

2. Construction of GIS

GIS is an information system related to the real world. Therefore definition of information and map to plot the information are necessary.

2.1 Problem to construct GIS

In order to introduce GIS and to get approval from many persons, it is important to show what GIS can do in daily work. While the price of software is expensive, and cost to prepare GIS database is also expensive. It is said that about 70 percents of total expense to construct GIS is to prepare for data collection. So it is better to consider sharing the data between the organizations.



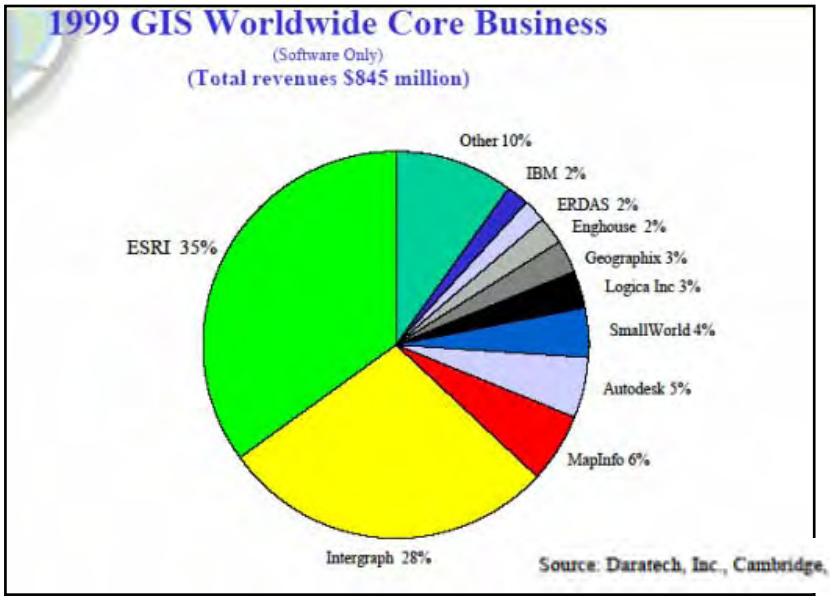
Source: GIS World (July 1996)

2.2 Selection of GIS Software

When GIS is constructed, at the same time it is very important to select software. The price is one reason to select the software. In another case, check the functions, which are installed in the software. If the function installed is little, oneself should develop some application software. However high price software has many functions, many of them are not used. And, it is also important item to maintain and manage GIS. If you are considering about data exchange, and information exchange or operation and solution of troubles, it is better to select the software, which has a wide share in a market.

The following software has a wide share in a market.

- ArcInfo (ESRI, USA)
- ArcView (ESRI, USA)
- GeoMedia (Intergraph, USA)
- MapInfo (MapInfo, USA)



2.3 Selection of GIS functions

In basic, GIS software has 4 functions. Check the function before selecting the software.

a. Data input
b. Data management
c. Data presentation
d. Data analysis

a. Data input (preparation) function

- Prepare graphical data such as point, line and polygon
- Give attribute information to graphical data
- Delete, modify and correct data

b. Data management function

- Operate graphic data and attribute data
- Operate point data, line data and polygon data
- Manage database

c. Data presentation function

- Draw map using map represent function
- Draw map using map symbols and to add marginal information

d. Data analysis function

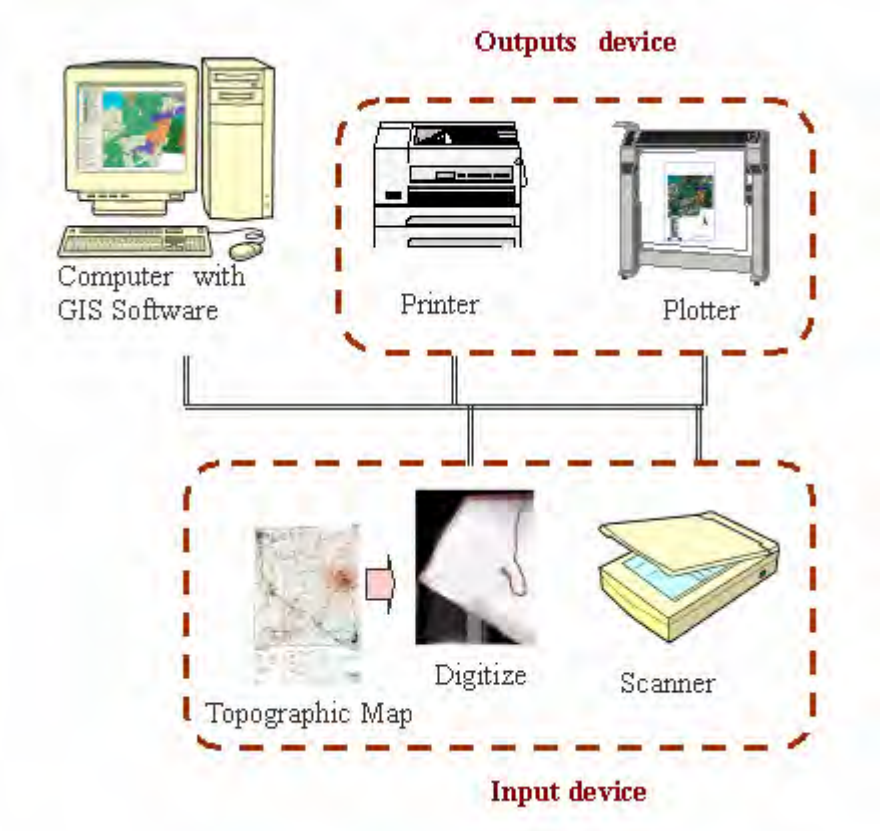
- Graphical process function
- Polygon analysis function
- Convert geographic coordinates to other in different Map projections

2.4 Hardware and peripheral Instruments

The GIS system is composed of following hardware.

- Computer (Select newest computer with high speed processor and memory is recommended).
- Display (Large format and high resolution type display is recommended).
- Plotter (Output device. In order to plot large map A0 type of plotter is recommended.)
- Printer (A3 or A4 type device is recommended).

- Scanner (Device to input data such as maps and photographs. Large format type is recommended.).
- Digitizer (Device to input data. Numerical data are prepared from paper-based materials such as maps.).



2.5 Preparation of Topographic data

Topographic data (base map) is very important in GIS. You must decide the accuracy of the map according to the purpose. Because accuracy of dataset such as existence of feature, annotation and attribute information in small scale topographic data and large-scale topographic data are deferent.

3. Maintenance and management of applied GIS

To apply advanced GIS, the following items should be maintained and managed.

3.1 Security of budget

- Maintenance fee of GIS.
- Upgrade or version up of instrument, hardware and software.
- Update of data.
- Expansion of study area.

3.2 Arrangement of GIS engineers

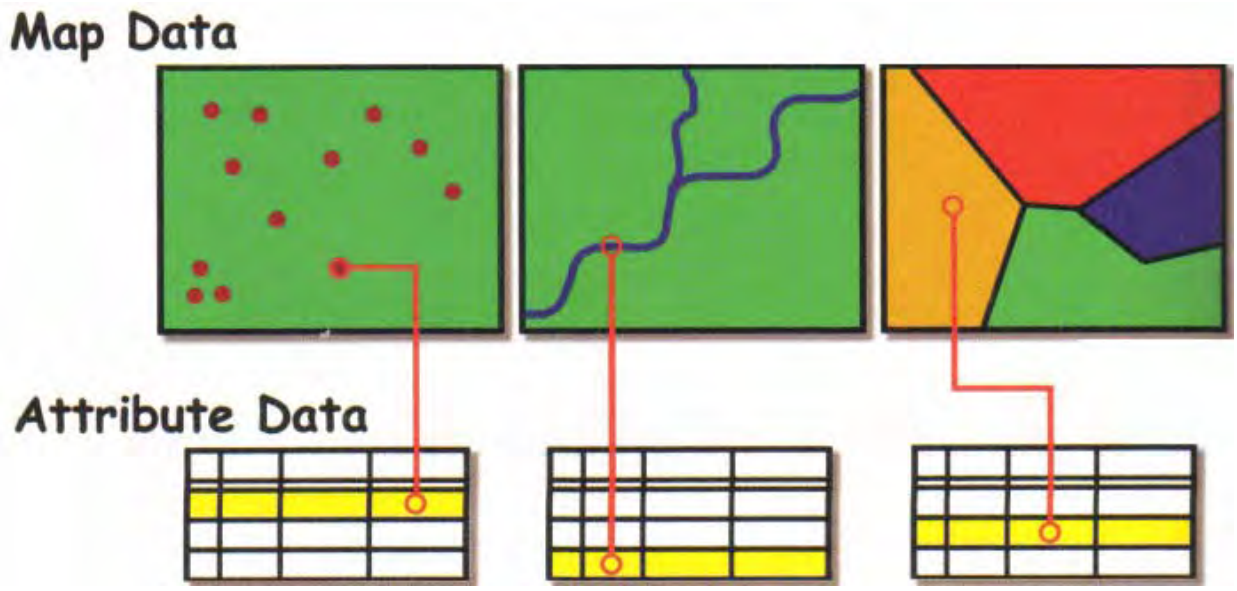
- Staff members.
- To use GIS, staff members should be arranged to operate GIS, update data.
- To develop new application software and update applications, developing engineers should be arranged.

3.3 Education and promotion of GIS

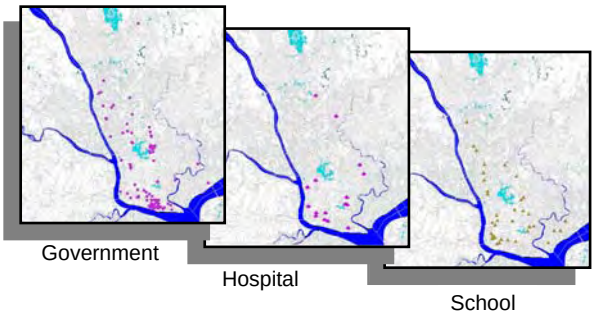
- Promotion by seminar.
- Technical information concerning GIS will be exchanged through seminar periodically.
- Training engineers to maintain a high skill.
- System engineers should be trained to manage and maintain GIS system.

4. Creating data for GIS

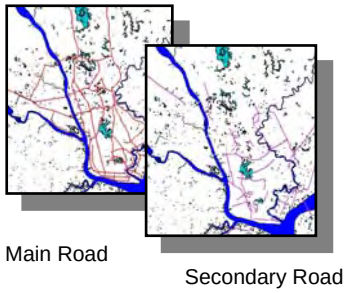
Types of data you can use in GIS are points, lines, and polygons. Point is defined by its coordinates x,y. Line string is defined by the coordinates of all point's $x_1,y_1 \ldots x_n,y_n$. Polygon is defined by the coordinates of the line string ending at the initial points. Also, the information that GIS stores about map features is referred to as attribute information.



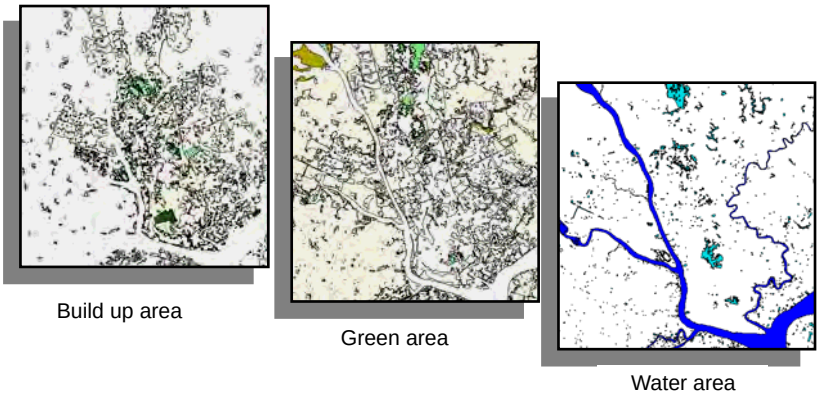
Samples of collected data



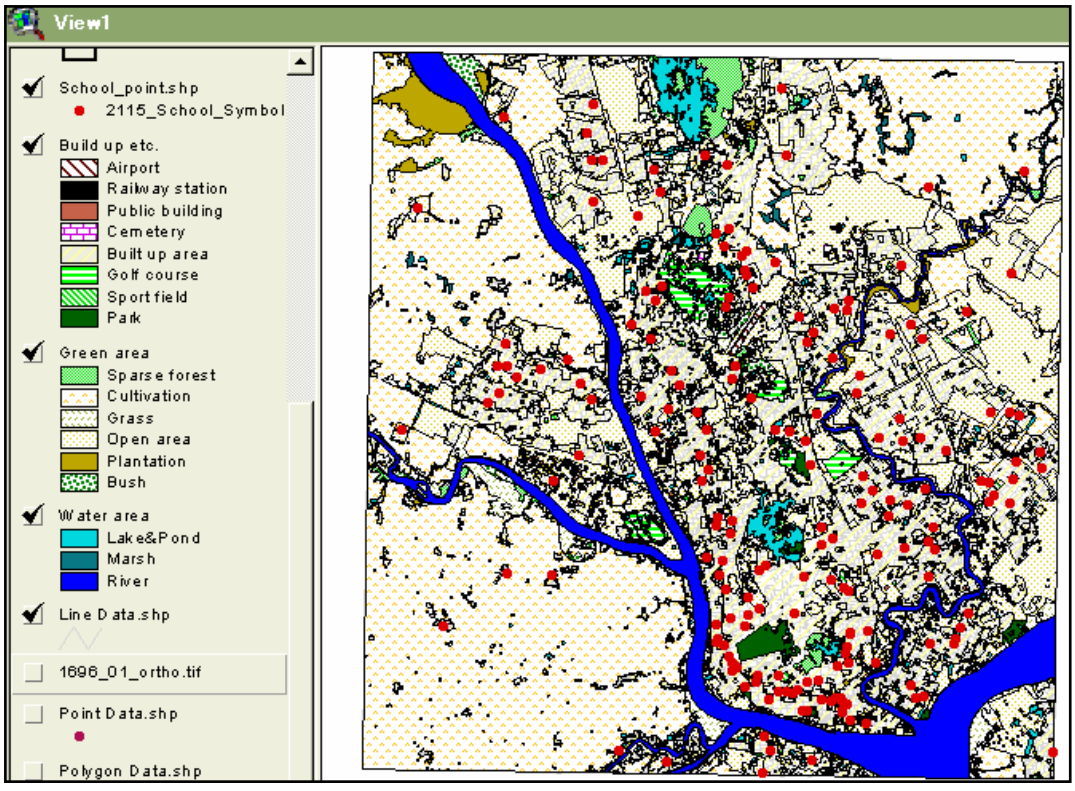
Point data



Line data



Polygon data

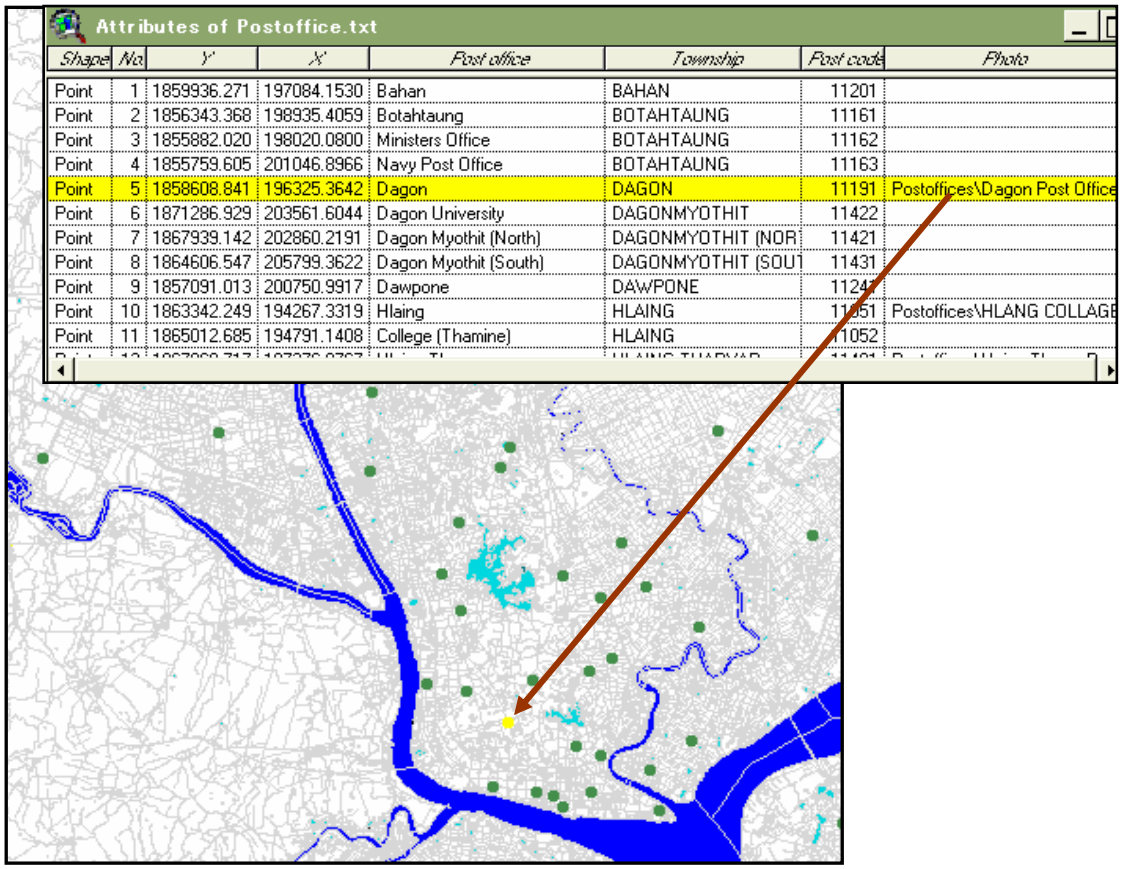


GIS features showing points, lines and polygons

5. How to get information from GIS.

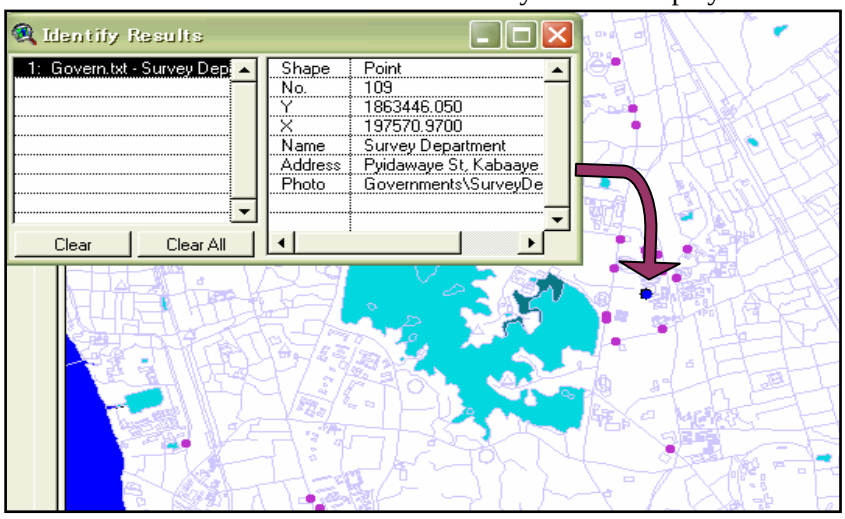
1) Getting information about features

You can select features based on their attributes. A theme table contains descriptive information about the features in the theme. Each record represents a single feature in the theme. You can access them by clicking on a feature in the view, or you can find a feature in the view by clicking on its recorded in the table.
The highlighted records contain information for the selected school.



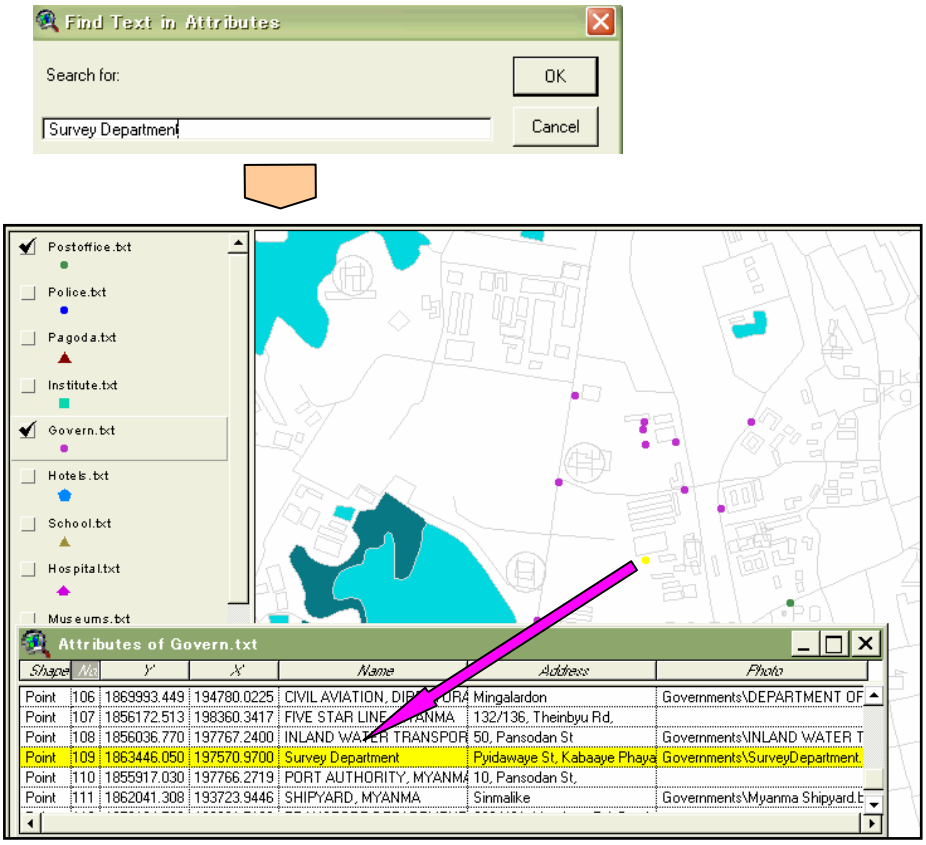
Shape	No	Y	X	Post office	Township	Post code	Photo
Point	1	1859936.271	197084.1530	Bahan	BAHAN	11201	
Point	2	1856343.368	198935.4059	Botahtaung	BOTAHTAUNG	11161	
Point	3	1855882.020	198020.0800	Ministers Office	BOTAHTAUNG	11162	
Point	4	1855759.605	201046.8966	Navy Post Office	BOTAHTAUNG	11163	
Point	5	1858608.841	196325.3642	Dagon	DAGON	11191	Postoffices\Dagon Post Office
Point	6	1871286.929	203561.6044	Dagon University	DAGONMYOTHIT	11422	
Point	7	1867939.142	202860.2191	Dagon Myothit (North)	DAGONMYOTHIT (NOR	11421	
Point	8	1864606.547	205799.3622	Dagon Myothit (South)	DAGONMYOTHIT (SOU	11431	
Point	9	1857091.013	200750.9917	Dawpone	DAWPONE	1124	
Point	10	1863342.249	194267.3319	Hlaing	HLAING	1105	Postoffices\HLANG COLLAGE
Point	11	1865012.685	194791.1408	College (Thamine)	HLAING	1052	

You can click on a feature on a view with an “Identify” tool to display its attribute in a dialog box.



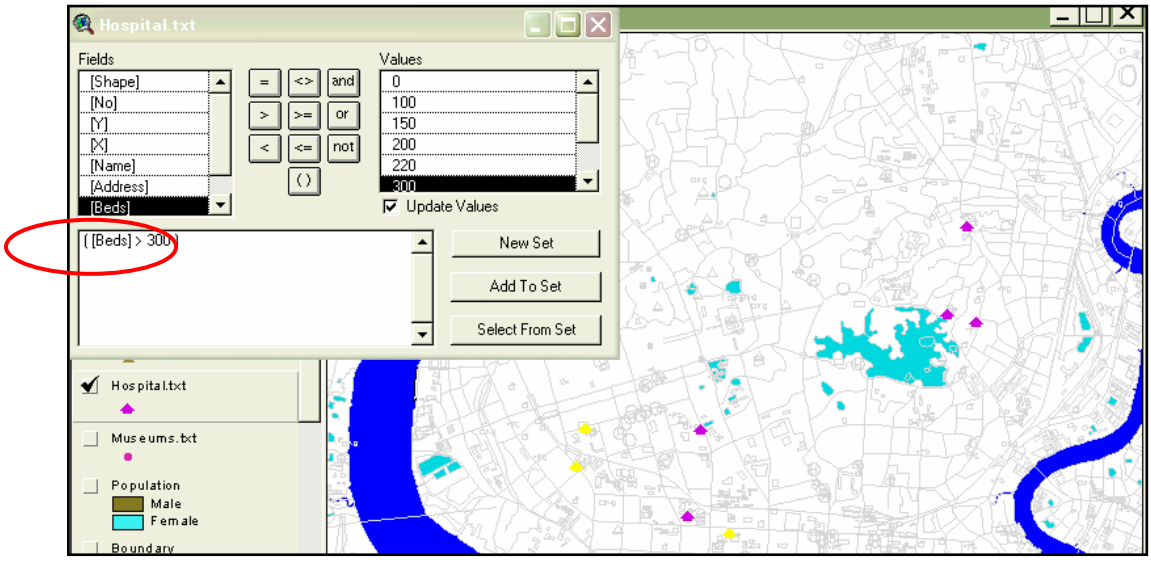
2) Selecting features based on their attributes.

You can select features by entering a statement to get the values you are interested in. By using the "Find tool", you can find the feature that matches your request.
Figure below shows the location of Survey Department using feature information.



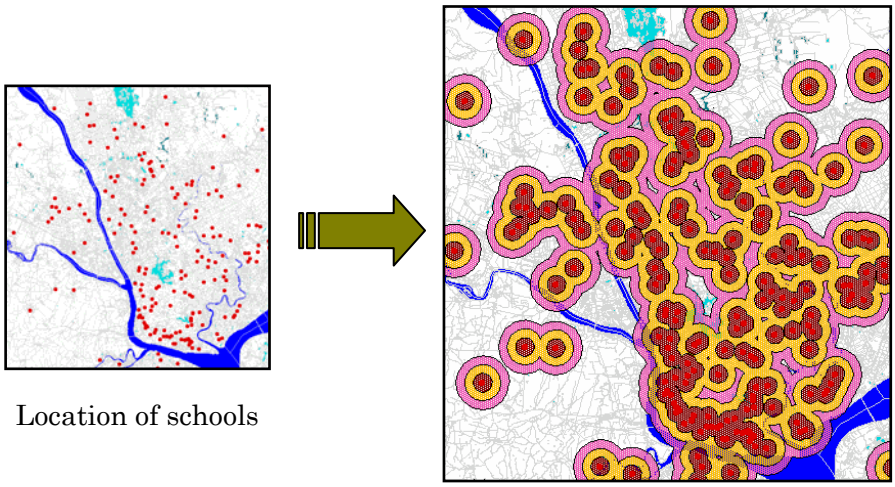
3) Querying data

You can write query to define features in view.
By entering the query in the text box to select all the hospitals with beds that have more than 300.
Highlighted in yellow color symbols shows the hospital with beds more than 300.



4) Distance buffers

Draw buffers at specific distances around features to show overlapping areas of influence, and so on. Multiple-ring buffers within a 0.5km, 1.0km and 1.5km radius are drown around the schools in Yangon City.

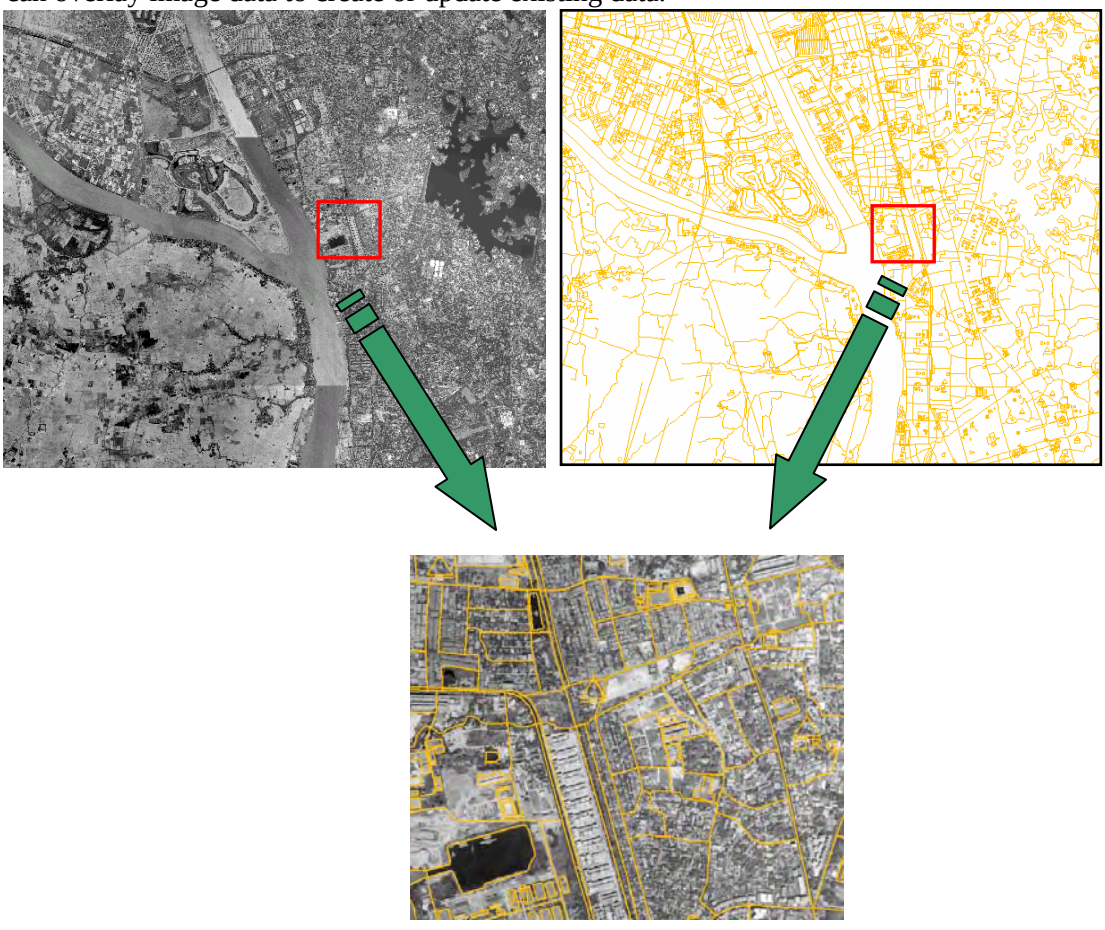


Location of schools

Distance buffers

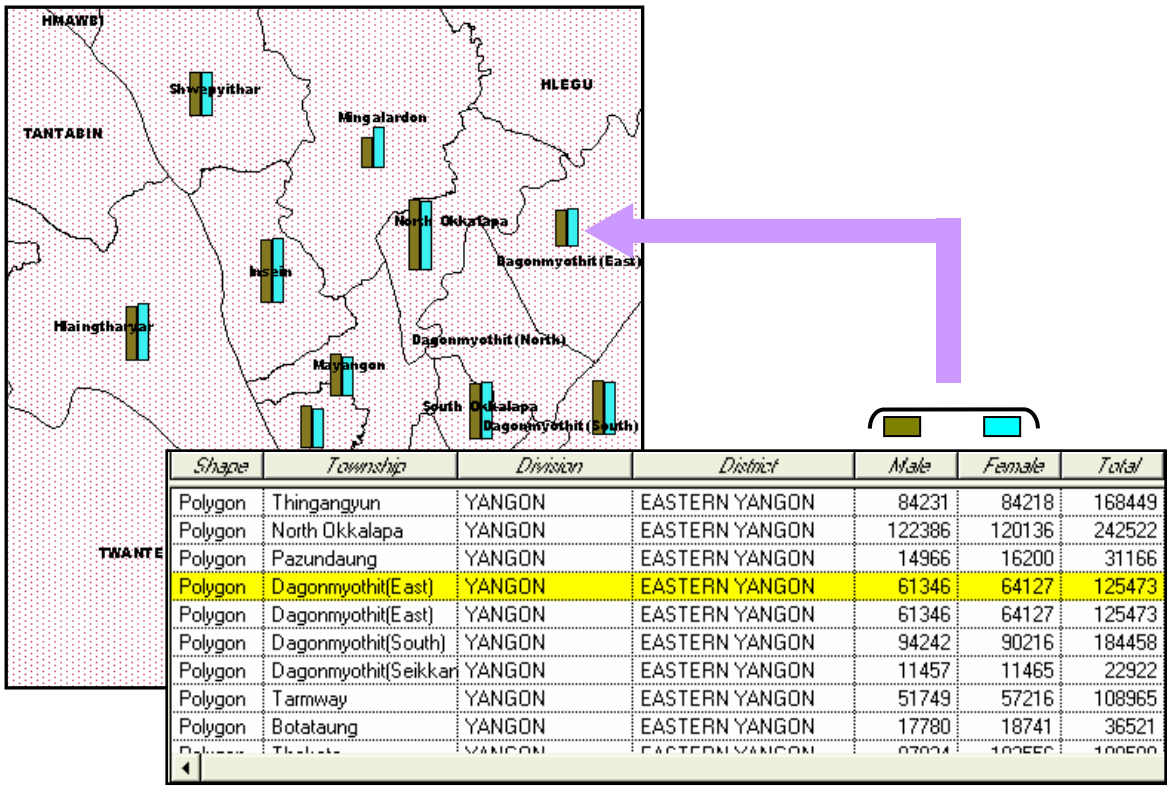
5) Creating data

You can overlay image data to create or update existing data.



6) Creating chart

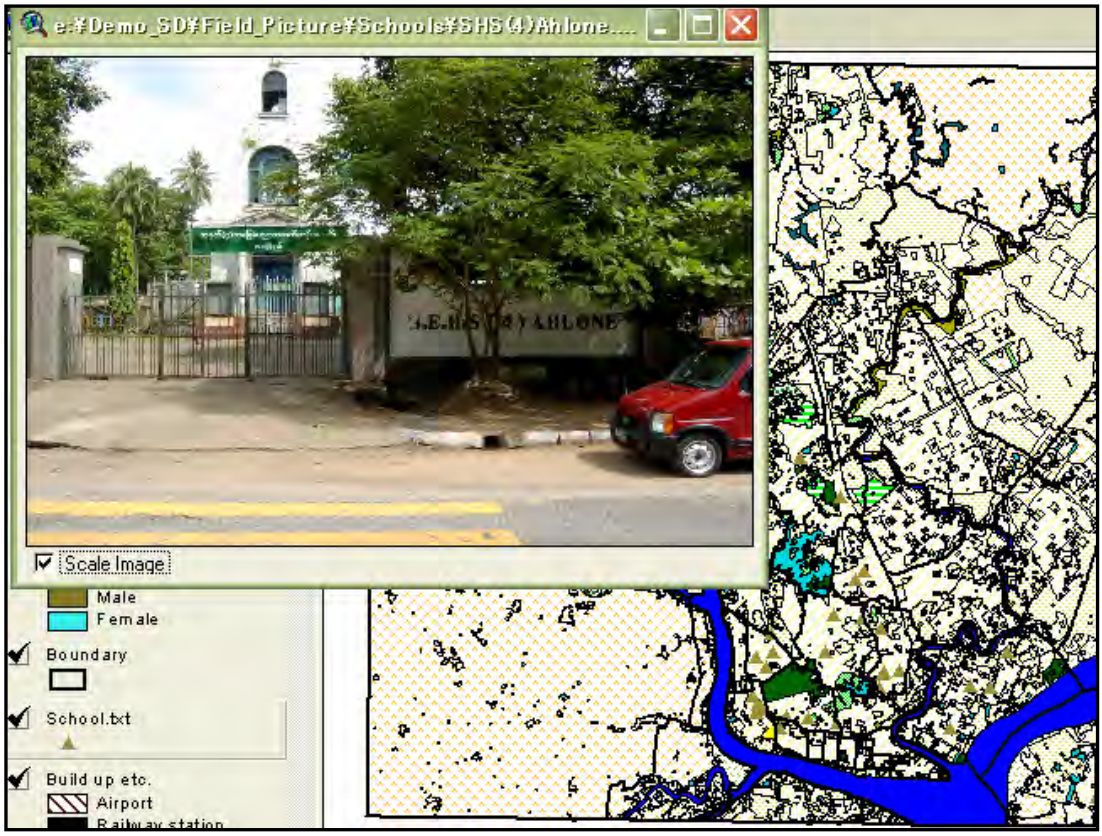
Charts are simple to create. With a chart, you can turn list of complicated figures into brightly colored graphics that clarify complex relationships at a glance.
You can create a chart comparing the population attribute of Yangon division in the table.



Shape	Township	Division	District	Male	Female	Total
Polygon	Thingangyun	YANGON	EASTERN YANGON	84231	84218	168449
Polygon	North Okkalapa	YANGON	EASTERN YANGON	122386	120136	242522
Polygon	Pazundaung	YANGON	EASTERN YANGON	14966	16200	31166
Polygon	Dagonmyothit(East)	YANGON	EASTERN YANGON	61346	64127	125473
Polygon	Dagonmyothit(East)	YANGON	EASTERN YANGON	61346	64127	125473
Polygon	Dagonmyothit(South)	YANGON	EASTERN YANGON	94242	90216	184458
Polygon	Dagonmyothit(Seikkan	YANGON	EASTERN YANGON	11457	11465	22922
Polygon	Tarmway	YANGON	EASTERN YANGON	51749	57216	108965
Polygon	Botataung	YANGON	EASTERN YANGON	17780	18741	36521

7) Creating hot links

You can link a feature in a view to a data source such as a text file, image.
By using hot link, you can make your presentation more interesting, you'll show a map of the area; along with photographs of school you took in the field.



Appendix D:

Application development for spatial analysis of selected social functions in North Okkalapa Township, Yangon City

Win Tint[1], Aung Kyaw[2], Myint Myint Sein[3], Than Nyut[4]

1. Introduction

Since the introduction of Geographic Information Systems (GIS), academic application of it is gradually increased in terms of fields and usages. Although basic usage of GIS is mapping, it also provides as a very effective tools for spatial analysis. It is difficult to apply spatial analysis for the beginners, its potential for spatial analysis greatly helps in understanding the underlying factors that generate the spatial arrangement of peoples and manmade activities.

In the Department of Geography, Yangon University, *Diploma Course for GIS and Remote Sensing* is opened since 2000. Modules offered are Remote Sensing, GIS, Cartography, Statistical Techniques, and Computer Application. Although the exercises of early GIS diploma classes were directly referred to the foreign countries, it gradually changes to give Myanmar examples. With the development of Myanmar database and giving of Myanmar example, GIS techniques will become familiar in our society. This paper tried to present the above transformation process that led from theory to practical works in Myanmar.

Purpose

Major purposes of this paper are as follows:

(1) To introduce the Myanmar examples for diploma classes
(2) To develop some applications for spatial analysis
(3) To construct a basic spatial database for selected social functions— health, education and religion – for North Okkalapa Township
(4) To analyze the distribution of above mentioned social functions

Study Area

North Okkalapa Township is selected as a sample study area for two reasons: its location and development stage.

First, it is located at the edge of Yangon City by which location makes the town to developed separate social functions. If it is chosen a township located near or in the downtown the social functions will be part of the downtown area and clear structure of it will not reveal.

North Okkalapa Township was established as a satellite town of Yangon City since 1960. Therefore, it has a time enough to develop distinct social functions. If very newly established townships like Dagon Myothit (North) is chosen for example, the distributional patterns of social

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[3] Associate Professor, Department of Geography, Eastern Yangon University
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functions will not be clearly found out.

Data

Although there are many sources to extract the spatial features for North Okkalapa GIS database, we used the mosaic orthophotographs of Yangon City, UTM sheet No. ---- and some digital format of spatial entities. For the spatial functions of the Township we conducted intensive field survey.

Orthophotographs and digital data are provided from JICA project with the courtesy of Survey Department, Ministry of Forestry. It is used to get the accurate base-map of North Okkaplapa Township, including road networks of varying levels. Some necessary points are verified by ground checking.

Based on the map derived from Orthophotographs, field surveys related to three social functions are conducted through out North Okkalapa Township during April and May 2004.

All three social functions are checked to include the following points: (1) Name; (2) Location; (3) Number of people attached to the respective social activities; (4) Street Address; (5) Type of social functions (Church, Dhamayon, Mosque, etc.). (6) Ownership (Government, Private, Organization, etc.).

All social functions with their attributes are added to the North Okkalapa GIS database.

The accuracy, georeferencing and transformation of spatial data are as follows:

- Orthophotographs taken with 1:25,000 scale
- Georeferencing is UTM Zone 47 North, ---

Method

The spatial entities which needed for analysis are edited and added by using *GeoMedia Professional Version 4* and spatial distribution of each social function is analyzed by using *ArcView 3.2* GIS software. Then, for convenience to find out the factors (transportation networks, population density, etc.) that generating the spatial variation of social functions in North Okkalapa Township, some applications are developed with *Avenue Script*. Finally, spatial patterns of selected social functions on the structure of North Okkalapa are pictured.

2. Construction of Spatial Database

Mosaic Orthophotographs was transformed to UTM Zone 47 North with the Datum of WGS 1984 in GeoMedia. By using it, distinguished physical features, like rivers, lakes, creeks and prominent manmade features like roads, railroads are digitized by means of screen digitizing. Political boundary of North Okkalapa Township and its wards was demarcated by the reference of official documents. Some ground verifications, were made to identify unclear roads and creeks and some features.

The base map for field survey of social functions is extracted from the derived spatial database. Since it is time consuming and difficult to record every social function by Global

Positioning System (GPS), the 4th level roads (smallest roads) are used as a reference to allocate each feature on the base map. Then, those features are added again as point objects in the spatial database by means of digitizing.

This paper emphasizes on three social functions of education, religions and health. The detailed properties and intensities of each activity are also recorded as spatial sub-types in the database of each social function. For example, monasteries are registered on their relative position with number of monks while clinics are registered in the spatial database together with number of doctors and nurses. In addition, some functions like health and education also need attribute with its ownership since different types of ownership should generate different locational patterns.

3. Development of Some Application for Spatial Analysis

Regarding the convenience of analyzing collected data, it is necessary to develop some spatial analysis program. Although there are many available readymade application software in GIS environment, we can not use it directly. Therefore, we have to develop some suitable applications for our geographic discipline and also for Myanmar GIS environment. In this paper Avenue Script of ArcView GIS could be used to develop application. Following table shows the examples of applications used for analysis of social functions in our study.

Sr. No.	Script Name	Application
1.	Add-xy	To automatically extract latitude and longitude
2.	M_Center	To automatically calculate and draw the mean center point
3.	W_M_Center	If weighted factors are required this script can be use
4.	Std_Distance	To show the extent of spatial dispersion of point patterns
5.	Dev_Ellipse	To show the extent of spatial dispersion while distribution are in linear pattern

All above scripts are complied as extensions to make easily installed in any ArcView environment.

4. Analysis of Spatial Database

Our primary aim is to develop the application to analyze the spatial distribution of social functions related to the spatial structure of a town. In this paper, the North Okkalapa Township is used as a sample for work flow of analysis. Weighted mean and standard deviational ellipse of selected social functions are depicted by mean of above mentioned applications. It is necessary to find out the spatial structure of town by using some indices, before analyzing the social functions. We used population density of each ward to figure out the town structure.

Location of the township

North Okkalapa Township is located in the northern part of Yangon City. Southern and southwestern part of the township is bounded by Mayangone Township, while Mingaladon

Township is located in the Western part. Northern part is bordered by Hlegu Township. Ngamoyeik Creek flows from the northeast to southwest and empties into the Bago River. It serves as an eastern boundary of the Township. Dagon Myothit (East) and Dagon Myothit (North) are located on the other side of Ngamoeyeik Creek (Figure 1).

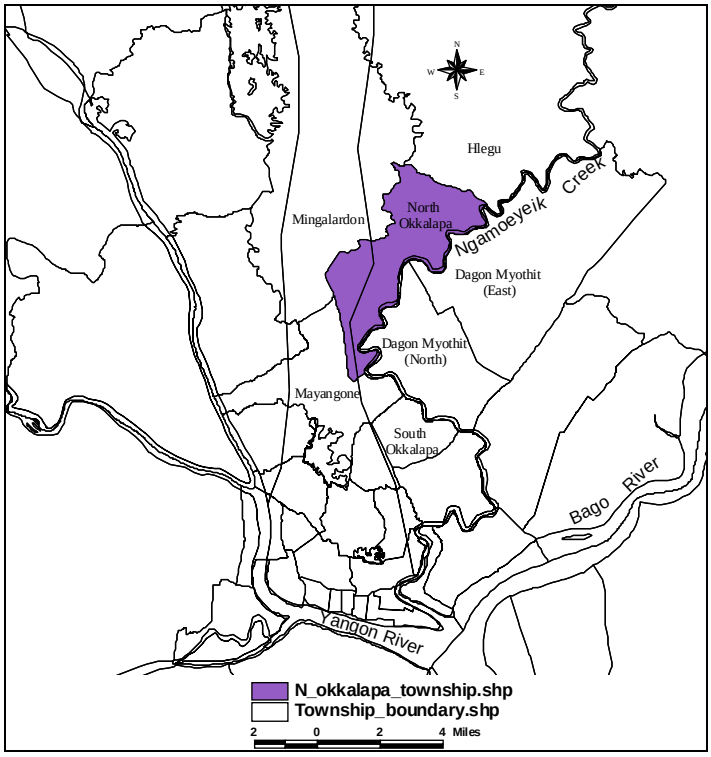

Figure (1) Location of North Okkalapa Township in Yangon City

Urban structure

Figure (2) shows the distribution of population density of 19 wards in North Okkalapa Township. It is clear that the most populated areas are found in *Ga Nge*, *Sa Lone, Za Gwe* and *Nya* Wards. Some of the second most populated areas of *Hsa Lein*, *Ga Gyi,* and *Ka Gyi* Wards are partially bounded by the most populated areas. Number (1) and (2) Wards which are located in the southernmost part of the township has relatively higher number of population density. Actually, Number (1) and (2) Wards were formerly included in the South Okkalapa Township and had developed earlier than the rest of the wards in North Okkalapa Township. Therefore, the area formed by these two wards could be considered as a secondary core area of North Okkalapa Township.

To be able to point out the town center obviously, center points of each ward are calculated from the spatial database. Then each center point is weighted by population density before calculating the mean center of the North Okkalapa Township. Standard deviational ellipse which could measure and depict the spatial dispersion of points in the selected areas is also used to figure out the pattern of North Okkalapa Township more clearly. Figure (2) depicts mean centre and standard deviational ellipse weighted by ward population of North Okkalapa Township. The mean center is located in the *Hsa Lein Ward* and standard deviational ellipse indicates the Southwest-Northeast alignment of Township's location.

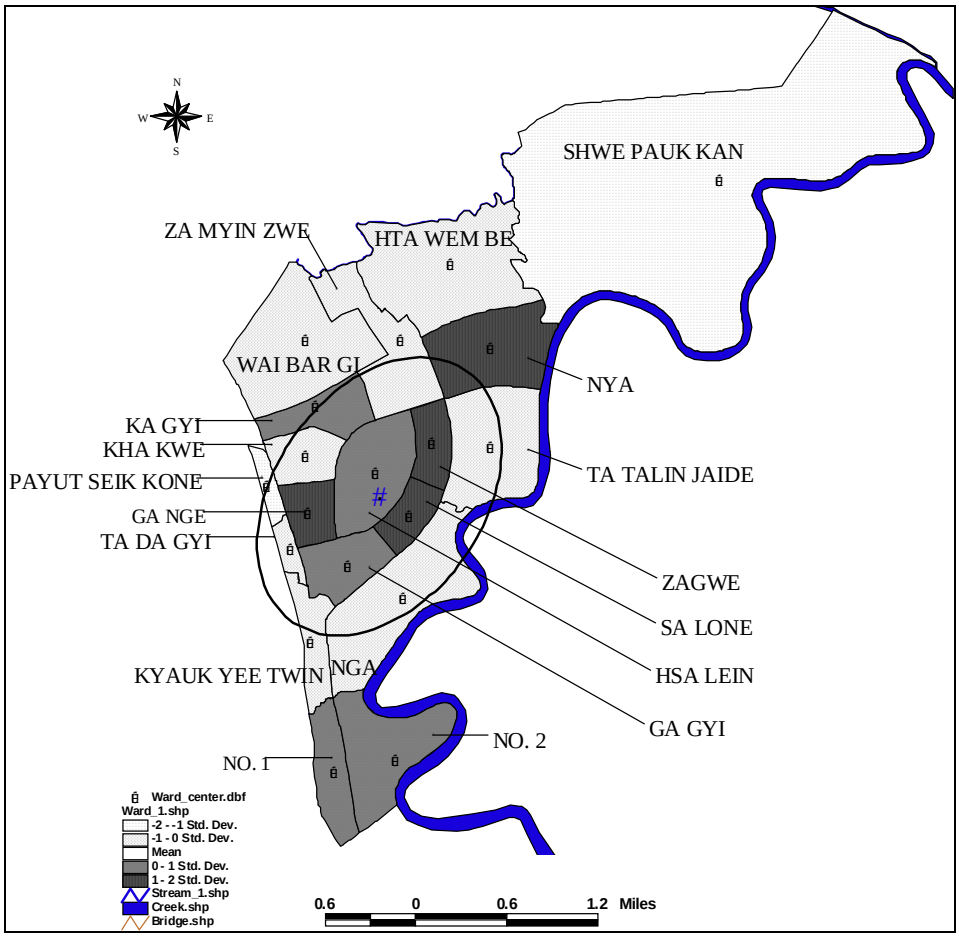

Figure (1) Population weighted mean centre of North Okkalapa Township

Source: Based on population data derived from N. Okkalapa Township Peace and Development Council (2004).

Analysis of health function

Health function is divided into ordinary clinics, hospitals, special clinics, traditional medicine clinics, maternal and children welfare associations, and township healthcare centers. Each of health facility demands different location in the town. For example, ordinary clinic could demand disperse location to avoid the overlapping of market area while special clinics will be located in cluster form at the most accessible segments of the roads. The locational pattern of the health facilities could also be different with respect to the type of ownership. For example, hospital, maternal and children welfare association, and township healthcare centers should be located which are the best accessible areas in the town. On the other hand, many private clinics and special clinics are tended to be densely located where good accessibility and market are available. In addition, most of the government health facilities are allocated since the beginning of town planning and there is little chance of response to the changing market situation.

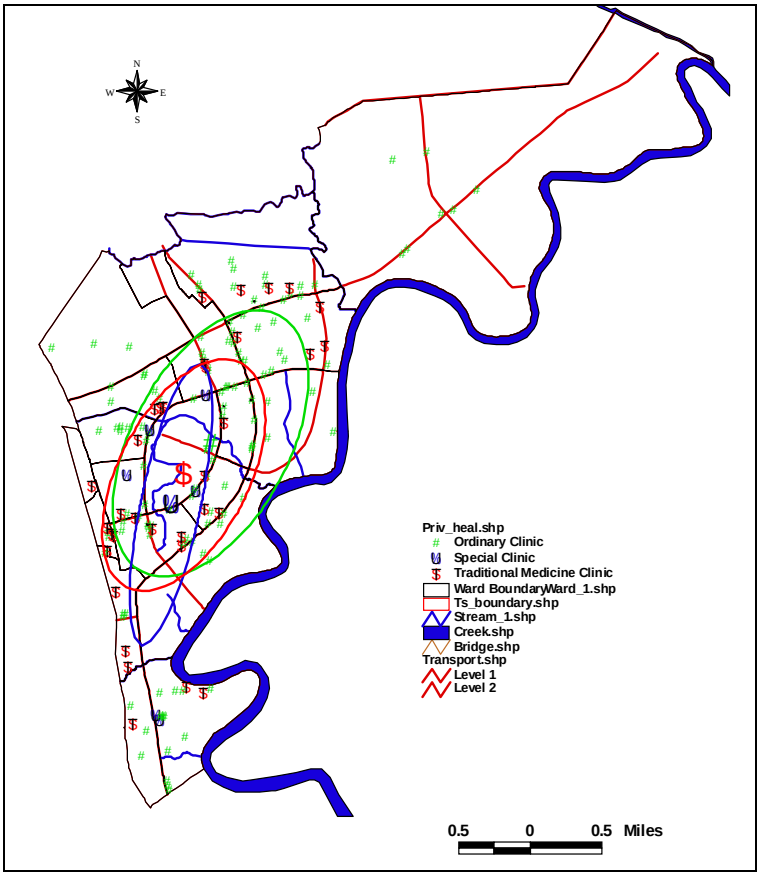

Figure (3) Distribution of private health functions and their standard deviational ellipse

Source: Field observation, April, 2004

Figure (3) shows the location of ordinary, special and traditional medicine clinics. Respective weighted mean centers and standard deviational ellipse are also depicted. The weighted mean centers of all three health facilities are located around the place where population weighted mean centers is located. However, it is different in their distribution type. All three health facilities show more or less degree of linear distribution. Standard deviational ellipse for special clinics show highly elongated in shape along the central part of the town, while other ordinary clinics and traditional medicine clinics have lesser elongated shape. From Figure (3), it can be seen that ordinary clinics are located through out the township along the major roads. It reveals the nature of the ordinary clinic which demand dispersed location to avoid the market area overlapping. Special clinics, on the other hand, have to be located at the central part to serve the whole North Okkalapa Township.

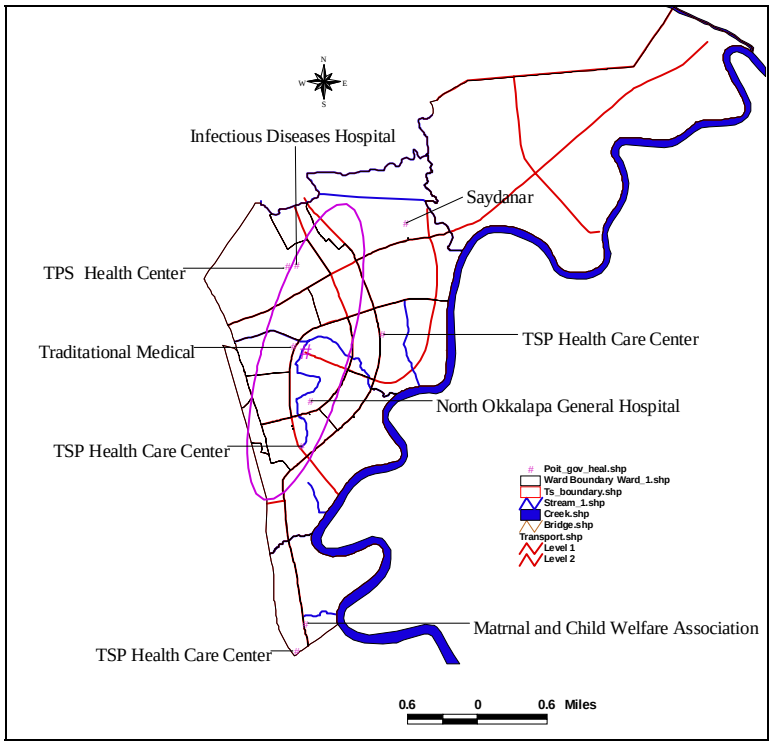

Figure (4) Distribution and standard deviational ellipse of government health facilities in North Okkalapa Township

Source: Field Survey (April, 2004)

Distribution of government health facilities are shown in Figure (4). Location of each government health facilities is weighted by total number of specialist, doctors and nurse having in each facility. The distribution pattern, weighted mean center and standard deviational ellipse show that all functions are dispersedly located with a north- south linear alignment.

Analysis of Education Function

Education function includes all education activities found in the North Okkalapa Township. It ranges from university level to pre-school level. Education activities could be divided into two groups: government and private. Distribution of government education activities can be expected to form in hierarchical structure. It means that primary, middle and high schools are distributed in hierarchical order throughout the township. From the nature of school organization, the number of students in high school seems to be smaller than that of primary and middle schools. In addition, primary students are young enough to go very far from their home to attend the school. Therefore, primary schools have to be located very close to the student's house. At the middle school level, number of student becomes lesser since some leave the school. With growing age, student could walk and attend school located in more distant place compared to primary school. As a consequence, one middle school has to be allocated in the place where three to five primary schools are close to it. The same principle is applicable to the high schools. In addition, locations of nearly all government schools are designated since the period of town planning with an aim to serve the inhabitant equally and effectively. Therefore, their distributional pattern could not reflect

the dynamism of locational competition.

Actual distribution pattern of government education facilities are shown in Figure (5). As in assumption, primary schools are distributed throughout the Township. Middle schools are located at the walking distance of three to five primary schools. High schools are distributed at the distance that can accept many middle schools.

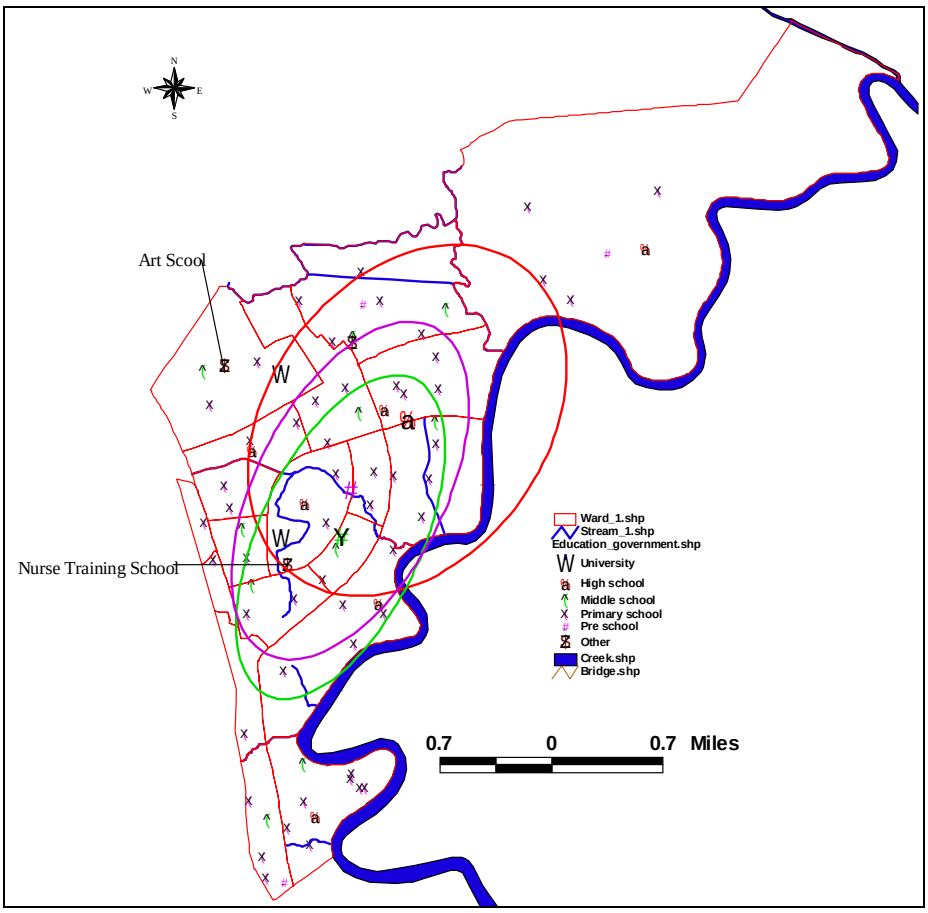

Figure (5) Distribution of government education facilities and their standard deviational ellipses

Source: Field observation, April 2004.

Hierarchical organization of school becomes clearer when depicted the buffer zone of each school weighted by student population attending in the school (Figure 6).

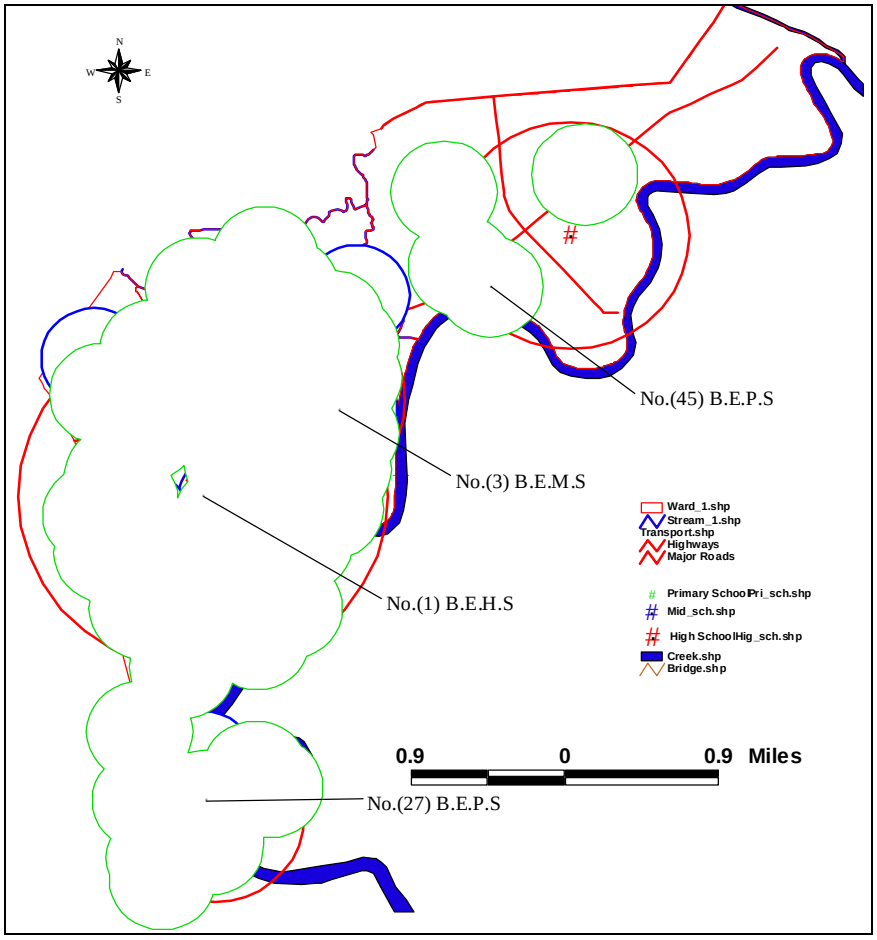

Figure (6) Hierarchical distribution of government schools

Source: Field observation, April 2004.

Distribution of private tuitions and other private schools, like language schools, are shown in Figure (7). Private tuitions are concentrated in the town center while preschools are located at the edge of town center. Other language and monastery schools are located at the outer part of town center.

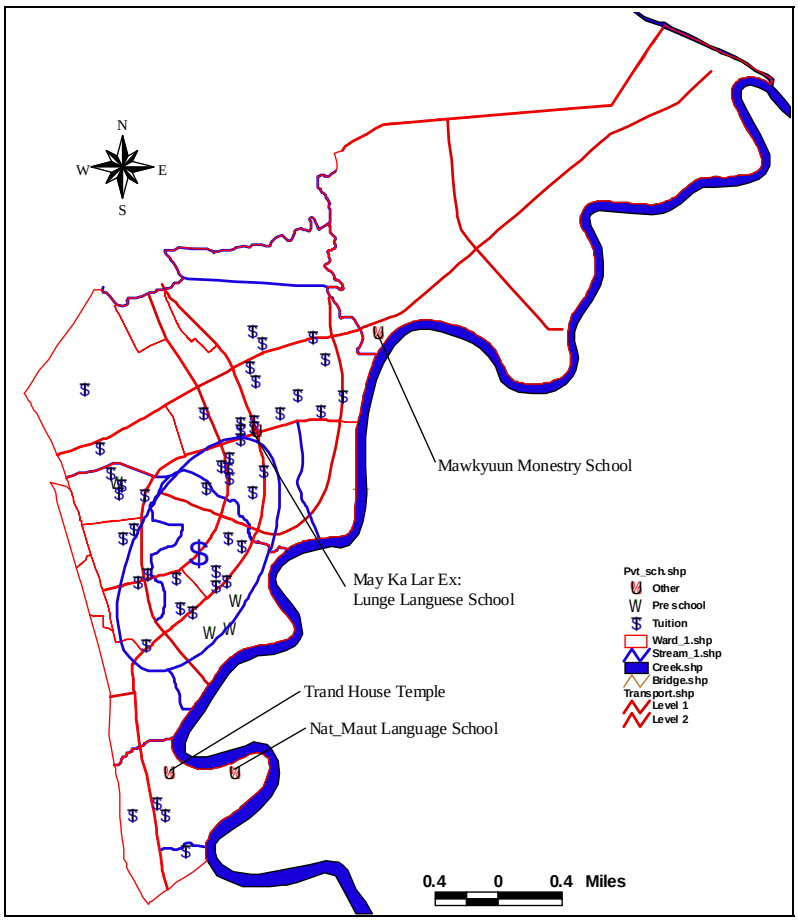

Figure (7) Distribution of private education activities and standard deviational ellipse for private tuitions

Source: Based on field observation, April 2004.

Analysis of Religious Function

Religious activities include both Buddhism as a major religion and other minorities like Christian and Muslim. Presence of a religion is characterized by features like pagoda, churches and mosques. Majority of the population in the Township is Buddhist and many Buddhism's features like monastery, pagoda, and *dhamayons* are found in the Township. Even in Buddhism, different feature shows different distribution patterns. For example, dhamayon which is used as a place of gathering religious affairs and holding donation ceremonies are found in every small scale (ward or street level) Buddhist communities. On the other hand, pagodas which are the place for worship are found at the edge of the town center. Monastery which is residents for monks and important for doing religious affairs is found attached to the pagoda and/or at the edge of the town where there is silent and calm environment. Figure (8) depicts the distribution of Buddhist features and standard deviational ellipses of it. As mentioned above, dhamayons are distributed throughout the township. Monastery and *Thi Hla Shin Kyaung* (nunnery) are found in the eastern and western part of the town.

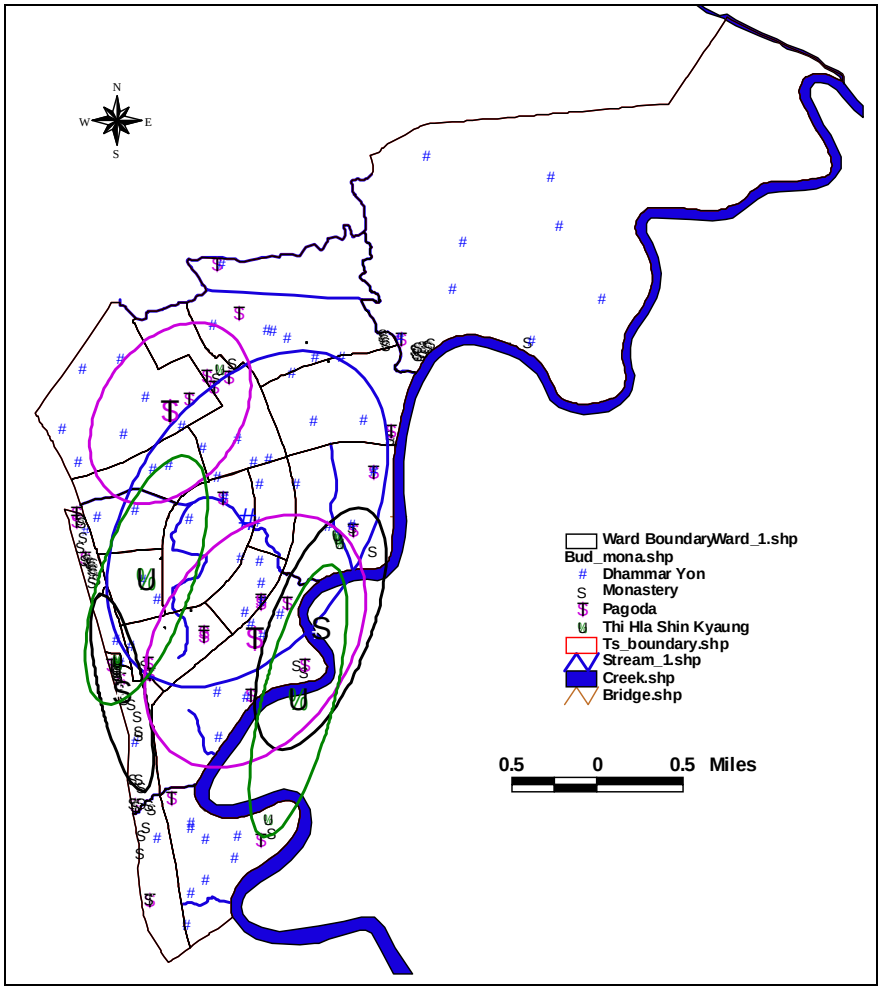

Figure (8) Distribution of Buddhism religious activities and their standard deviational ellipses

Source: Based on field observation, April 2004.

Distribution patterns of other religious symbols are shown on Figure (9). Two temples out of three are found near the town center. Churches are also found spreading around the town's center location.

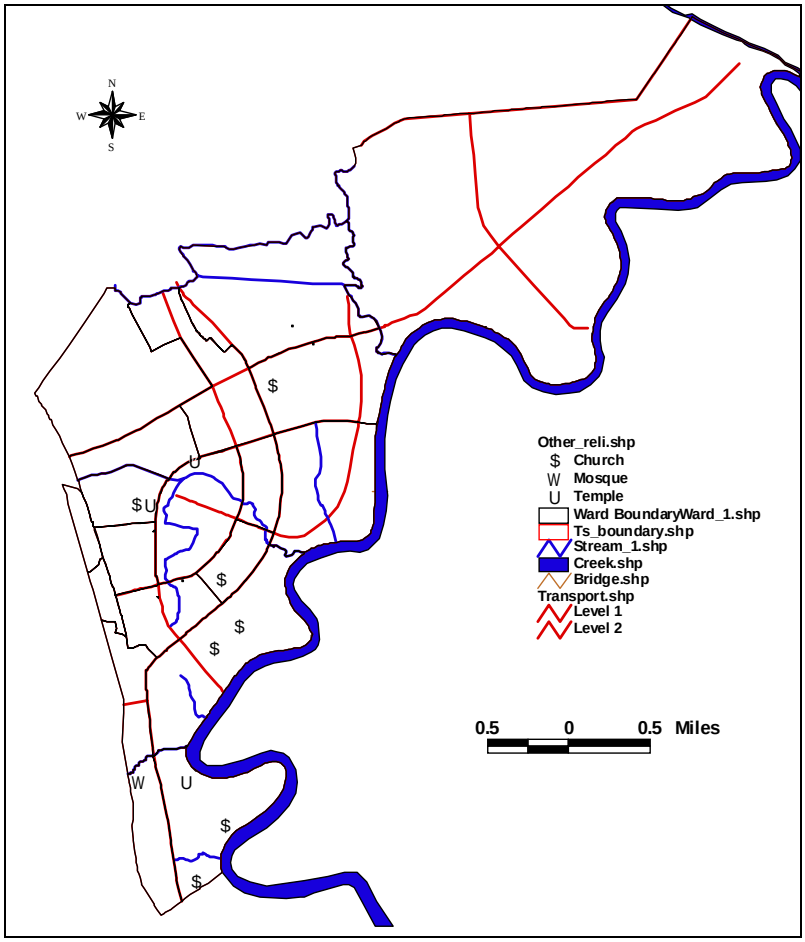

Figure (8) Distribution of minority religious activities in North Okkalapa Township

Source: Based on field observation, April 2004.

Conclusion

The accessibility of existing spatial database of many governments or non-government organizations is very helpful to the education environment. In this research availability of digital format is very advantage and could be reduce large amount of time and eliminate a laborious portion of establishing GIS. It also provides the consistency of spatial data for further analysis. Development of application for specific purpose is also important for organizations like university and governmental departments. By using above mentioned advantages of data availability and applicability of owned program, the spatial pattern of some spatial functions of North Okkalapa Township are easily analyzed. We can briefly conclude the result of the analysis can be concluded as follow.

The distribution pattern of three social functions—education, health and religion— are presented in this paper. It is found that each function has different location within a town area. Even within the same function, locational patterns differ with different nature of activities.

In case of government education schools, hierarchical organization of school and town's planning factors generated hierarchically dispersed school location. On the other hand, private education activities those have free choice of location are concentrated near the town center.

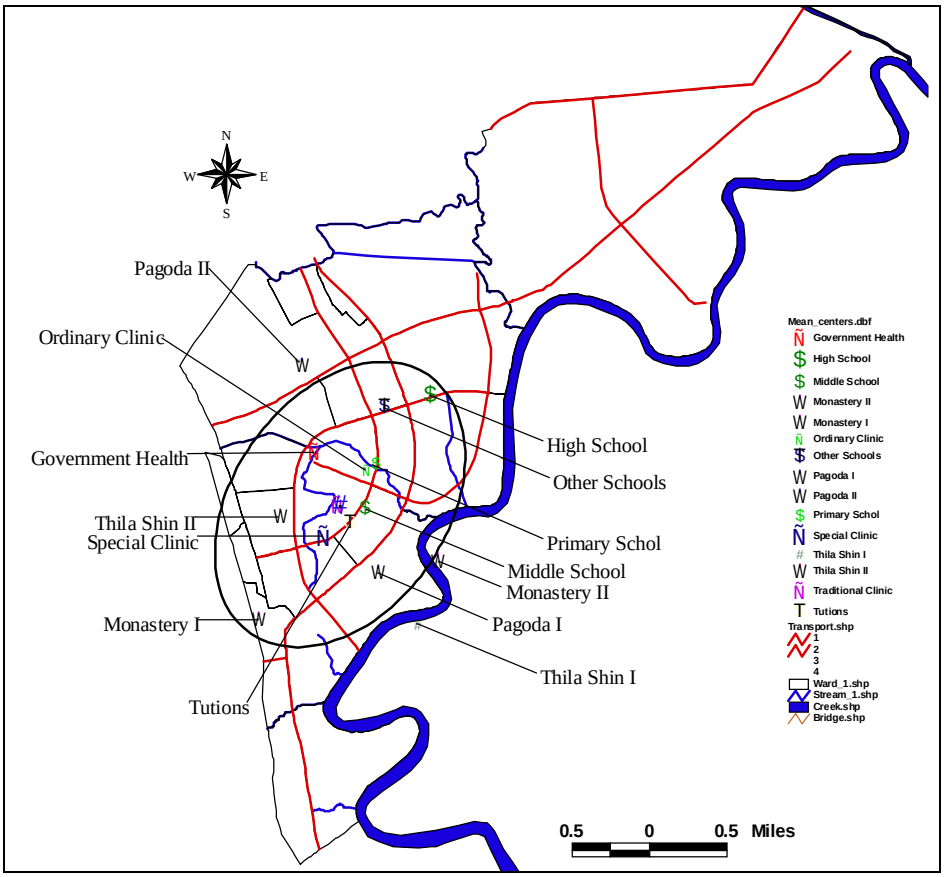

Figure (9) Location of mean centers of social activities in North Okkalapa Township

Source: Calculation based on field survey, April 2004.

In case of health, many ordinary private clinics are sparsely distributed to avoid the overlapping of market area. Special clinic, on the other hand, are located at the economic strategic points of the township. Government health facilities are sparsely located in the places where many of the people could easily access.

Religious activities show a general trend of dispersal. It is especially true for dhamayons. Since damayons are very frequently used by local community, they have to be allocated at every lowest level of Buddhist community. Monasteris on the other hand, have a tendency to be located in periphery of the township to avoid the noise and other disturbances of populated area.

Figure (9) depicts the locations of weighted mean centers of selected social facilities and activities. It can be generally said that religious activities like monastery, *Thila Shin Kyaung*, and pagoda are located at the periphery of the town while dhamayons are located throughout the township. In education function, government schools are distributed throughout the township while private schools like tuitions are located at the center of the town. All health functions demand centrality. Ordinary clinics and government health facilities, however, are dispersed through out the township while special clinics are located near the town center.

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