# The Study of Infrastructure Information Management System of the Dakar Metropolitan Area in the Republic of Senegal

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**Abstract**

The Dakar Metropolitan Area has urban problems caused by rapidly increasing population, illegal housing, traffic problem, flooding etc. Individual effort by responsible organizations has not yielded desired results bacause data preparation effort is duplicated among different organizations, their data collection by them are often mutually incompatible. It was desired to establish an information management system in the provision of social infrastructure utilizing GIS in order to support the development of urban facilities and services in the Dakar Metropolitan Area. JICA implemented the technical cooperation programs to establish a working system actually utilized by related organizations in Senegal through technology transfer.

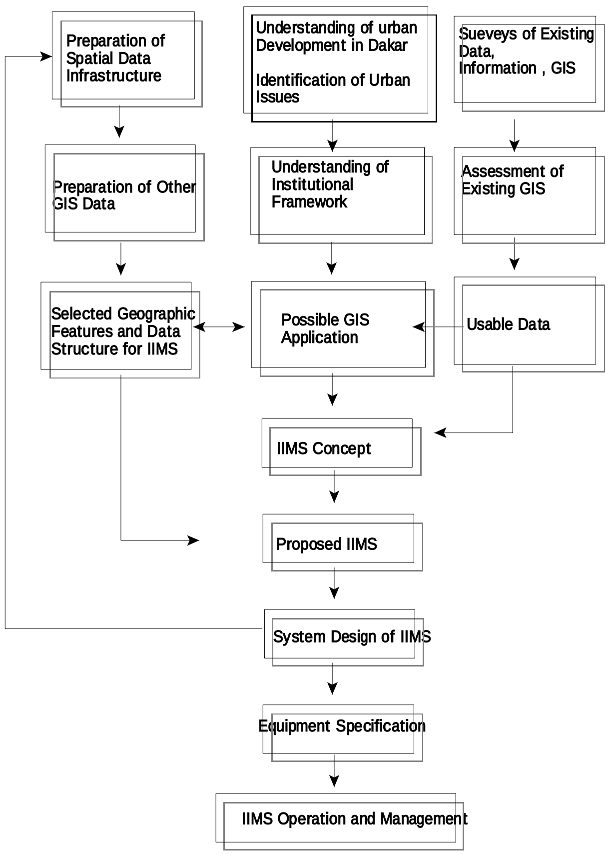
## 1. Background

The rate of population increase in the Dakar Metropolitan Area (its population projection of 1999 was 1,900,000) is 4 percents per year. The population density in the city is too high and the capacity for accommodating its population is too small to catch up to develop infrastructure and maintain environment. As a consequence, random urban sprawl and deterioration of environment in Dakar become serious social problems. Efforts by the responsible department of local governments couldn't achieve their primary purpose and its inefficiency is pointed out, such as duplicate efforts for information development and incompatibility of information among different departments. Thus, it is requested in development of urban infrastructure to establish the Information Management System (Infrastructure Information Management System: IIMS), so that data can be shared and compatible among responsible departments.

Japanese International Cooperation Agency (JICA) established the mission composed of PADECO, Co., Ltd. and Asia Air Survey Co., Ltd. and had conducted a field study for 14 months, from September 1999 to January 2001. The mission was sent three times for 9 months in total and built the system through field studies and technology transfer. Organizations as a counterpart include two departments, the Department of Geographic and Cartographic Works (DTGC) of the Ministry of Equipment and Transport and the Department of Urban Planning and Architecture (DUA) of the Ministry of Urban Planning and Housing.

## 2. Infrastructure Information Management System and a role of GIS

Descriptions of urban issues in the Dakar Metropolitan City were collected, that is called urban carte, in order to conduct evaluation and analysis of phenomenon in urban planning and consider the potentiality of GIS application as a solution of urban issues. As a result of consideration, at first, it was designed both of a database and system, which structured information management system associated with infrastructure, and then established the system and a constitution of its management and maintenance. Figure 1 shows the flow of the research.




Final report Volume1 p8 Figure1.4.1 System Establishment Process

Figure 1. The flow of research

**2**.1 Urban carte described urban issues and designing social information management

Carte described urban issues was made to deliberate about specification of urban issues, cause analysis, action programs and responsible departments, the necessity of data related to action planning, and the possibility of GIS applications.

The targets of carte include transportation, flood, water and sewer supply, sewage disposal, garbage disposal, residential land, the lack of multifamily housing and public space, low-quality housing, insufficient services for emergency, and poor public facility. Solutions for individual item above were considered based on a result of urban carte to settle urban issues. A support system to resolve urban issues by utilizing GIS was developed through designing database necessary for this application. Figure 2 illustrates an example of urban carte.

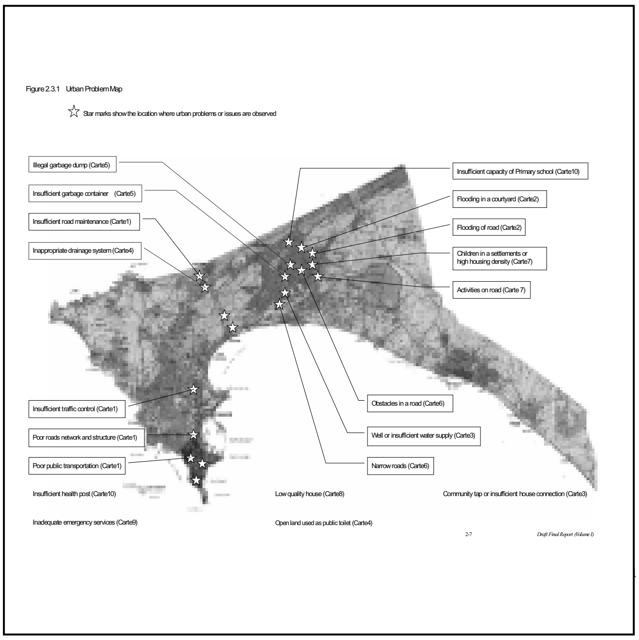



Figure 2. A distribution map of urban issues in Dakar as an urban carte

2.2 The establishment of an infrastructure information database

Datasets of infrastructure information was created by updating 42 sheets of 1: 5,000 topographic maps in the Dakar Metropolitan Area about 200 square kilometers. This database is composed of geospatial database and other types of GIS data. It was found out that these data among individual organizations were not compatible and difficult to import/export data straightforwardly, by developing an inventory of related departments in order to identify the availability of existing data. Because these datasets have the variety in terms of data's media and format, the extent of data, specifications and quality of data, reliability of the statistical data. Under these circumstances, it became clear that management and maintenance is a key subject for the establishment of database. The mission reconstructed new datasets, which is used 1:5,000 topographic map as a base map for geospatial database, which is updated existing topographic maps by utilizing aerial photos, and attribute data collected in the field on top of a base map. Through the collaboration with counterparts during the preparation of datasets, the recognition of sharing information among different organizations has increased. Figure 3 shows a map of current land-use distribution based on geospatial database.

**3. The establishment and management of the System of Infrastructure Information Management Planning**

The System of Infrastructure Information Management Planning derived several sub-systems like as below , which are established as a case study of GIS application employing data developed in urban planning.

3.1 A sub-system for urban information reference

It is established a sub-system that an application can query, display, compile, and prepare a thematic map for a purpose of information inquiry concerning urban planning. (Figure 4)

Thematic maps prepared for the system include information in public facilities, public services (garbage disposal and public transportation), infrastructure (roads, railroads, water supply, sewerage, and electricity), population, change of urbanized districts, the condition of land-use planning and zoning, and current land-use distribution.

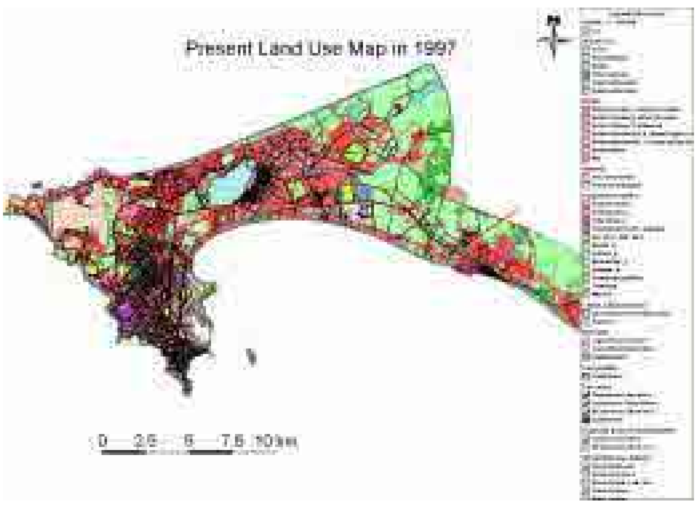



Figure 3. A distribution map of current land-use by using geospatial database

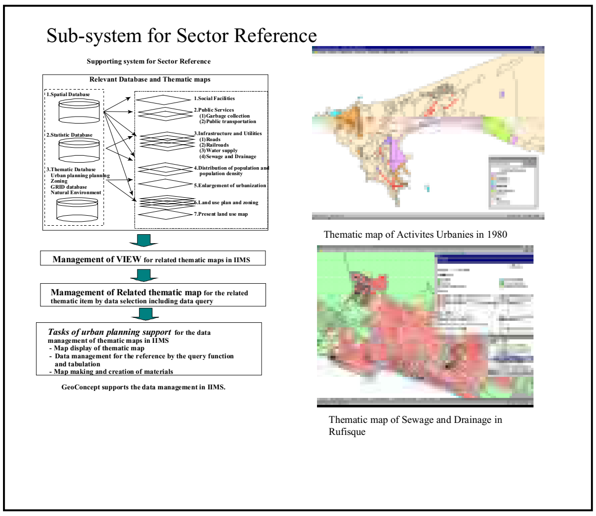



Figure 4. The Urban Information Reference System

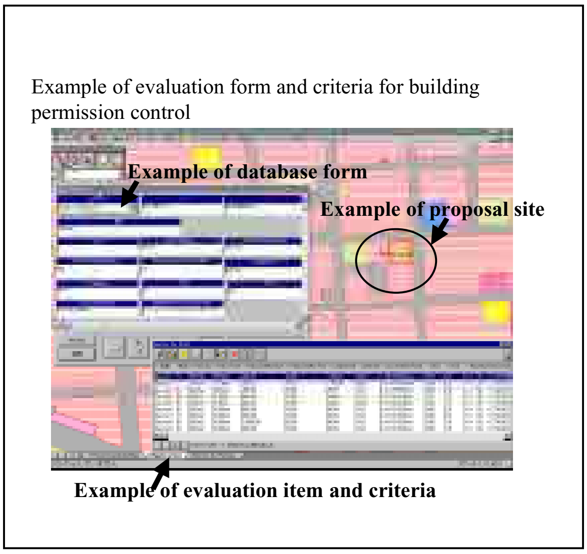



Figure 5. A sub-system for urban development management

3.2　A sub- system for urban development management

In order to standardize the management both of plans and appropriate criteria related to applications for construction permission, information filled out the application is putting into a database. The record management system was established to search and display information they need from the database. (Figure 5)

3.3　A sub-system for urban planning support

A sub-system for urban planning support was established as an application considered the best location of public facilities by utilizing several layers of administrative boundary, census data, and distribution of existing public facilities and present land-use.（Figure 6）

3.4　A sub-system for residentially suitable land evaluation

A sub-system for residentially suitable land evaluation was established as an application, which supports evaluation of residential environment and selection of a new residential district by means of geospatial database and GIS data, according to a current housing development plan (Figure 7)

3.5　Technology Transfer

The purpose to establish the system is to utilize the system more practically among associated organizations. Thus, there were enhanced efforts of holding seminars, workshops, and trainings in the field to transfer technology. The Department of

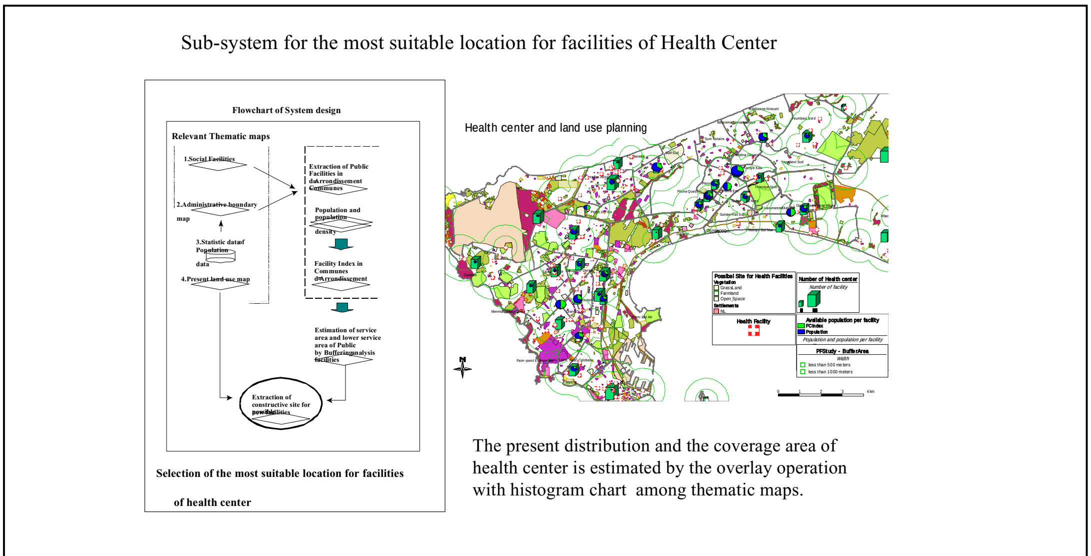



Figure 6. A sub-system for urban planning support (The best location for public facilities)

Geographic Survey and the Department of Urban Planning installed both hardware and software for the management system. It took two and half months to give trainings for responsible officers in both departments, such as setting up and operating hardware, installing software, establishing the Infrastructure Information Management System by creating a database, operating the system and holding practical trainings how to operate GIS. Figure 8 shows pictures of the room installed the system and training given to officers.

## 4. Outlook

It is essential for Infrastructure Information Management System to update database, develop the system and human resource, and maintain facilities and an important task in the

future to accomplish these assignments continually. It is necessary for an establishment of geospatial database in Senegal to enhance the consensus among different organizations for sharing data and practice the collaboration in an actual project. It is required to take an action for the standardization of GIS data discussed in the ISO/TC211. In addition, the sustainable development of the system is dispensable to continue technology transfer and develop human resource constantly. Currently, specialists are sent to the Department of Geographic Survey for long-term and carrying out follow-up for the research.

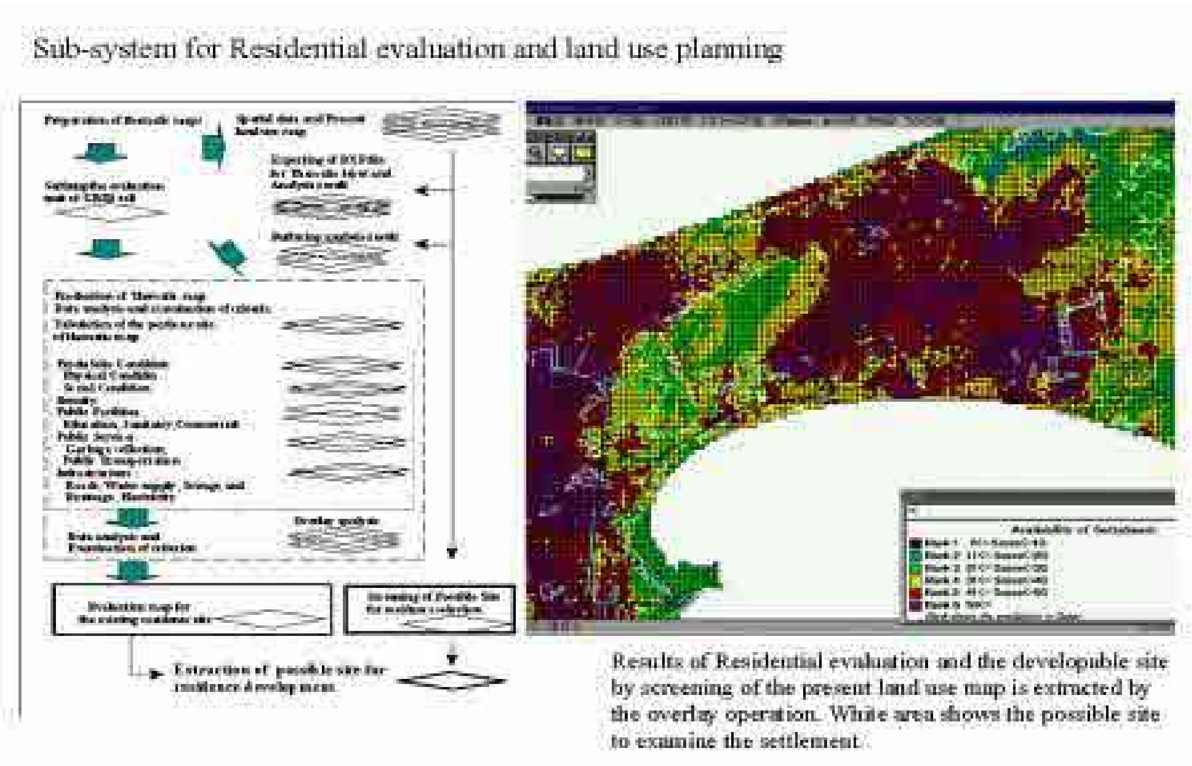



Figure 7. A sub-system for land evaluation of suitable location for residential development

Figure 8. Pictures of the room installed the system and technical training given to officers

# ESTABLISHMENT OF GEOGRAPHIC INFORMATION SSYTEM FOR DKI JAKARTA IN THE REPUBLIC OF INDONESIA

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Abstruct

The DKI Jakarta GIS Project started in 1992 and completed in 1997 having had the objective of establishing a geographic information system (GIS) for the efficient and effective support of land administration within the local government of DKI Jakarta. The work on the project has evolved through Phase I and II, performed by Pasco International Consortium under the finance of OECF, Japan.

The end product of the project was an operational GIS, having eight (8) applications for four (4) “core” applications; (i) DTK Site Measurement Application (ii) DTK KRK Planning Advice Application (iii) DTK Planning Related Records Maintenance System, and (iv) DPPT Library Maintenance System; and four (4) “Remaining Priority Applications”; (i) The Map Creation System (ii) DPPK Building Footprint Update Module to Support IBM Permitting System (iii) DPPK Building Footprint Update Module to Support IPB Occupancy Permit System, and (iv) BPN Parcel Maintenance System.

DKI Jakarta realized many benefits from implementing GIS technology, the coordination of data activities among the agencies and the efficiencies brought by computerization.

## 1. Background

The local government of DKI[1] Jakarta, with an area of 657 square kilometers, had a 1997 population of 10 million and was growing at approximately 3.7% annually. Based on this annual growth rate, the population projection for 2005 is 13 million. Such a rapid rate of population growth has accelerated the need for land space, infrastructure, and public services. To plan for such growth, the need for increased administration management was required, especially in the land use and development. DKI Jakarta has been developing a geographic information system to facilitate improved administration management, major decision making, policy determination, and city planning efforts.

## 2. Project History

The DKI Jakarta GIS Project started in May 1992 and finished in July 1997. The project was financed from the Overseas Economic Cooperation (OECF, now JBIC[2]) Fund of the Government of Japan. Work on the project has evolved through Phase I and II, performed by Pasco International Consortium, which is an assemblage of Japanese, American, and Indonesian companies, primed by Pasco International Inc. DPPT[3] has served as the Project Implementation Unit under the coordination of the GIS Technical Committee chaired by BAPPEDA[4].

1) Daerah Khusus Ibukota (Special Metropolitan Area)
2) Japan Bank for International Cooperation.
3) Dinas Pemetaan dan Pengukuran Tanah (Surveying and Mapping Department)
4) Badan Perencana Pembangunan Daerah (Regional Development Planning Board)

## 3. Project Objectives

The end product of the project was an operational GIS for the efficient and effective support of land administration within the local government of DKI Jakarta. The GIS was developed for use at the dinas[5] level of local government and the suku dinas[6] level within the five Wilayah[7] that comprise DKI Jakarta. The participating dinas and suku dinas were included:

DPPT, Surveying and Mapping Department
DTK, City Planning Department
DPPK, Building Development Control Office
BPN, National Land Board
BAPPEDA, Regional Development Planning Board
KPDE, Electronic Data Processing Office

## 4. Project Approach

The objective of Phase I was to create the conceptual system design and a detailed physical design for GIS application and database. Phase I was followed by the preparation of a technical proposal for extending development of the GIS into a Phase Ⅱ. The objective of Phase Ⅱ was to implement the GIS according to the system design during Phase I. The Phase II was comprised of 16 tasks, i.e. 6 consultant tasks and 10 contractor tasks:

5) Sub-Directorate
6) Division
7) Region

Consultant Task

-Project Management

-Program Planning

-Database Development Pilot Study

-Application Development and Testing

-Institution Building

-Training Program

Contractor Task

-Aerial Photography

-Field Survey

-Base MapPlotting

-Data Collection &Compilation

-Structure Map Digitizing

-GIS Layer Digitizing

-Site Preparation of GIS Office

-Networking

-Hardware Installation

-Software Installation

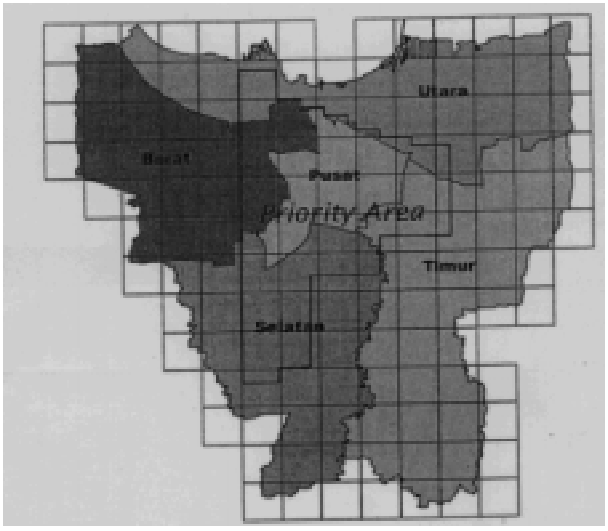


Figure 1. Project Area for Source Data Preparation and Automation

## 5. Priority GIS Applications

The 8 applications were split into two groups. One group was called the "core" applications and consists of the following:

1. DTK Site Measurement Application
2. DTK KRK[8] Planning Advice Application
3. DTK Planning Related Records Maintenance System
4. DPPT Library Maintenance System

The other 4 were placed in a group called the "Remaining Priority Applications" and consist of the following:

1. The Map Creation System
2. DPPK Building Footprint Update Module to Support IMB[9] Permit System
3. DPPK Building Footprint Update Module to Support IPB[10]
4. BPN Parcel Maintenance System

## 6. Benefits for DKI Jakarta GIS

DKI Jakarta realized many benefits from implementing GIS technology. These benefits arose from the coordination of data activities among the agencies and from the efficiencies brought by computerization. GIS brings special benefits because it combines maps with tabular data. This makes the computer-generated maps a very rapid method for viewing and analyzing a variety of information.

- Accurate geographical data supports urban development policy making, strategic planning and daily operations.
  Precise and properly controlled geographical information is critical as a basis for policy and supporting strategic planning and daily operations for urban development in Jakarta. The GIS brings together many types of map data based on the same coordinate system. This will speed up the development review and approval process for agencies.

- Accurate geographical data improve identification of taxable objects and improve capacities to increase tax revenues.
  Such information is also essential for identification, registration, valuation, and assessment of taxable objects. As such, these geographical data will be at the foundation of implementing laws targeted as increasing tax revenue from land, buildings, and other tax objects. Accurate inventories in the form of maps and related attributes can be established and rapidly updated as changes occur. Since the taxation agencies (PBB[11] and DIPENDA[12]) should receive more timely information about tax object creation and modification, the lag time to enter into these into the taxation system should be reduced.

8) Keterangan Rencna Kota, Planning advise given by DTK for developers within Jakarta

9) Izin Mendirikan Bangunan, Building permit issued by DPPK within Jakarta.

10) Izin Penggunaan Bangunan, Occupancy permit for a building issued by DPPK.

11) Pajak Bumi dan Bangunan, Literally, Tax on Land and Buildings. Indonesian national tax authority.

12) Dinas Pendapatan Daerah, Local revenue.

- GIS encourages agency coordination and data standardization
  GIS is a data integration tool. For agency to make the best use of its capabilities, they will need to access the data of other agencies. For data access and sharing to be successful, agreement must be reached on data standards. The opportunities for this were particularly strong among the land registration (BPN), land planning (DTK), and building processing (DPPK), taxation (PBB and DIPENDA), and mapping (DPPT) agencies.

- GIS will enable graphic (map) and nongraphic (tabular) data to be used together to support a variety of analysis, mapping, and reporting functions.
  The GIS makes maps and analysis and display tools for all tabular data related to geographic locations such as buildings, parcels, roads, and utilities. These functions cannot be performed manually. This will enable immediate viewing of issues, such as delinquent taxes, and opportunities, such as coordination of development activities, that improves operations of DKI Jakarta agencies.

# The Study on Urban Environmental Improvement Program in Bangkok Metropolitan Area

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Abstract

The economy of the Royal Government of Thailand grew at the rate of approximately 10 % a year for a decade from 1987. Environmental problems such as traffic congestion and air pollution caused by massive rural urban migration to Bangkok have become serious problems, which need to be fundamentally solved. Using GIS, Bangkok's urban environmental problems from five aspects, namely, land use/urban structure, urban transportation, air pollution, water related environment (floods, water supply and water quality) and living environment (housing/solid waste) were categorically evaluated. The Study recommends realizing strategic projects/programs based on the 6 planning policies.

## 1. Introduction

The Government of Japan decided to implement this study upon request from the Kingdom of Thailand and entrusted the study to JICA. JICA dispatched a study team from Pacific Consultants International and Suuri-Keikaku Co., Ltd to Thailand between 1995 and 1996. In Japan, Pasco Corporation has rendered GIS technology on the study. After returning from the country the study team worked in Japan and prepared the report in February 1997.

## 2. Objectives of the Study

The objective of the present study is to propose a new urban system and social rules for appropriate social capital and environmental resource use of the city with the aim of improving living standards of the people of Bangkok accompanied by sustainable development. The ultimate purpose is to prepare a master plan for Bangkok Metropolitan area's comprehensive urban environmental improvement by 2011.

## 3. Present Conditions of the City and Its Environment

The analysis on the present conditions and environment in Bangkok were carried out using GIS as follows:

### 3.1 Built-up Area

The built-up area was less than 100 square kilometres in the late 1950s but increased to 200 square kilometres in the early 1970s and to 482 square kilometres by 1993. The city centre has not expanded, but new built-up areas have been expanding along major trunk roads, where remarkable population growth has occurred in the last 20 years.

### 3.2 Present Land Use

According to the land use (Figure 1) made from aerial photos taken in 1993, the industrial areas (dark blue) tend to be located in outer areas of the centre, commercial areas (deep pink) are distributed in the center and large commercial areas in the suburbs.

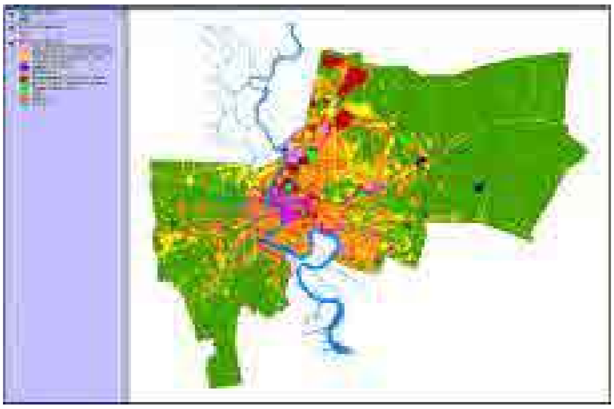

Figure 1. Existing Land Use (1993)

### 3.3 Land Subsidence and Floods

Rapid urbanisation and industrialisation accelerates groundwater use and land subsidence. The city centre has less subsidence by regulations, but in the suburbs there are noticeable subsidences. As a result, there are serious flooding problems occurring in the suburbs. Bangkok for a long time has been suffering from floods due to its location on alluvia and from 1983 to 1995 experienced large flood hazards. According to the GIS analysis, a flooded area in BMA (Bangkok Metropolitan Administration) in 1983 was 424 square kilometres. More than 80 % of the Phra Khanong district was flooded. More than one meter land subsidence is calculated to occur.

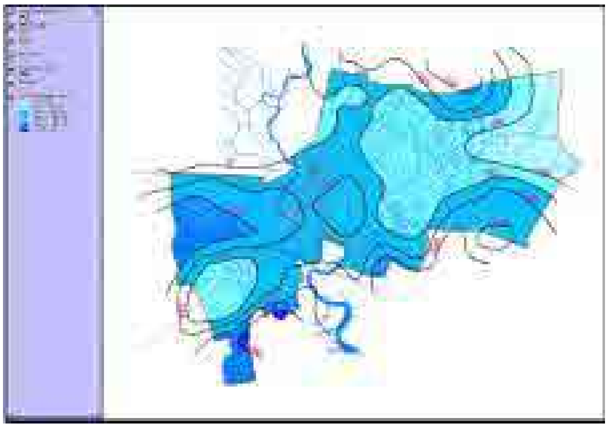

Figure 2. Problem Areas on Natural Constraints

3.4 Air Pollution

About 50% of the total consumption of petroleum products in the country are consumed in BMA. Due to this consumption, heavy air pollution has been occurring continuously. NOx, CO and PM-10 (Particulate Matter Smaller than 10 μ ) from traffic are the main pollutants. The simulation analysis of the air pollution confirmed that SOx, NOx, CO and PM-10, which were thought to be the main pollutants, were generated from vehicles, and their ground level concentrations are simulated.

3.5 Water Pollution

Water pollution areas are spreading in an east-west direction in BMA. BOD (Biological Oxygen Demand) is between 20-40 mg/litre and DO (Dissolved Oxygen) is between 0-20 mg/litre. The water pollution in Khlong has lately been improved a little. However, the water pollution in Khlong has to be improved for water transportation for the residents in Bangkok and for tourism.

3.6 Distribution of Green areas

Distributions of green areas were analysed by Landsat TM image. Very few large green areas excluding parks and open spaces were observed in the built-up areas. And green areas seemed to be scattered mainly in private owned lands. In the suburbs, relatively large green areas remain along channels but decreasing due to development.

3.7 Urban Transportation

Of the average of 21,300,000 person trips per day in the BMR (Bangkok Metropolitan Region), trips which have origins or destinations within BMA occupy about 82% of the total trips. Within this 82%, 90% of them have both destinations and origins within BMA. From the point of the daily travel BMA is a relatively closed area. Therefore traffic problems in Bangkok are caused by socio-economic activities within Bangkok. Road/railway network and traffic zones in 1995 are shown in the figure 3.

Causes of traffic congestion in Bangkok are thought to be as follows;

∉# shortage of roads (road occupancy rates relative to land use are 5% in Bangkok, 15% in Tokyo, 20% in London),

∉# shortage in efficient subsidiary trunk roads,

∉# shortage in reliable alternative traffic system other than roads,

∉# imbalance between land development and road development, and

∉# shortages of restrictions and measures to meet traffic demand increases.

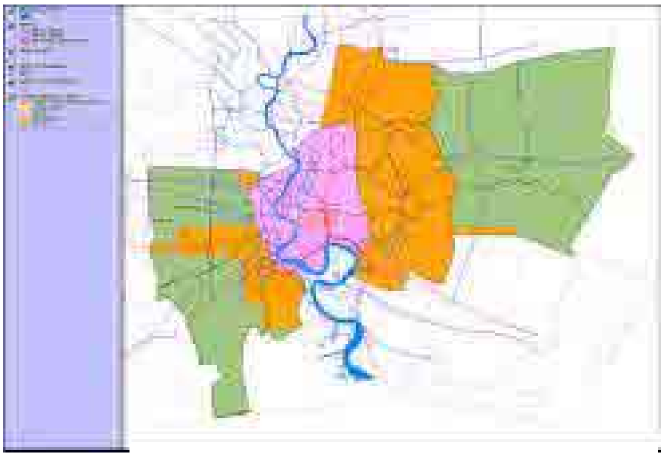

Figure 3. Road/railway network and traffic zones in 1995

3.8 Integrated Environmental Problem Area Map

A workflow of the urban environment evaluation is given in figure 4. A field survey was carried out to collect existing data on urban environment, particularly on urban development, urban transportation, air pollution, water pollution and waste treatment, and ground survey to substitute the data. The GIS database was created. Analysis and simulation were made based on this database. Environmental problem areas were identified by overlaying these analytical results.

Urban environmental problems are extending in the whole Bangkok area but air pollution, water pollution, traffic congestion and population concentrations are serious in the city centre. In the suburbs, floods, land subsidence, water pollution, and overflow of waste products and urban sprawling are serious urban environmental problems.

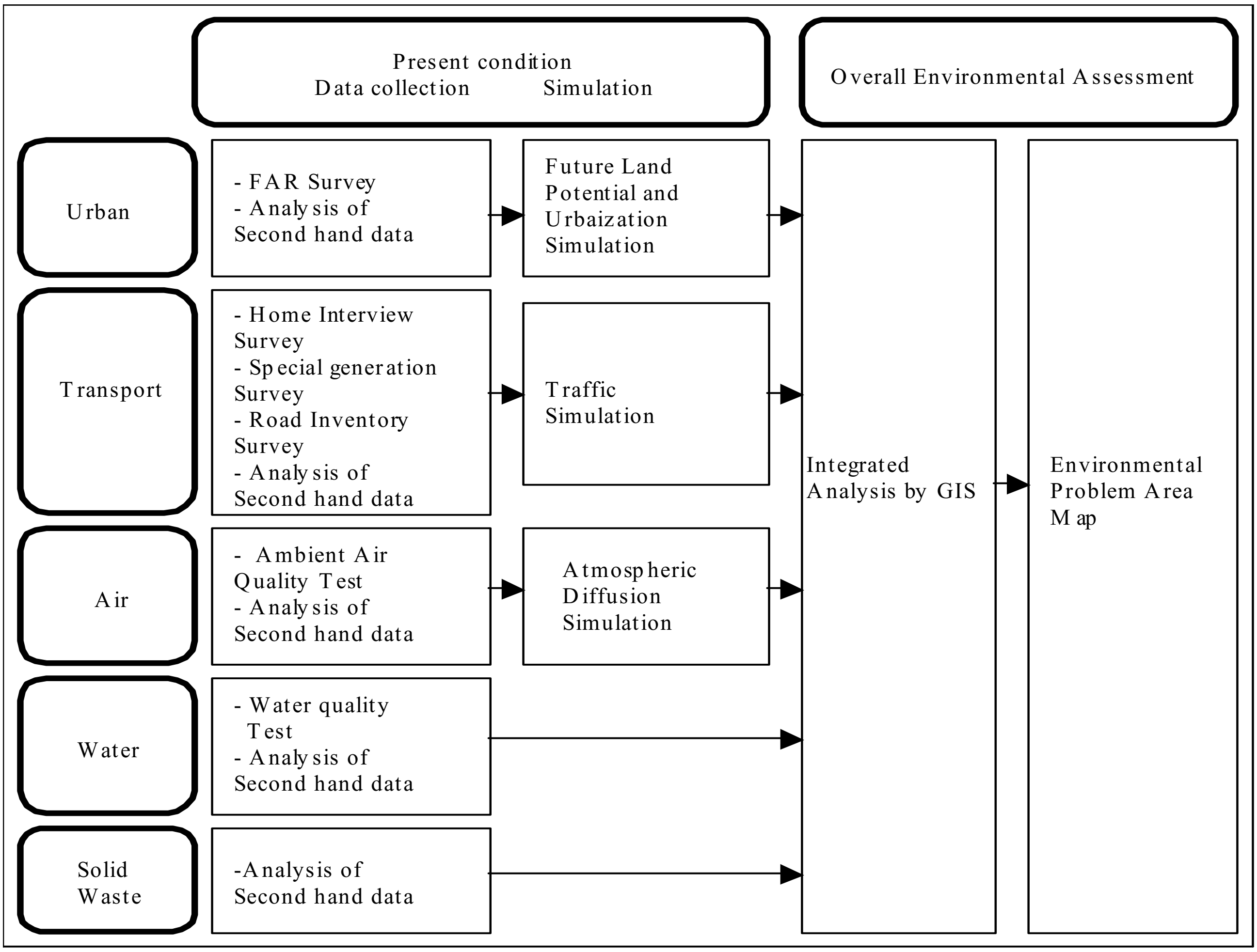


Figure 4 Overall Flow of Urban Environmental Assessment

**4. Land Development Potential and Urbanisation**

4.1 Analysis of Urban Development Potential

The analysis flow of urban development potential is illustrated in figure 5. An urbanisation model was constructed based on the existing factors influencing urbanisation of land. The whole Bangkok city was divided into one square kilometre grids. After each grid was given scores based on aspects using future infrastructure condition, future land potentials were simulated based on the developed urbanisation model. Future urban potentials were projected based on future land potentials and population frameworks. Each indicator's scores were determined and indicators of the urbanisation model were calculated.

4.2 Distribution of Urban Development Potentials

The analytical results showed that Bangkok could be divided into four areas, namely,

∉# areas with more than 90% built-up areas, with limited open spaces

∉# areas with 76-89% built-up areas

∉# areas with 51-75% built-up areas

∉# areas with less than 50% built-up areas, with sufficient open spaces

**5. Conclusion**

Planning issues, based on the findings through the assessment of the present states, are identified into the following six issues;

∉#Sustainable Resource Utilization in Vulnerable Environment;

∉#Flood-free Urbanization;

∉#Environment-initiative Urban Transport System;

∉#Pursuance of "Fresh and Clean Air policy";

∉#Creation of "Water-friendly Eco-city"; and

∉#Up-grading of Quality of Living Environment.

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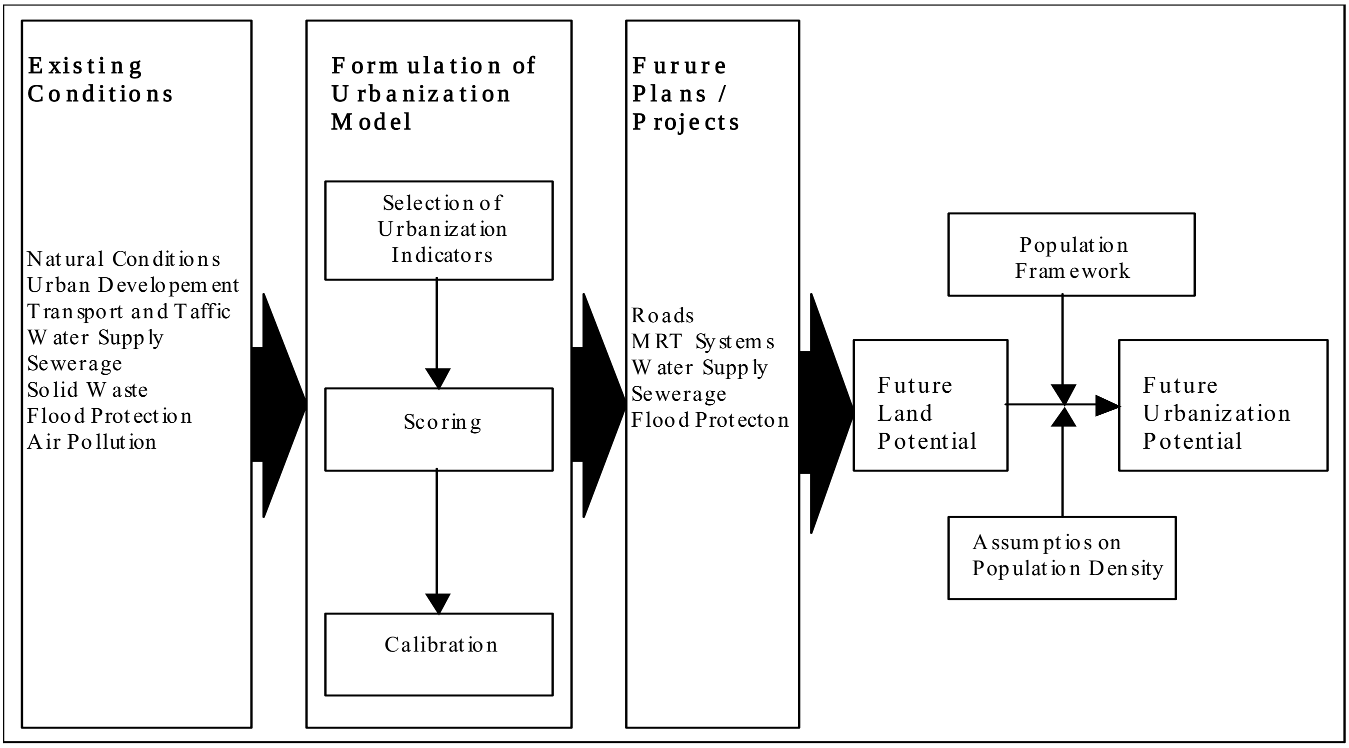


Figure 5. Flowchart for Urban Land Development Potential Analysis

## 6. Acknowledgement

The author would like to acknowledge appreciation to all those who extended their kind assistance and cooperation to the Study Team, in particular, relevant officials of Bangkok Metropolitan Administration and the Thai counterpart agency.

# Kuwait Utility Management System（KUDAMS）

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An international tender was called at Kuwait Municipality to create the most sophisticated Geographic Information System (GIS) in the period of 6years. It contains the establishment of national geodetic network, creations of cadastral database, utility database, digital topographic mapping and delivery of software and hardware. Due to the weather conditions in Kuwait, aerial photography can be carried out in winter. Therefore, project area was divided into 4 progress areas in order to take aerial photographs every year. This paper describes the difficulties encountered to execute the big project.

## 1. Purpose

For the purpose of efficient execution of administrative activities with strategic utilization of Geographic Information System (GIS), Surveying Department of Kuwait Municipality drew up a project called Kuwait Utility Data Management System (KUDAMS) in 1983. Main objectives of this project are to establish national geodetic network covering the entire country and construct comprehensive management system for the cadastre data of the urban area about 580 km$^2$ as well as the underground utilities with the aid of computer technology.

The GIS for the KUDAMAS was not only the largest in scale but also utilized the cutting-edge technology in those days and, therefore, received high acclaim as the word first full-blown Facility Management System.


Figure 1. Location of Kuwait

## 2. Outline of the System

Graphical and non-graphical data about the topography, cadastre and underground utilities in the urban area of Kuwait were all digitized and recorded in the databank. Whenever necessary, these data can be output on the computer display or as a hard copy in the form of graphic images or tabulated lists.

Data maintenance can be performed in real time by various inputting and editing devices. The system has been maintained and managed by Kuwait Municipality officials themselves since its completion.

The following are the main operations related to the system construction.

1. Establishment of geodetic network
2. Creation of cadastre database
3. Creation of underground utility database
4. Digital photogrammetry
5. System construction (both hardware and software)
6. Training of Kuwait Municipality officials

## 3. Contents of Database

### 3.1 Establishment of Geodetic Network

Centralized information management, that is, to manage various data under the same coordinate system, is crucial for effective usage of data in GIS system.

Consequently, establishment of high precision national geodetic network was required. Surveys including the first-order geodetic network (101 stations), second-order geodetic network and first-order leveling network were carried out and permanent markers were installed accordingly at each station.

Furthermore, for cadastre surveying control points, data collection and investigation on 50,000 BTPs (Boundary Traverse Point) were carried out, and as a result, 6,000 BTPs were confirmed. Markers were installed at the confirmed points and their coordinates were measured in the course of digital map making.

All these results were input in the database on the basis of the KTM (Kuwait Transverse Mercator), the new national geodetic coordinate system, which would be the basis of all the data for the KUDAMS.

3.2 Creation of Cadastre Database

Instead of using traditional way of mapping i.e. graphic method, numerical cadastre mapping was introduced so as to manage cadastre data by computer. The scale for basic maps is 1/500, and information such as boundary points, boundary lines between parcels, the new as well as old addresses of the parcels and the name of parcel owners were recorded in the database. Other kinds of attribute information were kept in the Regional Legal Affairs Bureau, and, due to their confidential nature, the officials of the Survey Bureau themselves had to input such data. They include registration certificate numbers, names of parcel holders, ratio of ownership, cadastre map numbers and registered cadastre.

Underlying concept of constructing the database in Kuwait Municipality was to create “multi-purpose cadastre database”, which allowed efficient management of administrative activities. This means that the database could be used not only for registering parcels by digitizing cadastre maps but also used as a GIS system in urban planning, management of underground utilities and administrative activities.

In multi-purpose cadastre, in general, the present state of land ownership is clearly shown by simply selecting some of the graphic data prepared by other administrative organizations and overlapping them each other. These graphic data include topographic maps, schematic drawings, electric facility control charts, land use maps, transportation maps, agriculture-related maps, hydrographic maps, forest maps, mineral resources maps, etc.

In addition, one of the purposes of creating multi-purpose cadastre is that it stores attribute information (non-graphic information) in database and therefore, such information can be used to calculate cadastral statistic data, assess prices of land, evaluate taxation, and thus can be used as the basic materials for national census and economic statistics.

The following were used as source materials in data input.

- Surveying field notes: about 800 volumes
- Cadastre maps: about 4,000 pieces
- Schematic drawing: about 500 pieces
- Register control ledgers: about 3 meter

Figure 2 Operation Scene

3.3 Creation of Underground Utility Database

Field surveys and measurements were carried out on 12 items of each of 7 kinds of underground facilities.

Markers were set on all the structures such as manholes that could be seen on the ground so that they could be identified on aerial photographs. In digital photogrammetry their positions were measured and recorded in the database along with the results of field surveys. Later, they were output on a 1/500 topographic map for the management of underground utilities.

Items that constitute the database were city water (water supply and waste water reuse), street lams, telephone, electricity (high-voltage and low-voltage), gas, rainwater drainage and sewage.

Other necessary materials for database such as layout drawings, construction drawings, etc. were collected from the related government ministries and agencies. These materials were used to identify exact location of structures in the field surveys. As long as 3,000 km of city water was input in the database.

Information showing present state of underground utilities was recorded and saved in the form of layers to allow central management of these utilities along with cadastre database.

3.4 Digital Photogrammetry

An aircraft for aerial photographing was brought from Japan. Due to sand storms, the period for aerial photographing was limited only from December to March, and this was the most difficult job. Entire area was divided into 4 parts for annual aerial photographing. It took 4 years to complete shooting of the whole area.

In order to keep the same level of accuracy between underground utility maps and cadastre maps, it was determined the scale of topographic maps for the whole are should be 1:500.

Analytical plotters were used to measure topographic features so that their coordinates could be directly recorded in a digital format. This also contributed to maintaining of accuracy. Coordinates of building corners, walls, roads, curb stones, minor diameters, underground utilities, street lamps, counter lines as well as crossline information were measured and recorded.

Furthermore, entire country was covered with photomaps at the scale of 1:10,000, while residential areas were covered with topographic maps at the scale of 1:2,000.

Figure 3　Assembling an Aircraft

Figure 4　Investigation of Underground Utilities (sensor)

3.5　Systems (Hardware and Software)

GIS system in the KUDAMS project was expected to perform the following functions.

1. Various utility data (both graphic and non-graphic data) should be managed in a centralized manner.
2. Precision and reliability of utility data should be improved and uniformity among the data should be achieved.
3. Inputting, editing and outputting of various data can be performed in a simple manner.

As a result, the following were to be achieved.

1. Standardization of utility data
2. Quick updating of secular changes
3. Easy output of maps and statistic data
4. Prevention of accidents during the execution of the work
5. Facilitating inter-availability of various data among the different ministries concerned
6. Easy safekeeping

Upon completion, GIS system would exert great impact on the daily administrative task.

3.6　Training of Kuwait Municipality Officials

Upon completion of data production, the system was required to turn over to Kuwait Municipality. Then, the officials of Kuwait Municipality were supposed to engage in system control and data maintenance.

Therefore, the same systems with the same functions were created both in Kuwait and Japan. The one in Japan was exclusively used for data production and Japanese staff worked in three shifts to advance delivery date.

On the part of Kuwait Municipality, on the other hand, input of the classified data was carried out by the municipality officials themselves. This is because such data were kept at Regional Legal Affairs Bureau and not allowed to take out.

The operations were carried out under the supervision of the Japanese. Cadastre database was finally completed with 5-year of strenuous efforts of about 5 officials of Survey Bureau of Kuwait Municipality and about 20 Japanese engineers.

Figure 5　Staff of Survey Bureau

## 4. Conclusion

All the contracted jobs were completed in 1990 and the final product was delivered to Kuwait Municipality in the presence of Director General of Survey of Kuwait. Without a long cooperation with the officials of Survey Bureau of Kuwait Municipality for 7 years, we could not have accomplished such a difficult job. Unfortunately, the system was damaged and most of its function was lost in Gulf War. However, I heard that a new database was re-constructed from the backup data kept in Japan and now it is functioning very efficiently in day-to-day administrative work in the Survey of Kuwait.

# Establishment of Database for Geographic Information Systems of the Capital Area of the Republic of Madagascar

## - GIS Applications for Urban Facilities Management -

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Abstract

The Study of the "Establishment of Database for Geographic Information Systems of the Capital Area of the Republic of Madagascar" produced three types of geographic information database for urban base maps, land-use/land-condition maps, and urban facilities were built. This report relates to the development of the urban facility database and introduces the background for the development and database production. First, the target facilities (road, sewerage, water supply, electricity, and communications facilities) were selected. Then, the items and structure of the database were determined on the basis of the results of a hearing survey undertaken for the required GIS functionality at the related organization. Finally, the information necessary for urban facility management was entered into the database.

## 1. Outline

### 1.1 Outline of the Study

The Study of the "Establishment of Database for Geographic Information Systems of the Capital Area of the Republic of Madagascar" was carried out from October 1998 to November 1999, with the implementing organization being Japan International Cooperation Agency (JICA).

Various types of geographic information necessary for formulating city plans (including urban base, land-use/land-condition, and urban facility management maps) were produced digitally and stored in the database. The basic operation system provided for the database (Infrastructure Management System – IMS) was also developed.

### 1.2 Background

The living environment in the Republic of Madagascar varies greatly between the urban and rural areas, just like in any other developing countries, and the movement of the population from the rural to the urban area is remarkable. The Metropolitan Antananarivo shows a similar tendency, for which the increase in population was drastic. The resulting living conditions have since worsened, and the urban facilities could not cope with the demographic increase.

Under these circumstances, the City of Antananarivo and the Government of Madagascar decided to formulate a concrete city plan in accordance with the Master Plan prepared by the United Nations Development Program (UNDP).

### 1.3 Objectives

In the above-mentioned background, the Study of the "Establishment of Database for Geographic Information Systems of the Capital Area of the Republic of Madagascar" was undertaken with the objectives of developing the databases for urban base maps, land-use/land-condition maps, and urban facilities.


Figure 1. Study Area

## 2. Target Urban Facilities

### 2.1 Selection of Target Facilities

The guidelines for development of the urban facilities database were established as follows:

① To acquire the data that allow a better understanding of the existing conditions of the urban facilities in the city and surrounding areas.
② To develop the database that can be used effectively for city plans and urban facilities construction plans, as well as for the management and maintenance of urban facilities.

③ To develop the database with an architecture that allows the simple and fast building and updating of data.

Following these guidelines, a survey of the database functionality was made with the related agencies, and the urban facilities and related agencies to meet the said guidelines were selected for the database to be built as described below.

a. Roads: Agency, not specified
b. Water supply: JIRAMA (Electricity and Water Company of Madagascar)
c. Sewerage: AGETIPA (Executive Agency and Public Infrastructure Works of Antananarivo)
BDU (Urban Development Bureau)
TECSULT
d. Electricity: JIRAMA
e. Communications: TELEMA (Telecom Malagasy)

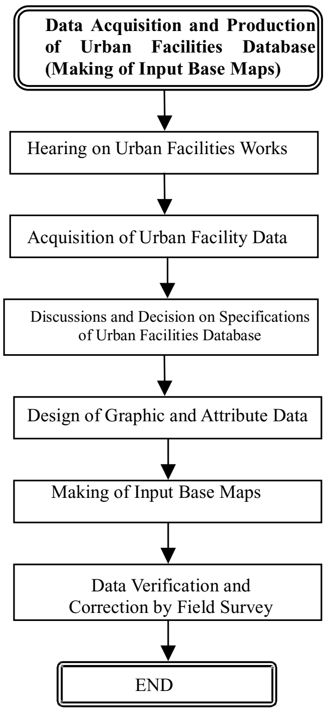



Figure 2. Flowchart of Data Acquisition and Production of Urban Facilities Database (Making of Input Base Map)

2.2 Study with the Related Agencies

A hearing survey with the agencies related to urban facilities was made for the following items:

① Procedures of urban facilities maintenance and management works
② Materials (data) used for urban facilities maintenance and management works
③ Issues and problems in urban facilities maintenance and management works
④ Relationship with other agencies related to urban facilities
⑤ Effective use of materials (data) following the establishment of the database

The survey on Items ① and ② shows clearly that the drawings of the facilities had often been used in the maintenance and management works, and that the retrieval of those drawings took considerable time.

The survey on Item ③ shows that it was important to efficiently update the drawings for maintenance and management of urban facilities, and that there were problems of lost drawings and method of taking custody of the drawings.

The survey on Item ④ shows clearly that the related agencies prepared individually the drawings for maintenance and management.

The survey on Item ⑤ shows clearly that, if the database of the materials (data) for maintenance and management of urban facilities is produced, then the works of maintenance and management would improve substantially.

2.3 Data Acquisition for Facilities Management

Two types of materials for the maintenance and management of urban facilities were collected:

① Drawing materials (data): Topographic maps and facility completion drawings as used for maintenance and management of urban facilities.
② Statistic materials (data): Forms and registers

## 3. Analysis of Collected Materials

3.1 Classification of Collected Materials

The materials that were collected from the agencies related to urban facilities were classified according to the following categories:

① Graphic materials from which the geographic locations can be specified: Piping and cabling drawings
② Graphic materials from which the geographic locations cannot be specified: Structural drawings
③ Text materials related to the graphic materials: Contracts and agreements
④ Text materials unrelated to the graphic materials: Various forms

3.2 Analysis of Collected Materials

The materials categorized as ① through ④ in 3.1 above were analyzed. The analysis clarifies the following matters:

- Dates of the materials, which were defined for almost all materials.
- From the materials ①, the locations of most facilities could also be defined on the city base map database. These graphic materials included the text information, which was deemed useful for the maintenance management works.
- The materials ② and ③ had a low frequency of utilization in the maintenance and management works.
- Some of the materials ④ were available following the production of the database.

## 4. Requirements for Facilities Management and Examination of GIS Functions

4.1 Requirements for Facilities Management

The hearing survey undertaken for the maintenance and management works at the agencies related to individual urban facilities clarifies the following requirements:

① The rational methods of custody of materials for facilities maintenance and management and retrieving the necessary materials, whenever needed
② The function for a fast retrieval of necessary materials for the facilities maintenance and management by designating the scope and number of copies.
③ The functions for a statistic process (such as addition, subtraction, multiplication, or division) of the numerical information in the materials for facilities maintenance and management and for obtaining immediate results.
④ The function of mutual correlation of the materials in a simple manner, since a large number of materials relate among them.

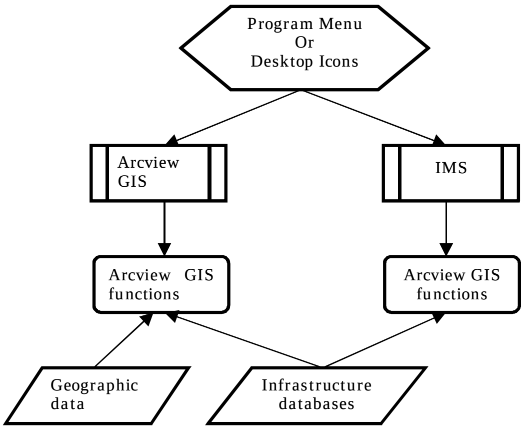
4.2 GIS Functionality

Based on the discussions on the requirements as described in 4.1 above, the following functions could be run on the GIS software (ArcView):

① Graphics-based functions: Scroll, zoom and scaling of graphics, display of specific items, and color designation.
② Retrieval functions: Retrieval through key codes, locations, and other conditions
③ Statistic functions: Data sum-up
④ Display (output) functions: Display and output of cut-out parts of drawings, specific items, and statistic calculation results

4.3 Infrastructure Management System (IMS)

The IMS was configured using the ArcView software. The IMS architecture is shown below.




IMS Configuration

Figure 3. IMS Configuration

① Input system
- Graphic input system
- Attribute data input system

② Management systems
- Urban base map IMS (Inactive database)
- Road IMS (Active database)
- Water supply IMS (Active database)
- Sewerage IMS (Active database)
- Electricity IMS (Active database)
- Communications IMS (Active database)

③ Functions of management systems
The four functions as described in 4.2 GIS Functionality were implemented.

**5. Database Development**

5.1 Decision of Data Items

The collected materials, the requirements for the facilities management, and the GIS functionality were examined to decide the following data items for each database:

① Road database
Graphic data: Road center line, road width lines, section lines, etc.
Text data: Road width, road number, road structure type, etc.

② Water supply database
Graphic data: Boundary, conduits, valves, and other facilities
Text data: Boundary name, conduit number, valve number, etc.

③ Sewerage database
Graphic data: Manholes, conduits, etc.
Text data: Watershed name, manholes, conduit number, etc.

④ Electricity database
Graphic data: Facilities (such as substation), power line, poles, etc.
Text data: District number, power line number, pole number, etc.

⑤ Communications database
Graphic data: Manholes, poles, armored cables, distribution units, etc.
Text data: Manhole number, pole number, armored cable number, etc.

Table 1. Graphic Coordinate Data Format

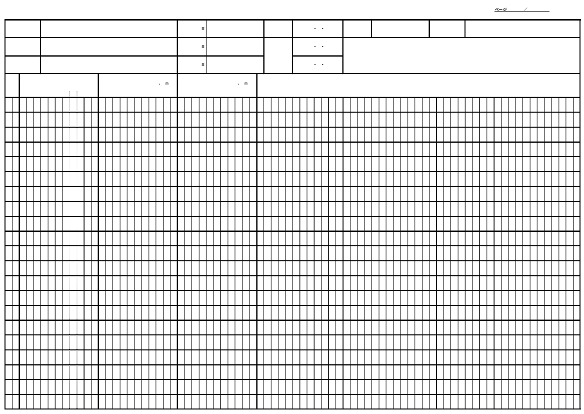
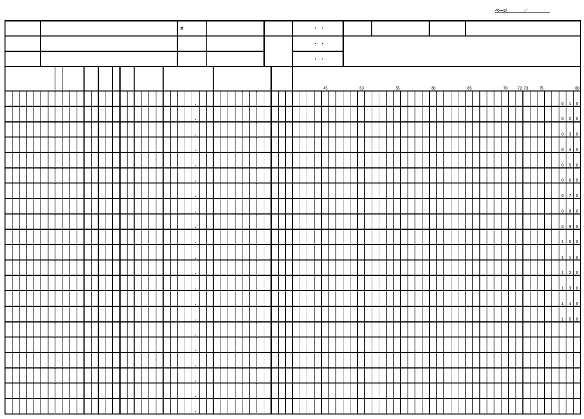


Table 2. Attribute Data Format



5.2 Design of Graphic and Attribute (Text) Data

The graphic and attribute data were built as follows:

① The graphic data were configured with points, lines, and polygons.
② The attribute data were defined by data type, display size, and number of characters.
③ As two or more data files are used simultaneously, the required key codes were set and the relational files defined.
④ The display windows for displaying graphic and attribute data were defined.

5.3 Data Entry

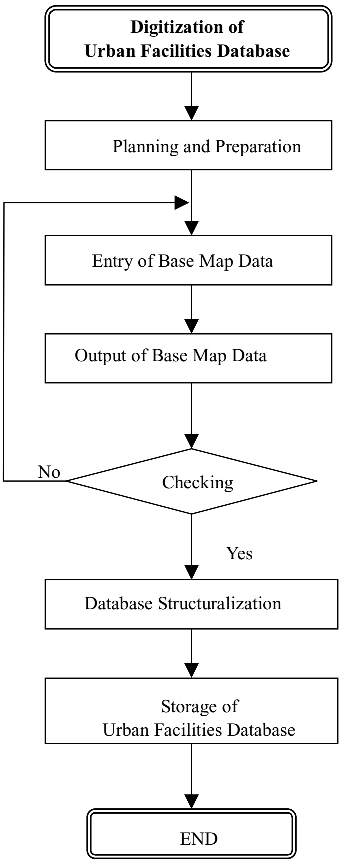



Figure 4. Flowchart of Digitization of Urban Facilities Data

The neat lines for a 1/2,000 map sheet were defined on the urban base map database and the data entry was made in the neat line unit.

5.3.1 Entry of Graphic Data

The input base map for the graphic data was prepared from a 1/2,000 map and the data were entered in the input map.

5.3.2 Entry of Attribute Data

A data sheet was prepared for the attribute data which were entered in the sheet before being input in the system.

5.4 Data Quality Control

5.4.1 Guidelines for Quality Control

Visual and logical checks were made for each process of developing the database and the minimization of data errors was adopted as the guideline for quality control.

5.4.2 Quality Control

In accordance with the above guideline, the data quality control was performed under several conditions, and various quality control methods (such as visual check, same check by two or more persons, and logical check through computer) were adopted and executed.

**6. GIS and its Future Issues**

For this Study, a limited number of data items, such as roads, water supply, sewerage, electricity, and communications, were selected from the urban facilities, and the database on those items was built for a limited range of areas of Antananarivo City.

6.1 Map Data in Building the Infrastructure Management Database

When building the urban facilities database, it is important to specify the geographic location of each facility. Should it be otherwise, the mutual relations between the facilities would be unclear, and operating the infrastructure management system would be hard to handle. Therefore, the urban base map database (map data) used to specify the geographic locations of urban facilities constitutes an essential instrument for building the infrastructure management database.

6.2 Operation of Infrastructure Management System (IMS)

(1) Validity of the IMS

Only five items of urban facilities in a limited area were adopted to develop the database. Though the database was built for a limited area and number of facility items, the GIS was used and the database became a powerful tool to understand the actual conditions and execute the construction or improvement plans for the urban facilities. The GIS will thus be instrumental in formulating the city plans in Antananarivo City.

(2) Review and Discussions on the IMS

A very limited basic infrastructure management system was configured in this Study. This system will allow a suitable management of the urban facilities. However, for an improvement of the system, it is necessary to carry out the study (work study) related to the detailed works of the administrators of the facilities, the procedures of the works, and the utilization of the materials (graphic and attribute information). Further, the functions of the IMS and the database design should be reviewed and discussed while taking into account the results of the study. When building the expanded database, the following issues should be treated:

① Discussions on expansion of the targets for the database development
② Discussions on information items to be covered by the database
③ Discussions on areas to be covered by the database
④ Standardization of material forms to be prepared for the urban facilities
⑤ Improvement of input base maps and attribute data creation

manual

⑥ Improvement of tools for building the database

⑦ Establishment of a method for systematic database quality control

### 7. Conclusion

A good deal of human resources will be required for the operation of the GIS that is usable for urban facilities management. To this end, the technology transfer must concern not only the building and operating of the Infrastructure Management System, but also the training of staff of the following categories:

- Engineers in the work-study and analysis
- GIS engineers
- Engineers in database development

The above issues must be dealt successfully for an effective use of the GIS, so as to cope properly with the actual situation of the Republic of Madagascar.

# An Asset Mapping in East Timor

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Abstract

The riot, which happened after the local referendum held in September 1999, heavily damaged infrastructure in East Timor. An asset mapping system is a management system of water pipelines in East Timor on purpose of understanding a current condition of water supply and launching a new development plan as part of the rehabilitation plan of infrastructure. Information described the present condition related to water pipeline, which was heavily damaged over the country, has been entered into a database. The management system of water supply have begun operating in fall 2000, which would be a foundation of the development plan of facilities in the future.

## 1. Background of East Timor

East Timor is 14,609 square kilometers in area, whose population in 1999 is 890,000. Since it became a colony of Portugal in the sixteenth century and Portugal gave a half of the western part of Timor Island to the Netherlands in the seventeenth century, Timor Island has been divided into two parts under two different countries, the eastern and western part of the Island. Socialist regime of Portugal carried out liberation policy to colonies outside of the country in 1975. As a result, power between the moderate and the independent parties launched a civil war and the independent party declared the sovereign of democratic republic of East Timor. Soon after the declaration, pro-Indonesian militiamen occupied the entire land of the country and established the provisional government of East Timor. The following year, Indonesia integrated East Timor as the 27th province of their territory.

As East Timor has been ruled by the Indonesian government under the amalgamation policy, citizen's resistance against the government has begun and force to seek their independence has grown. While UN deployed a mission in East Timor to keep peace and order in 1999, popular consultation to suggestion of special autonomy was held and the riot against the referendum happened by the pro-integration. The UN sent off Multinational Army to East Timor in September 1999 and established UNTAET. The establishment of UNTAET evacuated Indonesian Army from East Timor. The capital of East Timor is Dili, which has a population of 200,000. A common language is Tetung and about 90 % of the population is Catholic.

## 2. Water facilities in East Timor

It is not possible to find out details of the condition about the development of water facility in Dili during the government ruled by Indonesian because the storage building for government publications and documents was burned. But according to hearings to officers, who belong to division of water facility of UNTAET, it is said that three locations of facilities for purifying water and pipeline network in Dili was developed as well as water facilities and pipeline network in other few cities, by the assistance of Australian government since 1993.

At the same time, it began to operate a system to design water facilities in Dili, which is utilized such as CAD (Computer Aided Design), automated mappings, PC, and so on. The system makes it possible to register and manage data of drawings, which are designed and established in planning of a new water facility, and associated data, which are records of repairs and the maintenance expected in the future.

Water facilities became a target of the riot to cause serious damage since fall 1999 and three water purification plants in Dili have been torn down, and pipeline leakages were found everywhere because many water pipelines in the city was destroyed. In addition, the system was demolished, which designed water facility assisted by Australian government and already started operating, and there is no means to find out the system.

Numerous water facilities in cities other than Dili have been damaged and cannot supply water. Even if they can, the quality of water is not enough for drink.

## 3. The basic plan of an asset mapping system

The basic plan for an asset mapping system was established in Dili. The targets for the plan are Dili, the capital of East Timor, and other growing cities as follows;

Aileu, Ainaro, Atauro, Baucau, Ermera, Gleno, Liquica, Los Palos, Maliana, Maubisse, Manatuto, Same, Suai, Viqueque

### 3.1 Status of maps

Since it is not possible to find a map as the use of base map, it is collected topographic maps managed by UNTAET and maps developed during planning of the rehabilitation.

 Topographic map: 1/25,000 scale map printed by Australian Army in 1999 based on an original map, which is surveyed in 1990 to 1992 by BAKOSURTANAL Indonesia.
Coordinate system: Origin of Indonesia (1974), WGS84 coordinate system is added.
Projection: Transverse Mercator
 Topographic map: 1/2,000 scale digital map in the area of Dili created by JICA in 2000 through aerial survey.
Coordinate system: WGS84
Projection: Transverse Mercator
 Pipeline network map: scale and years of the preparation are not known and whose area covered only Dili.
 A map related to water supply and sanitary planning in East Timor: scale and years of the preparation are not known and whose area covered only Dili.
 Collection of plans related to the PETA LOKASI plan: scale and years of the preparation are not known and whose area mainly covered Dili, including some other rural cities. Descriptions of topography importantly related urban planning, natural environment, present conditions and future vision of public facilities. (Some part are damaged.)

Out of items above, the scale of 1/25,000 topographic maps was made enlarge or reduce into 1/50,000, 1/10,000, 1/5,000 and etc. so that it can be used for other different purposes.

### 3.2 Introduction of GIS

Since 1993 Dili introduced CAD by assistance from Australian government to carry out the development of facilities. This system has a main purpose to support designing and a consistency in designing new facility and estimating the cost at the same time. However, it is not effective in organizing data for the maintenance to update records for repairs of facilities. Since there is no database integrated drawings and associated data, it required making changes for two different databases individually. Because of that, it is often found such mistakes that CAD data were made changes while data associated with the construction history were not updated or wrong addresses were entered. This system employed GIS to make up for the disadvantage of CAD system and GIS software, called ArcView, can make both drawings and associated data integrate.

Following functions of geospatial analysis allow this system to apply for various goals in the future.

 Search drawings and retrieve tables
Identify dates established water facilities and find pipelines constructed more than 15 years ago
 Overlay
Create a plan to locate water facilities according to population data by overlaying topographic data and urban planning data.
 Buffering
Manage data about residents surrounding main roads
 Network
Analyze the pipeline network system

### 3.3 Hardware

PC (OS is Microsoft Windows NT) and a printer (connected to PC on network) are needed to carry out an asset mapping system.

### 3.4 Software

Applications used here to operate an asset mapping system are ArcView3.2, ArcPress3.0, and Office 2000.

## 4. Establishment of database

Most of data for an asset mapping system are geospatial data. Although it is necessary for the maintenance and management to establish a database of the data associated with drawings on a map, it has not been achieved yet since the demolition. This paper describes a target area, the city of Dili, and 14 cities in a different section.

### 4.1 The city of Dili area

Digital topographic data and 1/25,000 scale topographic maps produced a base map.

 1/2,000 digital topographic data (digital topographic map created by JICA).
 Associated data･･･ data of facilities and pipeline network

Data for pipelines and water facilities (including river intake facilities, wells, water purification plants, distributing reservoirs, pump stations) are maintained on different layers separately using on 83 topographic maps of the city of Dili. Water facility has associated data (vector data), such as field photos, survey data, and etc. Although it is not certain when maps of pipeline network were completed and what kind of scale they were, they are converted into digital maps, identifying whether a pipeline is located or not according to results of field survey. Thus, data for pipeline network are established by rectifying victor data based on topography. Pipeline network has two associated data, diameter of pipelines and direction of water flow. Figure 1 shows one of pipeline network.

Figure 1. Pipeline network in Dili (displaying pipeline in bold)

4.2 Other 14 cities

Following topographic maps produces a base map.

- Raster data obtained from scanning 1/25,000 scale topographic map
- Associated data···locations of water intake facility, data for service area(vector), data obtained from field survey, data for sectional plans of facility location(vector), field photos, sketches(raster), etc.

The coverage to create topographic data is from the location of supply facilities to the service districts, which is identified by field survey in 14 cities. The size of coverage would vary among these cities because of following reason. The coverage would be lager in the region, which have long distance from service districts to source of water, while the coverage would be smaller in the cities, which have relatively short distance. In addition, data for supply facilities and service districts should be vector data and maintained as an independent layer, separating from topographic data. Figure 2 shows an example of displaying the map.

Associated maps of field survey and sectional plans of facility locations are scanned and converted into vector data by raster-vector conversion. Filed photos and sketches are raster data. Data of facilities include water intake facilities (rivers and spring water), wells, water purification plants, distributing reservoirs, pump stations, tanks for reducing pressure, and pipelines.

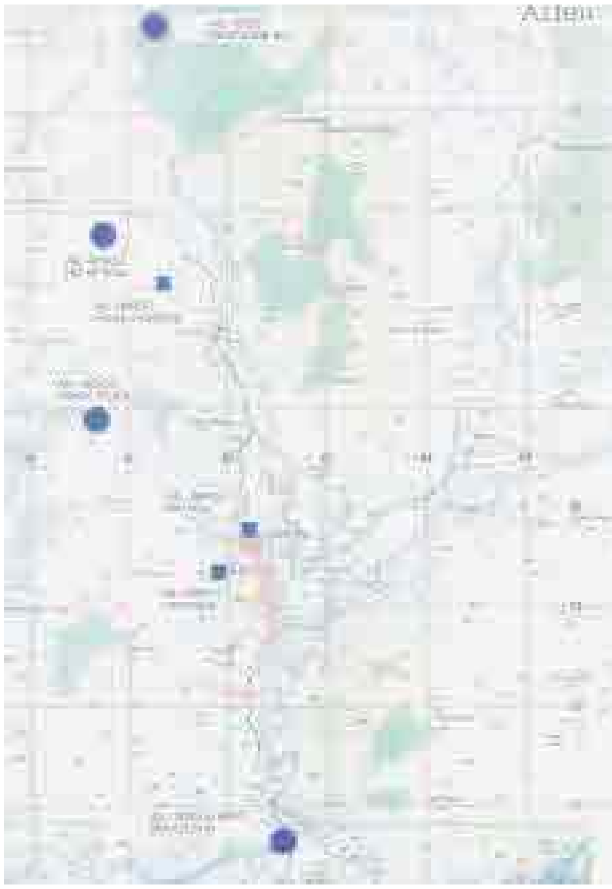

Figure 2. A present map described water pipeline in the rural area.

4.3 Data for the evaluation of facilities

It is raster data that entered as data of the evaluation of facilities, which describes the present condition and calculated cost to rehabilitate the deterioration in terms of entire water facilities from water intake facility to service area. Since Dili and other 14 cities have forms of data sheets in common, it is easy to display data through a filing function. Figure 3 shows a part of sheets.

**5. Operation of the system**

The operation of database has started after digital data were obtained from results of geographic survey. This system is operated by three PC, which is connected each other on network, and three PC are installed Office 2000 and two out of three installed ArcView. Although this system basically has functions to locate and search facilities, it is necessary in the future to increase additional functions, such as displaying drawings and updating database.

| Town: Dili | No. & Facility: 23 - Bedoisi Resevoir | Year of Construction: 1998 | Financed by: Bia Hula |
|---|---|---|---|
| **Existing Condition:**<br>*Structure:* Reinforced Concrete<br>*Shape:* Rectangular<br>*Dimension:* 5.8m x 5.6m x 2.2m.<br>*Capacity:* 45m$^3$<br>*Function:*<br>*Source of Water:* Bedoisi well<br>*Ground level:*<br>*Accessories:*<br>overflow pipe<br>washouts | **Photograph:**<br><br>(Date: June 2000) | | |
| **Evaluation:**<br>No ventilation & level gauge.<br>Water leak was seen coming from the valve. | | | |
| **Rehabilitation Plan:**<br>*1) Basic Calculation*<br>Reservoir is constructed close to private houses. For continuous use in the future, minor rehabilitation is required.<br>*2) Civil Work:*<br>Construction of securtiy fence<br>*3) Piping work:*<br>Installation of flow meter and controller<br>*4) Mechanical work:* none<br>*5) Electrical work:* none<br>*6) Miscellaneous:*<br>Installation of chlorine dosage devices | | | |
| **Estimated cost:** US$7,379 | **Construction schedule:** | **Priority:** A-2 | |

Figure 3. Data for the evaluation of water facilities

**6. Challenges for an establishment of setting the system**

Summary of challenges to establish an asset mapping system are as below in targeting on technology transfer and the environment of setting the system.

6.1 Difficulties of technology transfer

Even though East Timor has been ruled by UNTAET since the riot, the political situation hasn't been settled yet and a significant amount of people still sheltered from East Timor to West Timor after an evacuation of Indonesian Army. Therefore, it has been little to give a chance to learn higher skills for ArcView, GIS software, and it was not enough to transfer advanced technology. There are several factors to emphasize as follows.

- Lack of personnel, who have experience to operate PC.

There are little specialists to learn how to operate the system, since the distribution rate of PC is low in general. It is not possible to find who had managed and operated the system to design water facilities before. Even if it is found a person who was responsible for the operation under the specialist before, the knowledge of hardware and software skills is poor.

- Lack of specialists, who have comprehensive knowledge of water system.

There are no specialists who know well about supply facilities in Dili ranging from water purification plants to houses of customers and comprehensive knowledge of water system in other 14 cities ranging from supply facilities to service areas.

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6.2 The environment of setting the system

Although it was possible to establish an asset mapping system under the condition that the rehabilitation of facilities for water management is still underdeveloped, it remains following issues in the environment of setting the system.

- High humidity and high temperature

PC is not necessary to prepare a special room for computer, but it is not possible to install PC in a room without high humidity and high temperature seen in tropical zone. When the power of PC is switched on, the thermometer shows 35 centigrade. Even if fan is set, it is not still efficient. It needs to be improved.

- Concerning of disk crash because of the instability of power

Electrical power often becomes out of service, although Dili receives a supply of electrical power from generating power plant. Or even not power down, there is clear evidence that the electrical power have unstable frequency on a regular basis. Although UPS is setting up between the system and a power source, it needs additional devices to stabilize frequency of electrical power.

- Time issues that it takes long time to recover the system because there are no extra parts to repair.

Since there is no shop in Dili to sell PC accessories and extra parts, it needs to go to Darwin, Australia or Bali, Indonesia to purchase these.

# The Utilization of GIS Applications at Gas Companies in Japan and Other Asian Countries

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Abstract

It has been the most critical theme for gas companies to develop, manage, and maintain a network of gas pipeline accurately. Recent deregulations also make Geographic Information Systems (GIS) increasingly important. This paper describes overview of utilization and development of GIS at gas companies in Japan and other Asian countries and introduces case studies of the GIS development, the system development, and the specific applications (such as mobile and WEB GIS), which is applied by Tokyo Gas and Gas Malaysia.

## 1. Introduction

Turning to the twenty-fist century, the environment surrounding utility companies has become more difficult. A wave of globalization bringing deregulations, which is happening in particularly Europe and the United States, is pushing over to Japan gradually. This trend is already seen throughout communication industry and it is just a matter of time that energy and gas industry would have the same effect. To survive such an environment for utility companies, the most essential target strategy is exactly to realize infrastructure owned by the company and capture his own customers. It is true evidence that GIS will become most advantageous tool to achieve his strategy. Whether or not a company accurately realizes its own infrastructure is considered as not only a tool to survive this coming age of deregulation and competition but also a measurement to determine a company's rating.

This paper illustrates how gas companies of Japan and other Asian countries, introduce GIS, which plays an important role of strategy, and apply for their company strategy, giving examples of Tokyo Gas and Gas Malaysia.

## 2. The Utilization of GIS in Gas Company of Japan

### 2.1 History of GIS Development

There is no discussion to consider that the beginning of GIS development in Japanese gas business was from the gas accident of Tenroku, Osaka in 1969 and Itabashi, Tokyo in 1970. After these gas accidents, The Ministry of International Trade and Industry advised all gas companies to develop 1/500 scale map of gas pipeline. Tokyo Gas created gas pipeline maps, which had took ten years to complete since 1973, using a road map of local governments and Osaka Gas took aerial photos independently and developed gas pipeline maps. The effort to develop this gas pipeline maps was a major factor so that gas business could start GIS earlier than any other industries. Tokyo Gas has begun research and development of GIS since the end of 1970s, employed full-scale GIS in 1983; it was the first company amongst utility companies, and started data entry of 30,000 pipeline maps covered his own supply area.

Following Tokyo Gas, in the end of 1980, Hokkaido Gas, Seibu Gas, Osaka Gas, Touhou Gas, and Hiroshima Gas introduced GIS as well and began data of pipeline maps.

### 2.2 The Utilization condition of current GIS

Since Japanese gas companies confronted their necessity above mentioned, they have begun research and development and introduced GIS relatively earlier stage. Today more than 70 gas companies operate GIS system. Although the content of operations is a little different individually amongst companies, the figure 1 illustrates that GIS is applied for broad range of works as such as drawing plans, searching pipelines, maintaining facilities, preventing earthquake disaster, planning facility, and so forth.

GIS applications are particularly operated more important work associated with gas pipeline, such as drawing plans in plotter, searching pipelines, maintaining facility and calculating gas pressure and stream flow (network analysis).

In addition, 70% of gas companies introduced GIS use applications, which are integrated with Customer Information System (CIS), and it is clear that the form of integrated GIS combined with CIS is operated throughout all companies (Fig.1)

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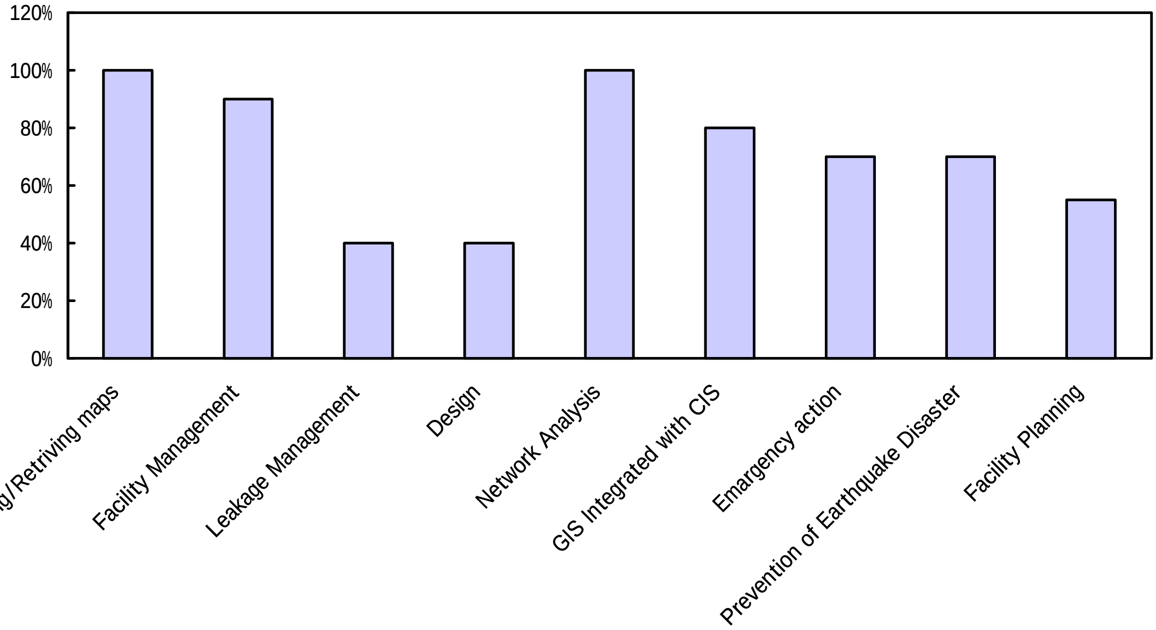


Figure 1. GIS Applications in Gas Companies

## 2.3 The utilization of GIS in Tokyo Gas

### 2.3.1 The Formation of GIS Development

The development process of GIS in Tokyo Gas has mainly three phases. Phase I is to achieve entry of 30,000 pipeline maps and the establishment of Automated Mapping and Facility mapping (from 1977 to 1987). Phase II is to integrate GIS with Customer's Information System; CIS (from 1988 to 1992). Phase III is to develop GIS in mobile and strategic fields (since 1993). Table-1 explains geospatial database and applications created during each phase.

Table 1. The Formation of GIS development at Tokyo Gas

| | | Subject | Geospatial Database | Specific Applications |
|---|---|---|---|---|
| Phase Ⅰ | Develop AM／FM | Conversion of Basic Maps and Development of Applications （from 1977 to 1987） | Build database for 30,000 maps of main/sub pipelines （main/sub pipelines, bulb, governor, topography, and place's names） | # Automated Mapping （AM）<br># Facility Mapping （FM） |
| Phase Ⅱ | Develop integrated GIS | Completion of GIS integrated CIS and integrated database （from 1988 to1992） | Build database for 22,000 maps of supply pipelines （supply pipelines, gas meters, and shapes and names of houses） | # Integrated Information Retrieval System<br># Pipeline Network Analysis System<br># Design System |
| Phase Ⅲ | Develop GIS | Mobile GIS and strategic GIS （Since 1993） | Enter strategic data （initial investment area and planning line, population projection data, and residential maps） | # Safety Planning System<br># Prevention and Rehabilitation for earthquake disaster<br># Emergency Safety Support System<br># Laser- Methane Locator System<br># Investment Planning Support System<br># Facility Investment Outcome Evaluation System |

### 2.3.2 Total System Structure

Figure 2 shows the system structure of GIS in Tokyo Gas. It is clearly seen in the figure that both database of GIS and CIS are setting a computer located at the department of Information Communication in Makuhari, Chiba prefecture and each server of GIS and CIS is controlled by Compaq ALPH 8400 and IBM system respectively.

The host server is connected with each office in 64,000bps high-speed digital network and approximately 300 terminals including Engineering Workstation(EWS), Personal Digital Assistant (PDA), and mobile terminals and emergency car. The host server maintains a geospatial database and 80 terminals located at offices keep database update online and real time for every report for repairing work.

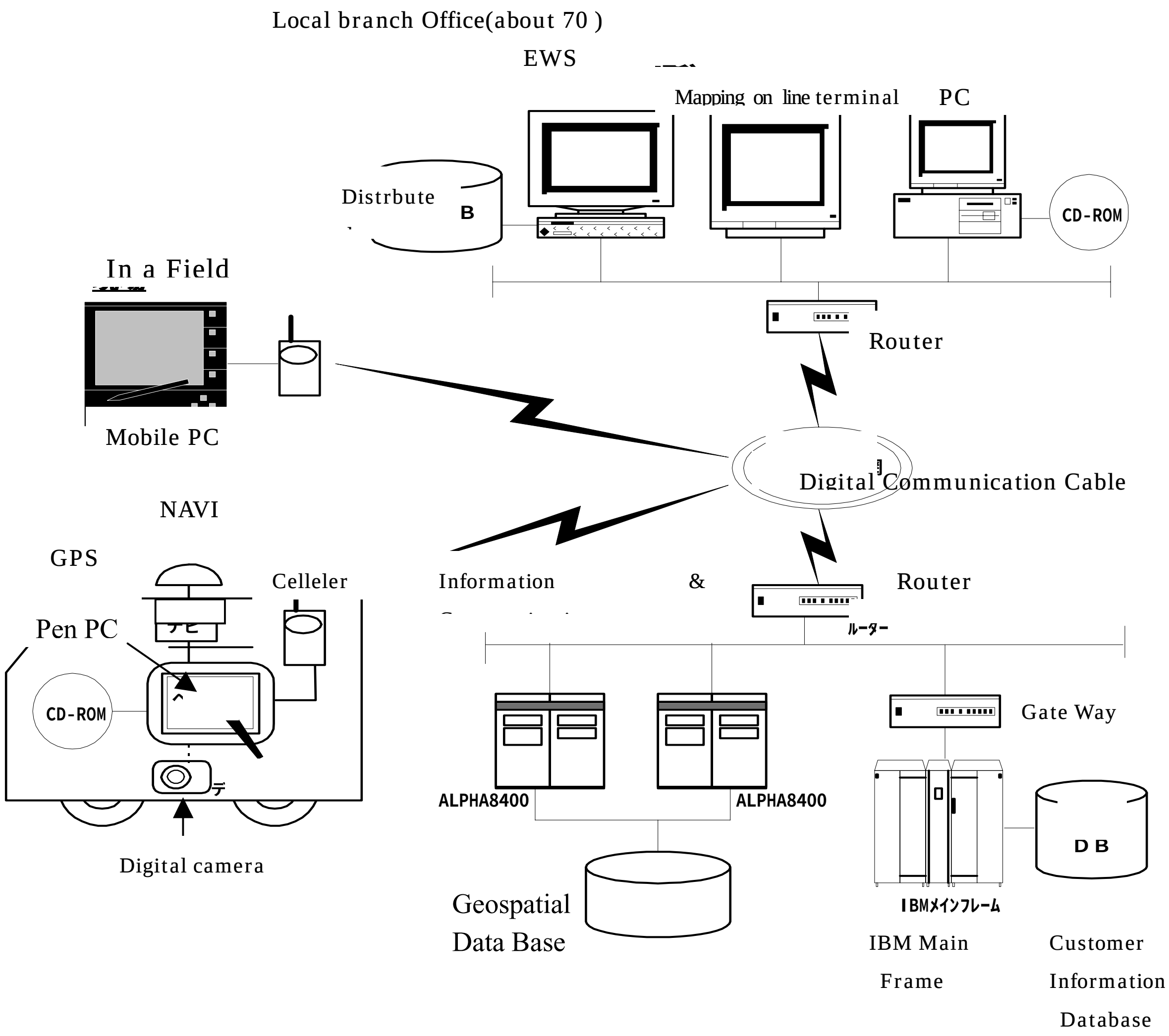


Figure 2. System Configuration

### 2.3.3 Mobile / WEB GIS Operation

The environments are called mobile and WEB GIS that everybody can simply and easily access to geospatial database by a personal computer at an office or PDA in a field. Tokyo Gas has run WEB GIS in about more than 5,000 OA terminals and PDA. Table 2 illustrates the utilization of WEB GIS in Tokyo Gas (Table 2).

Table 2. The Utilization of WEB / Mobile GIS at Tokyo Gas

| Category of Systems | Applications /Subjects | Description | Use of Divisions |
|---|---|---|---|
| WEB GIS | Pipeline Facility Information Retrieval System | Show a view of a plan specified by addresses and the code of pipeline map and an information table of specified pipeline. | Company-wide |
| | Locating Residential Maps | Show a view of residential map, which is specified by addresses and landmark. In addition, it makes it possible to search the name of the closest station based on address automatically. (it is used as various guide maps like setting a l ink to the company's bulletin board on intranet) | Company-wide |
| | Locating Gas Meter Guide Maps | Show a pass of the examination on the map when it is entered the examination code of the area assigned by responsible individual. (It includes information about individual vacation and relocation, education for a new staff, and etc.) | Division of Gas Meter Examination |
| | Business Information Registration/ Inquiry （has been developing） | Register locations of expecting new buildings on the map and show a distribution map of buildings adjacent to them. | Business Division |
| | Guide for local branch offices / service offices | A system for which a company can guide information of local branch offices and service offices and company's services to customers, when received a customer call. Search the closest local office to customer's address and inquire notes of direction. | Division of Customer Service |
| Mobile GIS | Emergency Work Support System | An emergency car, which is reserved and ready to go to the sites of accidents and constructions, are installed a terminal, which is able to enter data by pen, so that staffs make inquiries about information of gas pipeline in a field. It has a mobile function to take notes in a field and send reports to offices. | Department of Emergency Work Support |
| | Prevention and Rehabilitation for earthquake disaster (under consideration) | Show a map on a mobile terminal and enter description of damage on the map while the damages by a large-scale of earthquake is repaired for rehabilitation. In addition, it is possible to enter restoration information in the computer about gas pipeline damaged by earthquake in a field. | Division of Safety Support |
| | Methane Locator System | A car installed a terminal, which is associated with Methane Locator System and Car Location Management System, automatically record locations of gas leakage. | Division of Safety Support |
| | Regular Inspection Work Support System | Show a location of pipeline to extend or a gas meter of the building specified for a regular facility inspection. In addition, show a building on a map, which should examine and particularly need to inspect, and support work planning. | Division of Safety Support |
| | Business Support System | Inquire a map of gas pipeline in the field expected to build, conduct research about the condition of gas pipeline surrounding a target building for sale , and register information about a promising customer's building on the map. | Division of Business |

Following section introduces case studies of mobile and WEB GIS.

#### 2.3.3.1 Emergency Protection Work Support System: EAGLE24

Emergency Protection Work is to perform an emergency course of action when it is received urgent accidents like fire or gas leakage. In this context, Tokyo Gas has divided its own supply area into eight districts and established a special department called "Gas Light 24" for each district. Each Gas Light 24 is composed of an Emergency Call Center and several Sub Centers and emergency cars, which stand by each center and are ready to leave, can go to the front in emergency.

The Emergency Call Center maintains GIS for reserving emergency cars and supervising work condition and makes an order properly which emergency car should go to a place according to its location when an emergency call is received. Each emergency car can receive an order from Emergency Call Center, such as geographical information of the field and accident information, via a mobile terminal. Mobile terminal allows a field crew to inquire gas pipelines in a field, take notes or make reports of the condition of a field, and send them out to other centers (Figure 3).

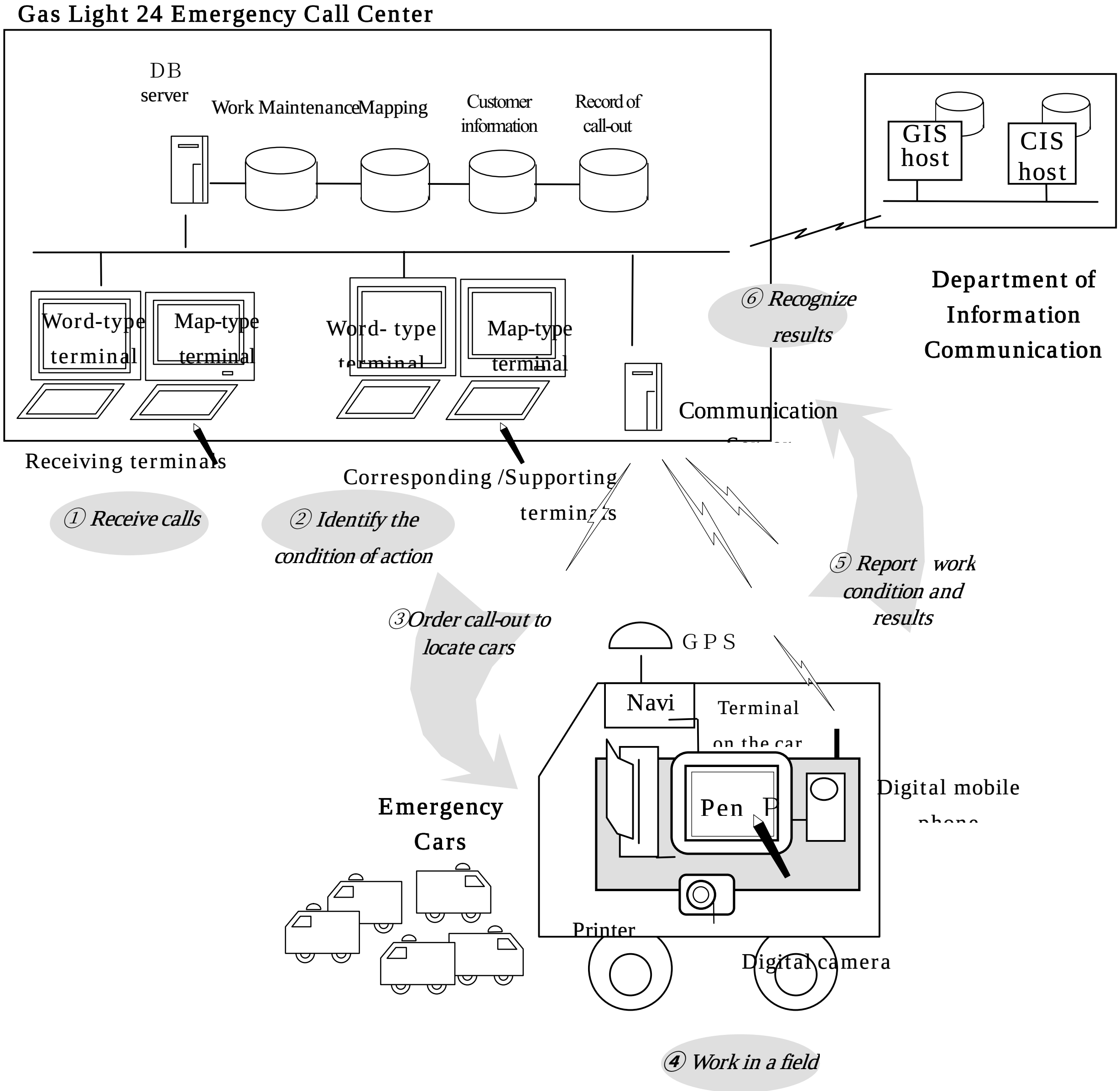


Figure 3. The System Structure Map of EAGLE

2.3.3.2 Business Support system

A system called Business Support System has been developing, which supports business operation with displaying status of gas pipes and customer information by means of PDA or mobile phones, when a staff sells services (solicit gas service, improvement and etc.) in a field. Figure 4 shows a pipeline map drawn by GIS (Figure 4).

Figure 4. The Utilization of WEB GIS on mobile phone

**3. Present status of utilization of GIS in Asian Gas Companies**

3.1 The Utilization of GIS at Gas Companies in other Asian countries

Introduction of GIS at gas companies in other Asian countries has begun since 1990s and GIS has been operated by a number of companies, such as Great Taipei Gas in Taiwan, Beijing Gas and Shanghai Gas in China, Seoul City Gas in Korea and others in Philippine, Singapore and Malaysia. Most of GIS applications are used the United States or European system like Intergraph, ESRI, and Smallworld, Inc. and the system architecture is applied for relatively new structure such as client/server system and LAN system.

3.2 GIS Operation of Gas Malaysia

Petronas Gas Bhd, Tokyo Gas, and Mitsui Company Limited. established Gas Malaysia in 1992 as a city gas business to employ abundant resource of Natural Gas in Malaysia. Gas Malaysia delivers gas to mainly Kuala Lumpur and industrial customers surrounding area, such as Shah Alam, Klang, and Seremban (Figure 5)

Although the number of customers are about 1,000, the sales of Natural Gas is approximately 600 millions cubic meters in volume per a year and the length of its pipeline is about 350 kilometer. Gas Malaysia introduced GIS in 1994 in order to maintain and plan its own Medium-High Pressure Network System and took five years to complete data entry of pipeline maps.

Currently, GIS is used for SCADA (Supervisory Control and Data Acquisition) as well as plotting and searching maps. Therefore, GIS performs pressure flow analysis (Network Analysis), one of geospatial analyses, and it is efficiently used for a primarily maintenance for Medium-High Pressure Network System and a future planning. In the future, it is expected that gas companies will implement mobile/WEB GIS to fulfill both works efficiently in fields and offices.
(Figure 6)

**4. Conclusion**

Although GIS initially introduced to manage their own infrastructure precisely, GIS has become an integrated type of application linked with a different system like CIS and play a very important role to backup the total management of a gas business. An important feature of GIS is that not only initial investment cost is huge for the entry of maps and plans into the computer but also the establishment of GIS brings a great advantage in the end. GIS makes it possible for companies to reduce cost in many work processes such as simplifying drawing plans and restructuring work outside of an office by mobile and WEB GIS.

Thus, it will be essential that gas companies in the world as well as Asia will introduce GIS system in the twenty-first century. Considered this situation, it is expected that GIS will be standardized by ISO/TC211 in 2002 to be able to manage system and data of GIS more easily. After standardized GIS, it is anticipated that more gas companies will operate GIS effectively.


Figure5. Supply Area of Gas Malaysia

Figure 6. The Result of Network Analysis