5 INFRASTRUCTURE INFORMATION MANAGEMENT SYSTEM

5.1 Concept of IIMS

5.1.1 Necessity and Objectives

It was found that a large number of concerned agencies are individually trying to cope with various pressing urban issues as described in Chapter 2 and Chapter 3. Each establishes its own sets of data which are in many cases not interchangeable. Some have developed their own GIS for their own purposes. Existing GIS systems in Dakar also suffer from the fact that their use are mostly limited to the very basic features. There is a great necessity in Dakar to establish a common GIS database and upgrade the level of GIS usage.

The objective of the IIMS is to support the policy formulation for desirable urban development in Dakar by establishing a geographic and social database and analytical toolkit that are to be jointly used by the agencies concerned. The IIMS takes advantage of the advanced GIS technology given the prevailing conditions in Dakar.

Figure 5.1.1 illustrates the process the Study Team used to formulate the conceptualization of the initial IIMS. It highlights three main paths of investigation toward a system. Understanding urban development in Dakar was the first important stage, as set out in Chapter 2. From site and interview surveys, pressing issues were identified which require an assessment of applicability to IIMS for their analysis. The institutional framework was then delineated and the roles of agencies clarified. In parallel with this, existing GIS and available data was surveyed, as set out in Chapter 3. The third path toward the IIMS concept is the supplementing of available map information. This was described in Chapter 4 and mapping surveys were carried out to ensure an adequate geographic data structure.

Completion of these three main tasks facilitates an assessment of requirements for an IIMS for Dakar and the conceptualization of the sub-systems to assist various aspects of urban planning and management.

5.1.2 Requirements for the IIMS

The study of urban issues and institutional framework in Dakar has led to the following requirements for the IIMS:

1) At least ten pressing issues can be addressed by the system without too much additional effort in data preparation.

2) The system should include features that can be used in the daily operation of the two departments.

3) For the purpose of urban planning in which inter-agency coordination is a critical matter, the necessary map scale is 1:5,000.

The study of existing data and GIS systems in DTGC, DUA, and other agencies has led to the following requirements:

4) The system should work at various levels of GIS application so that the users can learn the potential of the system.

5) The system should take advantage of existing data in its various forms to the maximum extent possible even if accuracy is compromised in certain cases, to compensate for the general dearth of good data sets.

6) The system could be operated by DTGC and DUA without significant changes in organization within both departments.

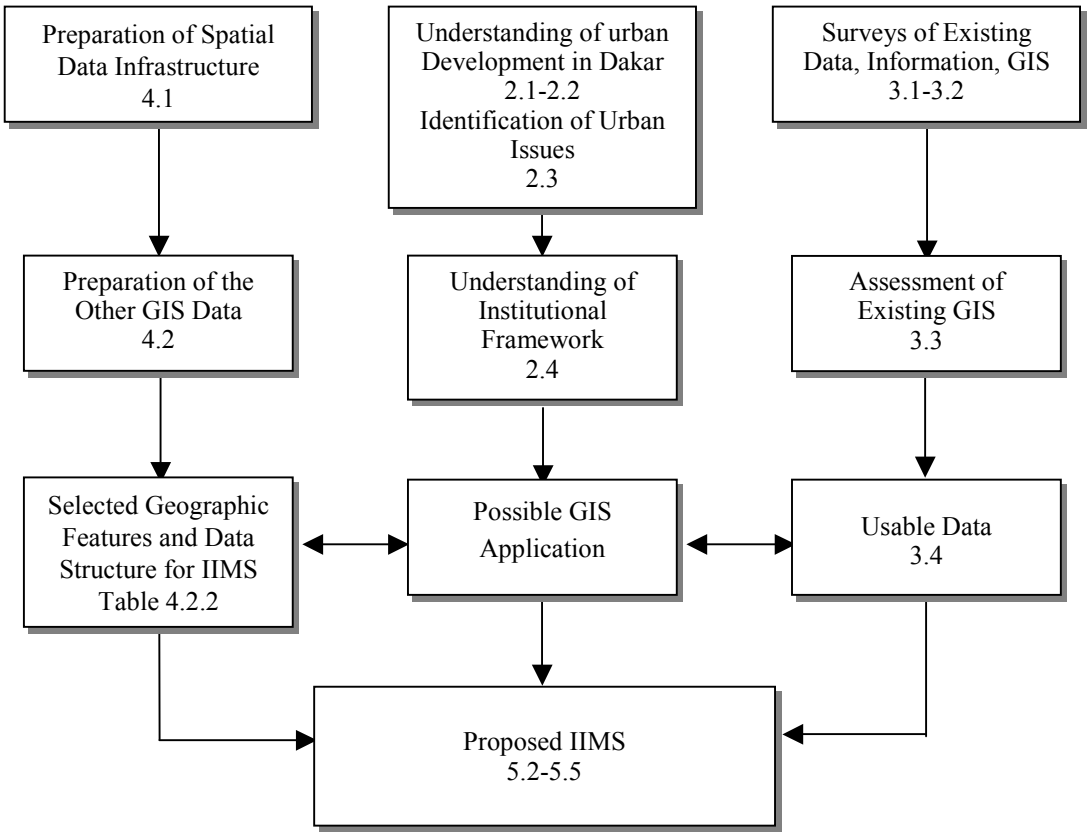
The work of preparing databases for the possible inclusion in the IIMS has led to the following conclusions:

7) Only practical common base map to be used is one with a scale of 1:5,000 considering what is available and what can be achieved within the time and budget allowed in this Study.

8) The system should contain as much available data as possible including that with accuracy less than 1:5,000, which can still be useful as reference data.

9) The system could easily be expanded in the future by both agencies.

Figure 5.1.1 Formation of IIMS Concept



Note: Numbers in boxes correspond to sections or tables within this report.

Source: JICA Study Team

The IIMS includes sub-systems that are designed for application to specific urban planning and management objectives. Chapter 2 identified both urban problems and the framework of concerned agencies, from which sub-systems are conceived. The following sections describe such systems as recommended for Dakar. It is hoped that the breadth of sub-systems presented here would facilitate the expansion of the IIMS in other applications.

5.1.3 Selected Sub-Systems and Their Roles

The following four sub-systems have been formulated for the initial IIMS satisfying the above requirements:

1 Urban Sector Information Reference Sub-System;
2 Urban Development Control Sub-System;
3 Urban Planning Support Sub-System; and
4 Residential Site Evaluation Sub-System.

They are arranged in order of complexity in operation, i.e. a higher number sub-system utilizes more GIS functions and requires more analytical work than the lower number sub-systems. They have been chosen to demonstrate the use of IIMS at various levels of sophistication and associated operational difficulty. It is intended that working at different levels of sophistication in GIS application would facilitate faster learning among users. Care was also taken in the choice so that these sub-systems address issues most pressing to potential users in Dakar thereby encouraging immediate and frequent application.

The first sub-system primarily recalls what has been stored in the IIMS and displays it either item by item or by overlaying one upon another to examine geographical inter-relationships among data items. The primary objective of this sub-system is understanding the situation represented by various thematic maps.

In the second sub-system, print output production and database generation functions are utilized in addition to the reference function as in the first sub-system. The primary objective of this sub-system is to assist daily administrative work that requires reference to thematic maps and databases.

The third sub-system takes advantage of buffering function and other computing functions of GIS. It requires analytical work planning by users. The primary objective of this sub-system is to assist in the evaluation of locational alternatives in planning.

In the fourth sub-system the level of operational complexity is the highest of the four. Not only are many GIS functions needed but also its use requires participation of stakeholders in the subject community. The primary objective of this sub-system is formalization of the evaluation process involving various stakeholders.

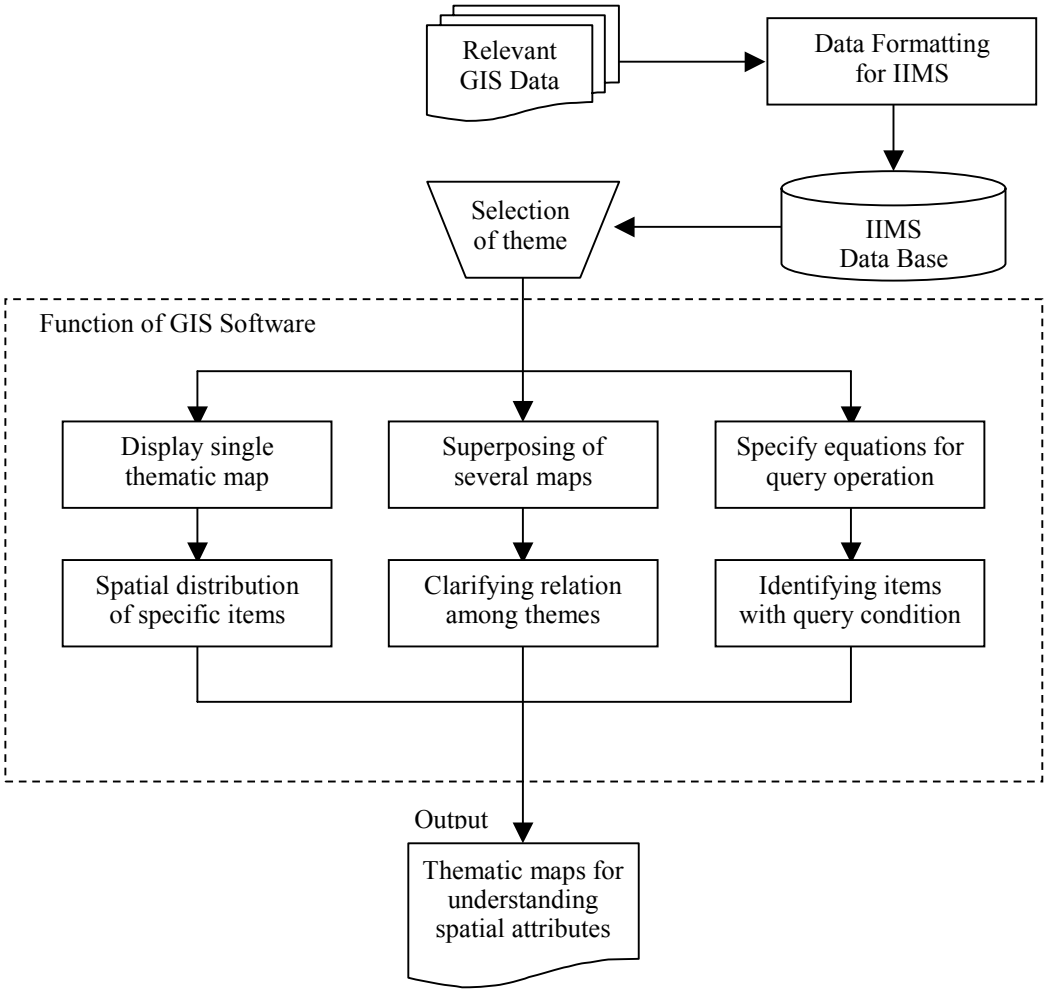
These sub-systems are detailed in sections 5.2 through 5.5.

5.2 Urban Sector Information Reference Sub-System

5.2.1 Role of the Sub-System

The Sector Information Reference Sub-System achieves its objectives by identifying and locating government and public facilities, services, and infrastructure; identifying existing land uses and zoning regulations; providing demographic data such as population distribution and density, and analyzing relationships among them.

Figure 5.2.1 System Design of Sector Information Reference Sub-System



Source: JICA Study Team

A large number of urban components of the Dakar Metropolitan Area have been compiled by their geographic features and associated attributes in the form of data files in IIMS as listed in Table 4.2.2. All of these data sets can be thought of as a series of "thematic maps" or "layers". The schools layer, for example, would show

the locations of all the schools in the Study Area. These layers can be viewed and manipulated individually, but they are most powerful when combined and overlaid with other layers so that the geographic relationship between two or more different layers can be clearly seen.

All of the thematic maps listed in Table 4.2.2 are candidates for being used in this Sub-System. Table 5.2.1 shows data sets or layers available in the initial IIMS.

Table 5.2.1 Available Data in the Initial Sector Information Reference Sub-System

Thematic Map	Name	Thematic Map	Name
1.	Built up area	9.	Public Facilities
101	Rural Settlement	901	Public agency
102	Settlement Regular	902	International Organization
103	Settlement Irregular	903	Embassy
104	Planned Settlement (middle)	904	Education
105	Planned Settlement (high)	905	Health Facility
106	Commerce & Residence	906	Security
107	Plant	907	Sports
108	Warehouse	908	Culture
2.	Administration	909	Tourism
201	Commune d'Arrondissement	910	Information
202	Arrondissement	911	Religion
203	Ville	912	Market
204	Department	10.	Orthophoto
205	Qartier	12.	Present land use map 1999
211	Zone	13.	Urban Activity
3.	Basic infrastructure	14.	Type of settlement
301	High voltage line	15.	Spatial Structure
302	Middle voltage line	16.	Past project and feature project
303	Low voltage line	17.	Potential of Site
303	Equipment	18.	Urban Equipment
304	Water pipe	19.	Present land use map 1987
305	Equipment	20.	Land development framework for 2021 (OSSATURE du SRAT POUR 2021)
306	Community tap	21.	Spatial development history
307	Main Sewer pipe	22.	Occupation du SOL
308	Sub-Sewer pipe	23.	Flight control area
309	Sewer pipe	24.	Zoning map for building control
310	Equipment	25.	Natural
311	Drain	2501	Slope map
312	Drain pipe	2502	Relief map
4.	Road/Rail way	2503	Depression
401	National Road	26.	Land form map
402	Region Road	27.	Agriculture potential map
403	Department Road	28.	Soil map
404	Road in city	29.	Soil degradation map
405	Farm road	30.	Water resource map
406	Railway	31.	Natural Disaster

Thematic Map	Name	Thematic Map	Name
407	Railway Station	32.	Conservation
408	Bus-Route	33.	Land price map
409	Bus Terminal	34.	Tourism
410	Garbage Collection Route	35.	Statistic Data
411	Garbage container	3501	Population data in 1996
5.	Vegetation	3502	Population data in 1996
501	Forestry	36.	PDU of Dakar 2001 in 1982(DUA-MUH)
502	Swamp area	3601	Population data (Distribution of population in 1980, household survey in August 1980)
503	Grassland	3602	Employment (population by employment, number of employee)
504	Farmland	3603	Level of comfort utilities
6.	Water surface	3604	Construction methods
601	Sea	3605	Density of housing per ha and per habitat
602	Lake	3606	Enrolment ration in schools
603	River	3607	Public and private primary schools
604	River	3608	Public and private secondary schools
7.	Topography	3609	Primary health centers and clinics
701	DTM (10m)	3610	Security, fir station, courthouse
8.	Control Points	3611	Movie theater, sports facilities
801	Triangulation Point	3612	Tourism facilities
802	Bench Mark	3613	Information facilities
		37.	Land price in the official gazette in December 1989

5.2.2 Application to Urban *Carte*

Various thematic maps and their attributes in the Sector Information Reference Sub-System can be directly applied to the analytic work listed in the Urban Carte shown in Chapter 2. The following are some examples. Many of the analyses presented in the Carte forms, however, cannot be done as presented since the required data is not available in Dakar at present. There will be a waiting period until such data becomes available in the future. However, utilizing the IIMS at its initial contents, a great deal can still be done as shown in the following examples utilizing this Sector Information Reference Sub-System. More can be done utilizing the Urban Planning Support Sub-System shown in Section 5.4.

Example 1:	Public Transportation (included in Carte No.1)
GIS data set (#; GIS data code)	
Spatial data: (Attributes)	#408:Bus route #409:Bus Terminals #401through 404:Road network
Supplemental data: (Physical)	#407: Railway station #901 through 912: Public facilities #1200 through 2200:Land Use
Supplemental data: (Socio-Economic)	#3501:Population distribution
Operation and effects:	

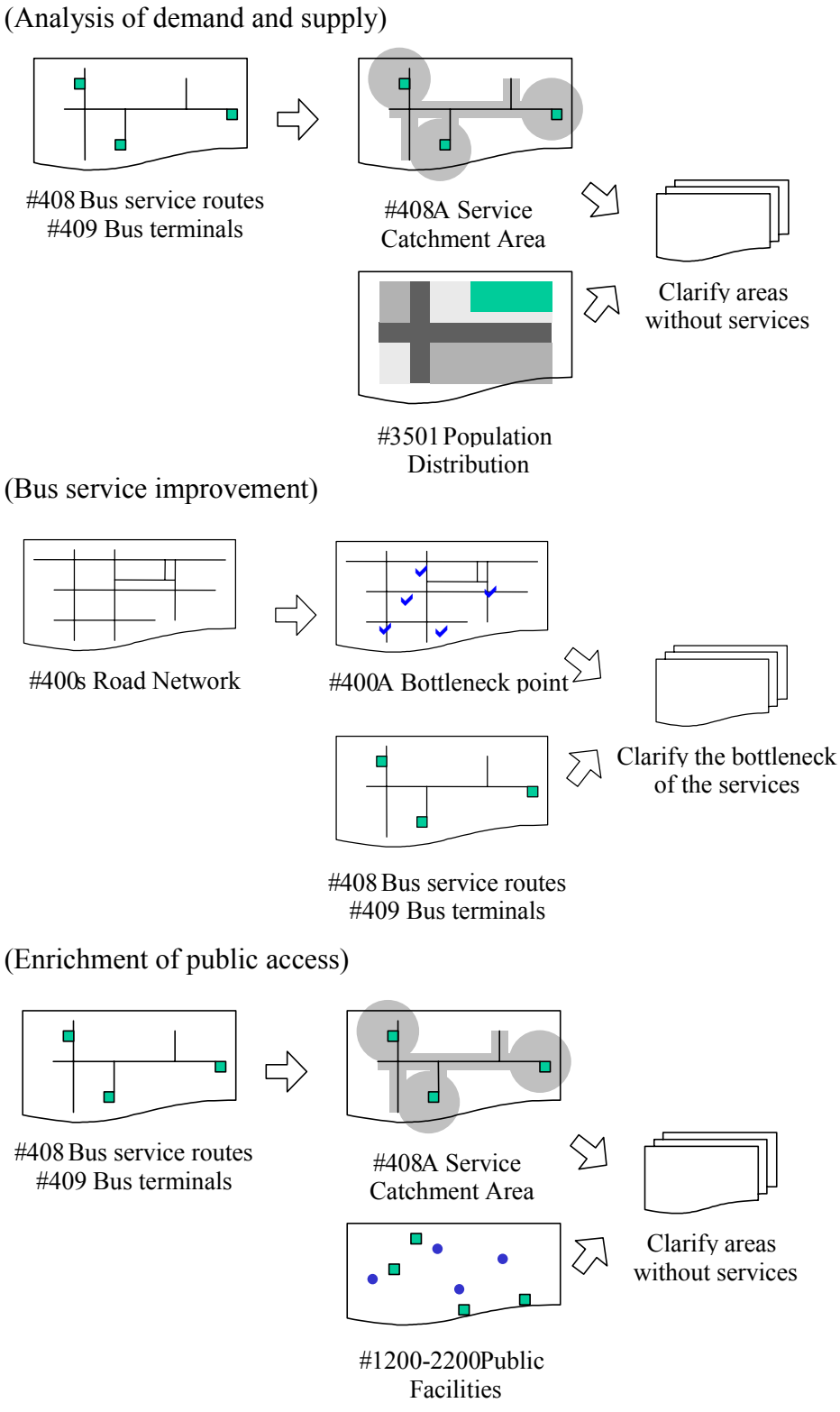
(Analysis of demand and supply)
1. Display the bus service route (#408) and terminals (#409);
2. Generate an adequate buffer layer (#408A) to clarify the service catchment area of a bus way;
3. Overlay the buffer layer (#408A) with population distribution (#3501);
4. Clarify areas without bus services.

(Bus service improvement)
1. Investigate points of traffic jam occurring and road pavement deterioration;
2. Generate new layers (#400A) to identify the traffic jam and pavement deterioration over the road network (#401 through 404);
3. Overlay the new layers (#400A) with bus route (#408);
4. Clarify the bottlenecks of the bus operation.

(Enrichment of public access)
1. Display the bus service route (#408) and terminals (#409);
2. Similarly, generate an adequate buffer layer (#408A) to clarify the service catchment area of a bus way (or bus stops);
3. Overlay the buffer layer (#408A) with public facilities (#901 through 912) and railway station (#407);
4. Clarify facilities without bus services.

(Options)
1. Estimate of trip generated and concentrated trips using the existing land use (#1200 through #2200);
2. OD (origin-destination) flows estimated by traffic models can be incorporated into the GIS as distributed traffic connecting various OD pairs providing graphic illustration of the flows of people throughout the city. This in turn can be used to identify the needs for enchanced transit connecting these points.

Figure 5.2.2 Structure of GIS Application (Public Transportation)



Source: JICA Study Team

Example 2:	Flooding (Carte No.2)
GIS data set:	
Spatial data: (Attributes)	# 701:DTM (height above sea level, slope of land) #3100: Location of inundation
Supplemental data: (Physical)	#311: Drainage #101 through #103: Settlement (Existing) #104 and #105: Settlement (Planned) #106: Commerce and residence #401 through 404: Road network
Supplemental data: (Socio-Economic)	#3501: Population data (option) Water born diseases occurrence
Operation and effects:	

Due to housing developments in areas without adequate drainage, or sprawling into the niaye (depression) where the water table is high, flooding or inundation during and after the rainy season is a serious urban problem in the Dakar metropolitan area.
DUA and respective municipalities are responsible for improving the living environment. However, due to incomplete information regarding causes and countermeasures, they are not able to take effective measures against the flooding. They may be able to better formulate a plan to counter the negative effects by using the GIS as stated below.

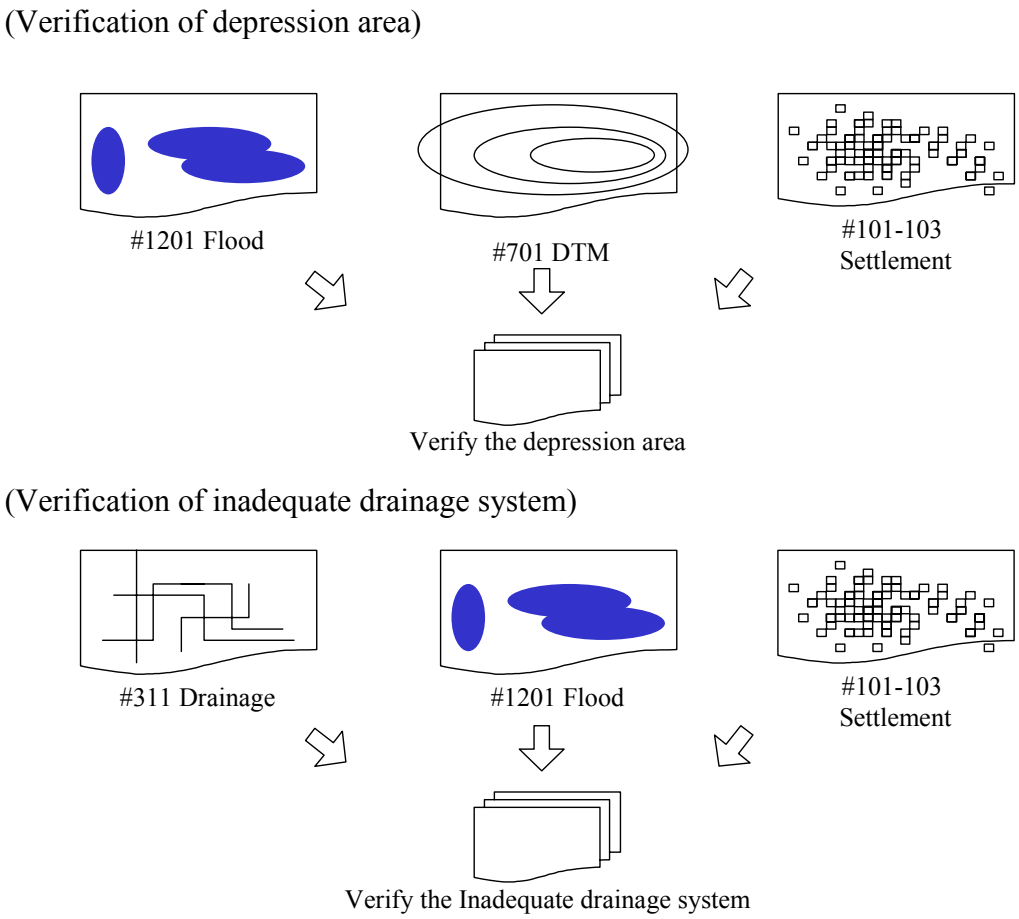
(Identification of flooding area)
1. See thematic map (#1201 Flood), identify the subject areas and see attributes of each area;

(Verification of depression area)
1. Niaye (depression) areas can be identified by examining existing settlement area (#101 through 103) and DTMs, and the identified areas can be enclosed to prevent future development;
2. Future land use plans or district plans can take potential flooding into account.

(Verification of inadequate drainage system)
1. Overlay the drainage network map (#311) and flood-prone areas (#1200) with settlement data (#101 through #103) to identify residential areas prone to flooding;
2. Where the drainage network (#311) covers areas affected by flood, the network may need maintenance or may need to be enhanced;
3. Areas subject to flooding that have no drainage network may be candidates for the construction of such a network;
4. A drainage priorities plan can be formulated by referring to data in the GIS such as the size of the affected area, penetration ratios based on existing land use, and elevation data drawn from DTMs.

(Option)
1. Overlaying the flood-prone areas and road network (#401 through #404) can clarify the weak area of existing road network;
2. Investigate the water born disease occurrence ratio and formulate new layer. Overlaying with the flood-prone areas, it will be able to analysis the relationship the flood and deseases.

Figure 5.2.3 Structure of GIS Application (Flooding)



Source: JICA Study Team

Example 3:	Water Supply (Carte No.3)
GIS data set:	
Spatial data: (Attributes)	#304: Water supply pipe #305: Water supply equipments #306: Community tap
Supplemental data: (Physical)	#101 through #103: Settlement (Existing) #104 and #105: Settlement (Planned) #106: Commerce and residence
Supplemental data: (Socio-Economic)	#3501: Population data (option) Water born diseases occurrence
Operation and effects:	

The easy access to safe water is an important element of human life. The following are some examples of how GIS can be used to evaluate and plan improvements to existing network.

(Extension of water supply network)

1. Display the map of water supply pipes (#304) and generate buffers with adequate distance (#304A).
2. Overlay settlement data (#102 through #106) with the buffer (#304A);
3. Identify areas where service is lacking.

(Construction of community fountains)

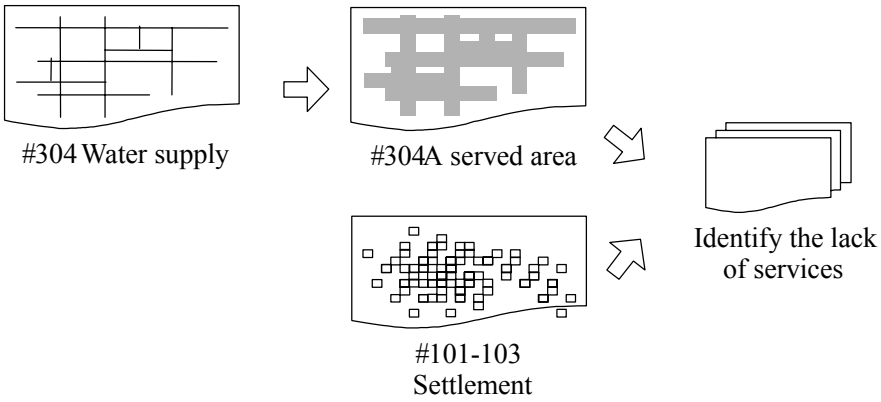
1. Data for existing community fountains are available for Medina of Pikine and Refisque shown in map #304. Other areas with similar characteristics as found in map #102 and #103 can be identified;
2. Generate buffers around community taps (#306B) that represent acceptable distance to walk for water;
3. Examine areas outside these buffers to identify potential sites for new community taps;
4. Create buffers around proposed new fountain to identify areas that would gain access to new water;
5. Using population data (#3501), calculate the number of residents with access to new fountains;
6. Prioritize construction of new community fountains by the number of additional residents served.

(Option; Analysis and prevention of water born disease)

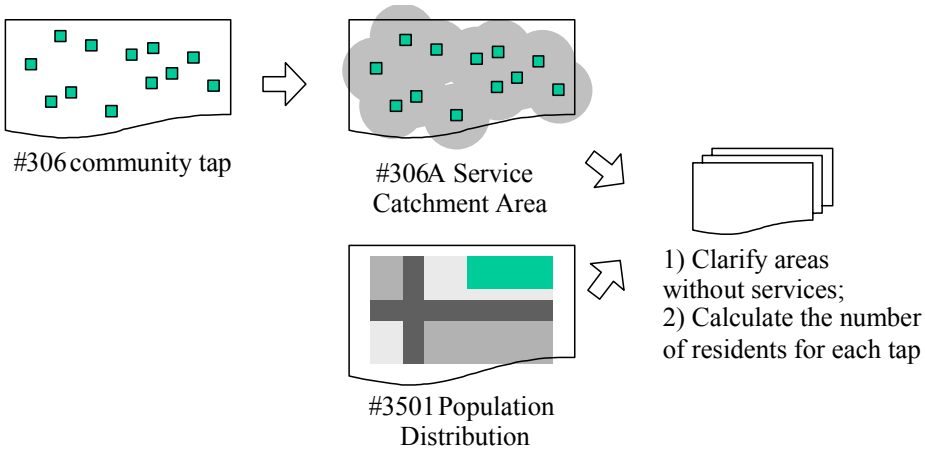
1. Identify communities with high incidence of water born disease;
2. Overlay water supply network (#304) and locations of community fountains(#305 and #306);
3. Determine if community has adequate access to clean water.

Figure 5.2.4 Structure of GIS Application (Water Supply)

(Extension of water supply network)

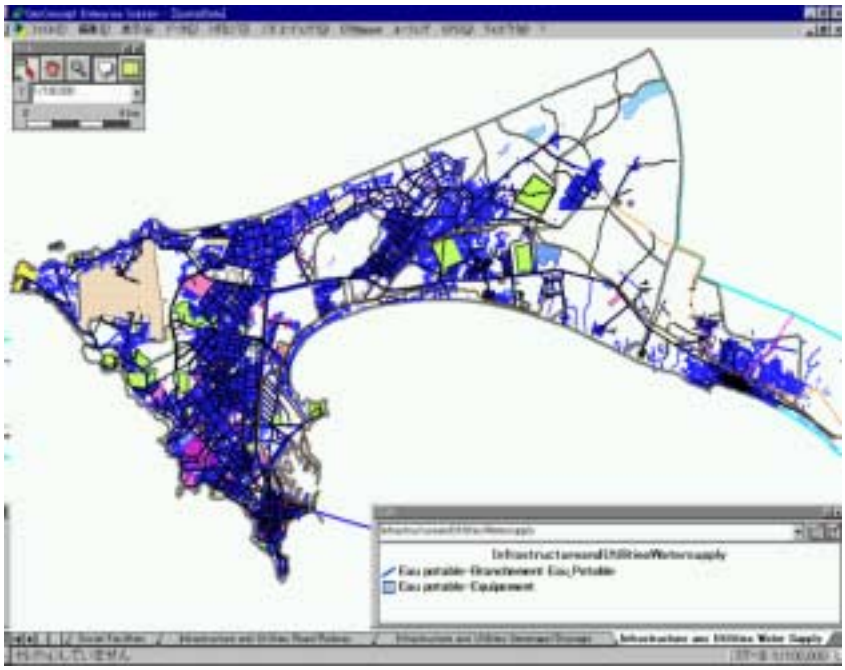


(Construction of community fountains)

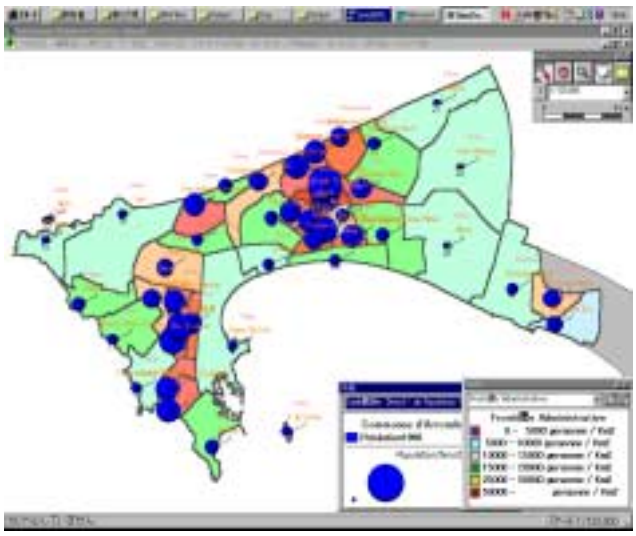


Source: JICA Study Team

Figure 5.2.5 Output Example of Sector Information Reference Sub-System



Utilities-Water Supply



Population and its density

Example 4:	Waste Water and Sewer Treatment (Carte No.4)
GIS data set:	
Spatial data: (Attributes)	#307 through 309: Sewerage network (option) #310: Sewerage network equipment
Supplemental data: (Physical)	#101 through #103: Settlement (Existing) #104 and #105: Settlement (Planned) #106: Commerce and residence #3100: Location of inundation
Supplemental data: (Socio-Economic)	#3501: Population distribution (option) Water born diseases occurrence
Operation and effects:	

Due to the shortage of sewerage network, most of houses use septic tanks to keep and treat waste water. When flooding occurs, these tanks overflow, creating unsanitary conditions. ONAS, the responsible agency for provision and management of sewerage network, may be able to plan a future sewerage construction project by using the GIS as follows:

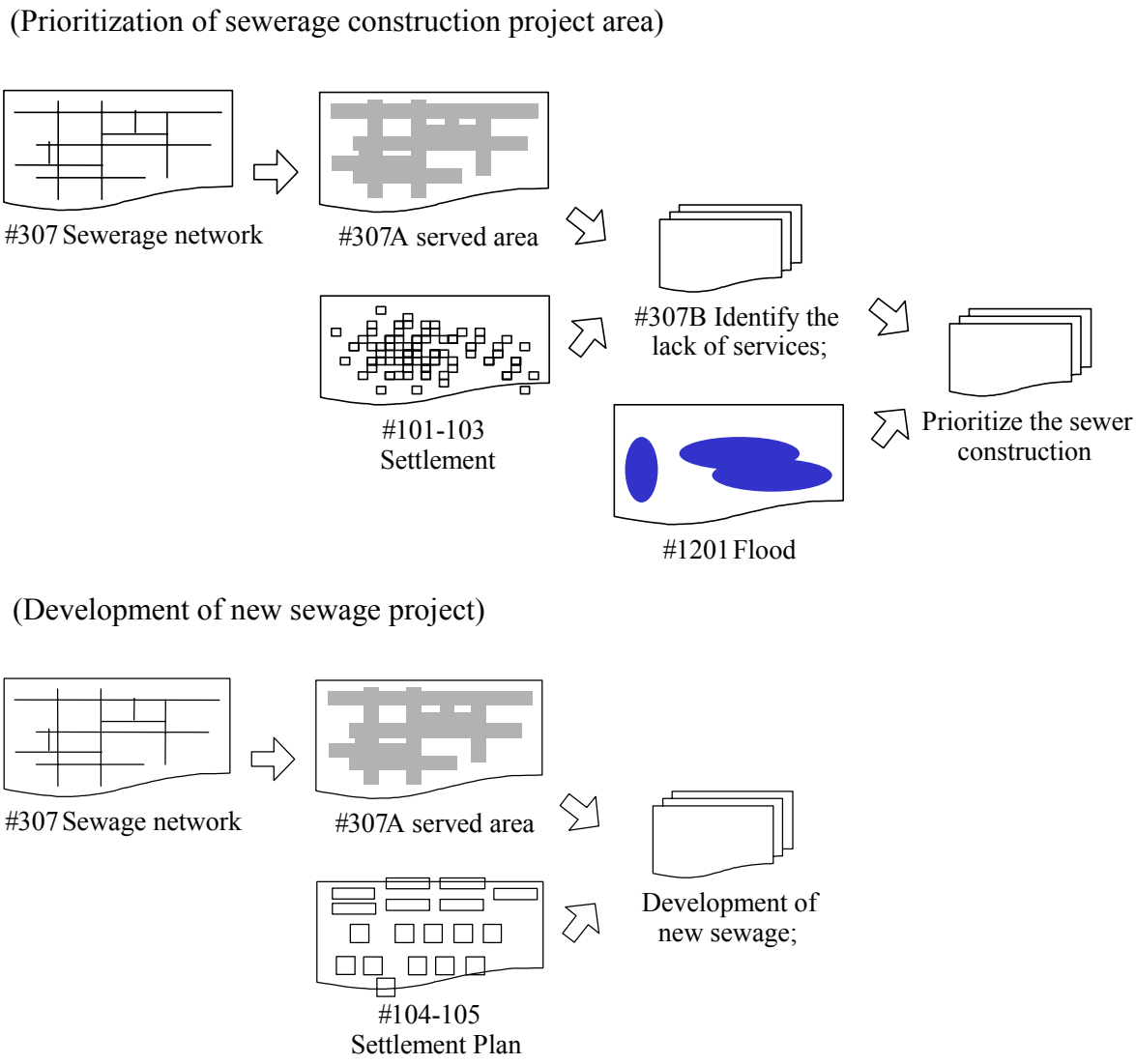
(Prioritization of sewerage construction project area)

1. Generate a buffer (#307A) with the existing sewerage network (#307 through #309)
2. Overlay the buffer layer (#307A) with existing settlement data (#101through #103);
3. Determine areas that are under-served;
4. Overlay under-served areas with flooded areas (#3100) or areas with high incidence of disease;
5. Select priority areas for new sewer construction projects.

(Development of new sewerage project)

1. See overlaid sewerage maps (#307 through 309) and settlement map (#101 through #103, or #106).
2. Update settlement data (#104 and #105) and see how sewerage system should grow.

Figure 5.2.6 Structure of GIS Application (Waste Water and Sewer Treatment)



Source: JICA Study Team

Example 5:	Garbage Collection (Carte No.5)
GIS data set:	
Spatial data: (Attributes)	#410: Garbage collection route #411: Garbage container
Supplemental data: (Physical)	#101 through #103: Settlement (Existing) #104 and #105: Settlement (Planned) #106: Commerce and residence
Supplemental data: (Socio-Economic)	#3501: Population distribution
Operation and effects:	

Garbage collection and disposal are serious problem in the Dakar metropolitan area. Due to the poor management of garbage collection, including inadequate distribution of containers, poor designation of garbage collection routes, insufficient frequency of collection, etc., there is always much garbage in and around garbage containers. Municipalities are the responsible organization for the solid waste management in the Dakar metropolitan area. However, as the collection and dumping are operated by the private concession, information and data are scattered. Municipalities may be able to manage better by using the GIS as stated below:

(Estimation of garbage volume)

1. For each garbage container (#411), generate a buffer (#411A) with adequate service catchment radius;
2. Overlay the buffer (#411A) with population data (#3501);
3. Calculate the served-population for each garbage container;
4. Estimate garbage generation for each garbage container.

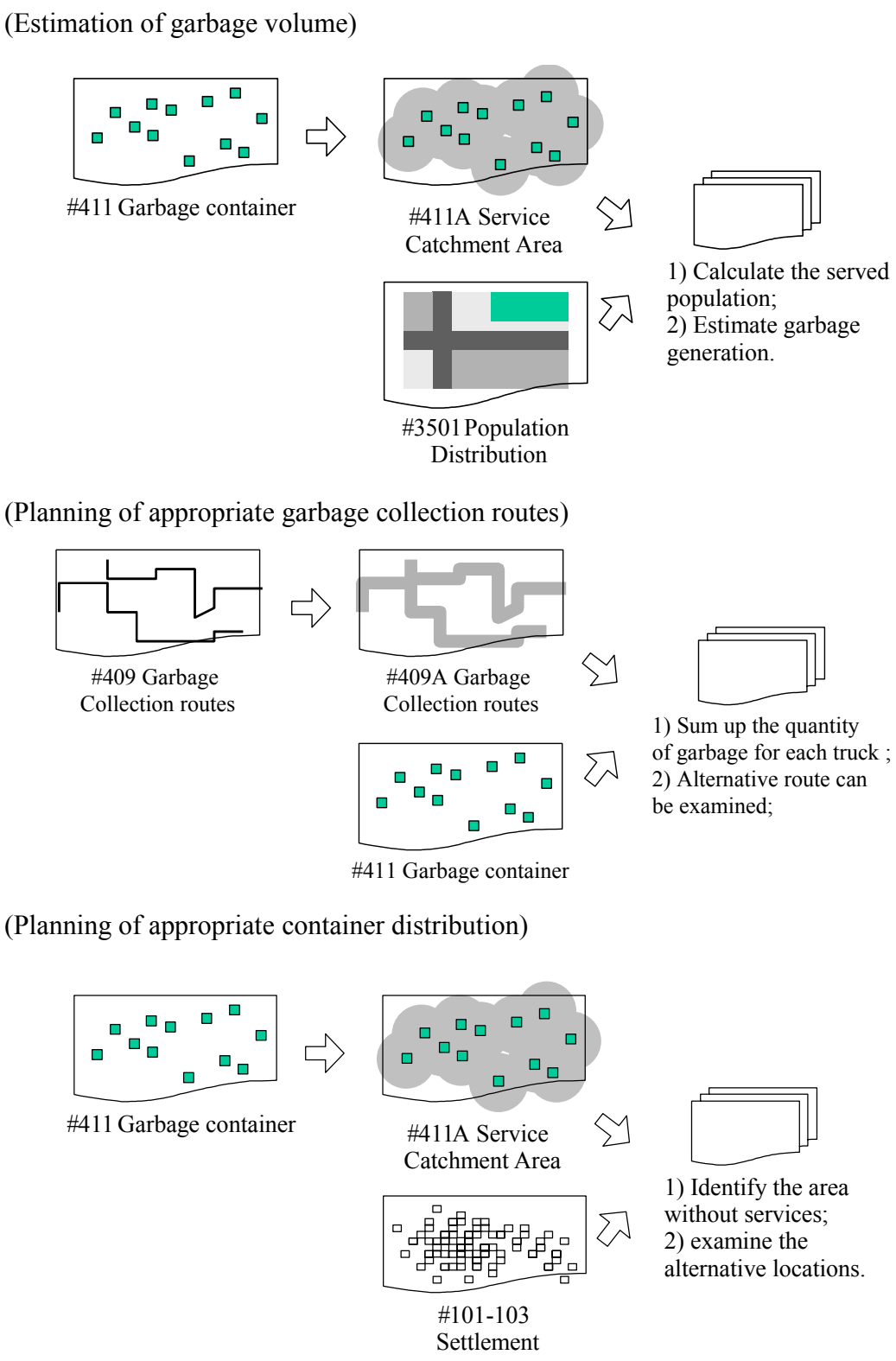
(Planning of appropriate garbage collection routes)

1. Generate a buffer with garbage collection routes (#409) with an adequate width;
2. Overlay the buffer with garbage container (#411) and calculate the total quantity of garbage for each route;
3. Alternative routes can be examined. In this examination, the capacity trucks and personnel limits should be taken into account.

(Planning of appropriate container distribution)

1. Similarly, by drawing buffers around the garbage containers (#410), overlaying that with housing settlement data (#101 through #103);
2. If the existing garbage containers do not provide adequate coverage, alternative locations may be proposed.

Figure 5.2.7 Structure of GIS Application (Garbage Collection)



Source: JICA Study Team

Example 6:	Accessibility to Houses (Carte No.6)
GIS data set:	
Spatial data: (Attributes)	#401through 404:Road network (especially, #404: Road in city)
Supplemental data: (Physical)	#101 through #103: Settlement (Existing) #104 and #105: Settlement (Planned) #106: Commerce and residence
Supplemental data: (Socio-Economic)	#3501: Population distribution
Operation and effects:	

Houses in some of the spontaneous settlements are difficult to reach. Roads in such areas are not wide enough and are not laid out in a systematic network. This situation causes the problems for vehicle based services such as ambulances, garbage trucks, and public transportation. Narrow roads often mean high housing density, which is a negative factor in fire prevention and privacy protection. The possible measures for providing accessibility to houses are explained below.

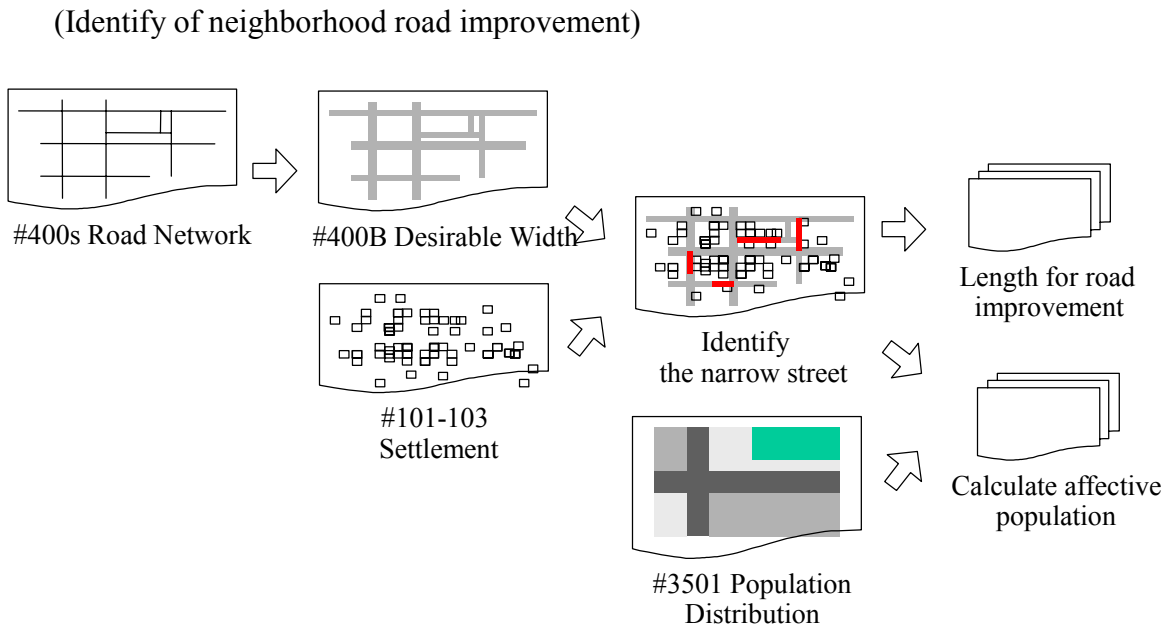
(Identify of neighborhood road improvement)

1. Display #404 Road network in city;
2. To show the desirable width of the road, generate a buffer along the road with a desirable widths from the road center;
3. Overlay the buffer with settlement data (#102 through #106);
4. To identify the narrow street, display the cumulated area.

(Improvement plan)

1. Calculate the length of road improvement with the above examination and estimate the cost for execution;
2. For prioritization, it needs to be determined by economical criteria;
3. For example, generate a buffer from the identified narrow street. overlaying population distribution (#3501) with the buffered area; it is possible to estimate the effected population. Comparing the affected population for each buffer, priority can be determined.

Figure 5.2.8 Structure of GIS Application (Accessibility to Houses)



Source: JICA Study Team

Example 7:	Housing Density and Open Spaces (Carte No.7)
GIS data set:	
Spatial data: (Attributes)	#101 through #103: Settlement (Existing) #104 and #105: Settlement (Planned)
Supplemental data: (Physical)	#1000: Orthophoto
Supplemental data: (Socio-Economic)	#3501: Population distribution #3300: Land price map
Operation and effects:	

High housing density with little open space can be observed in many settlements in Dakar. This causes the risk of fire disaster, pollution of well water, inaccessibility to public facilities, insufficient privacy, and smell and noise pollution. Each municipality in the Dakar metropolitan area is responsible for improving living conditions. Each municipality may be able to use the GIS to formulate plans to reduce these issues as follows:

(Identify the target zone)

1. Display the Orthophoto (#1000) overlaid with settlement plans (#104 and #105);
2. Identify subject areas (EG7).

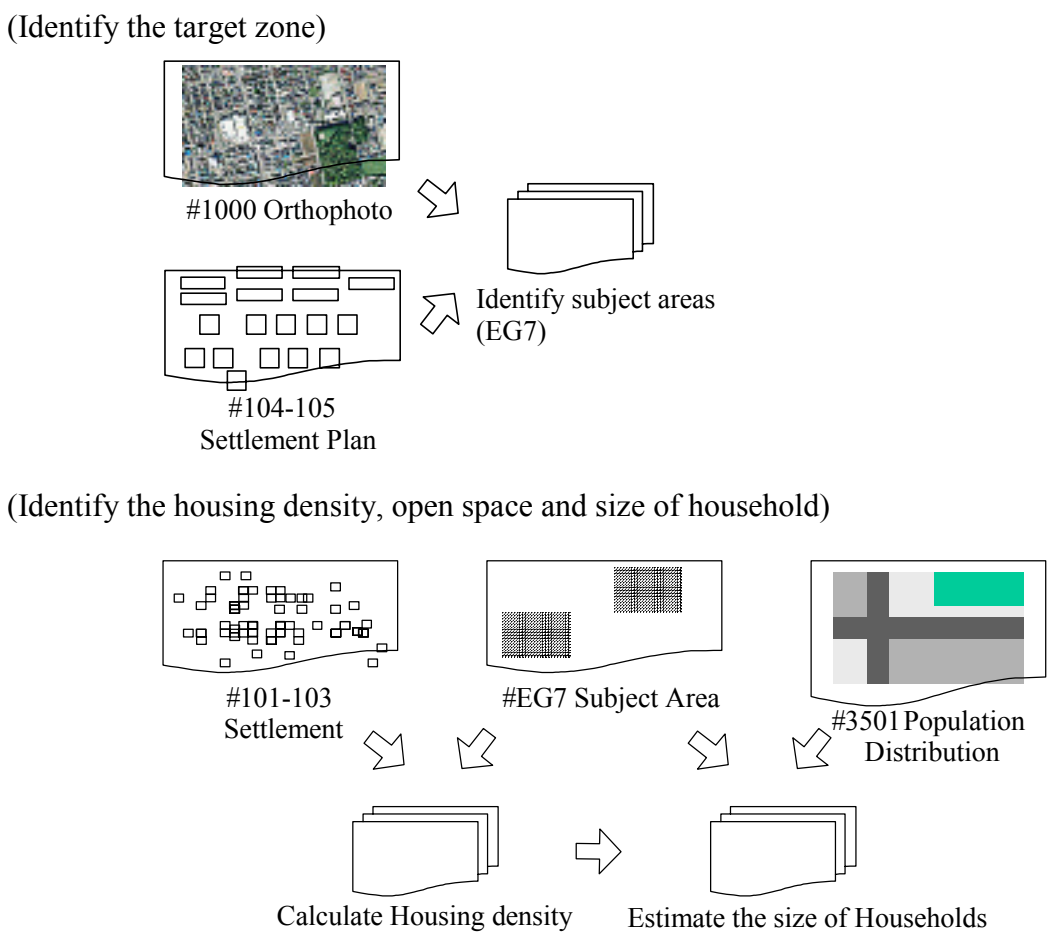
(Identify the housing density, open space and size of household)

1. Zones for analysis should be determined. Make a new layer of the zones (#EG7) beforehand;
2. Overlay the zone layer with settlement data (#101 through #103).
3. By counting polygons in a zone, it is able to calculate the residents in the zone. Housing density can be identified.
4. By measuring the surface of the housing, the size of open-space can be estimated.
5. Also using the Population distribution data (#3501), the size of household can be estimated.

(Assistance for implementation plan)

1. Zones (#EG7) for the implementation of the land readjustment should be determined beforehand;
2. To estimate rough costs, overlay the zone with the land price map (#3300);
3. To calculate the influence population from the implementation, overlay the zone with the population density (#3501);

Figure 5.2.9 Structure of GIS Application (Housing Density and Open Spaces)



Source: JICA Study Team

Example 8:	House Quality (Carte No.8)
GIS data set:	
Spatial data: (Attributes)	#101 through #103: Settlement (Existing) #104 and #105: Settlement (Planned)
Supplemental data: (Physical)	#1000: Orthophoto
Supplemental data: (Socio-Economic)	#3501: Population distribution #3300: Land price map
Operation and effects:	

In the Dakar metropolitan area, there are many settlements with poor quality, unregistered houses. They are generally in bad condition and thus pose a health hazard, and are at increased risk of disaster. The houses are often made of temporary materials which allow leakage of rain water, and intrusion of sand and insects. Each municipality is responsible for improvements of living condition in the subject area by encouraging residents in various ways. The land ownership project is such an action.

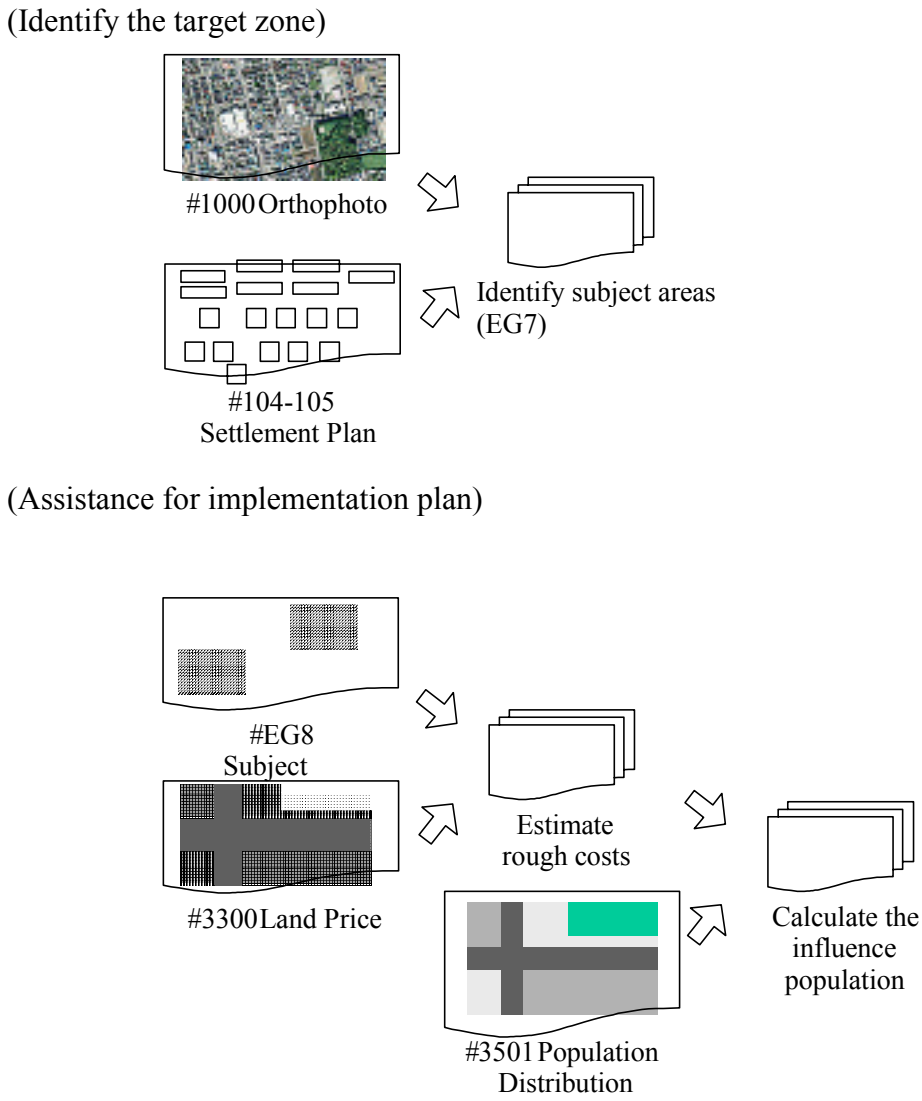
(Identify the target zone)

1. Display the Orthophoto (#1000) overlaid with settlement plans (#104 and #105);
2. Identify subject areas.

(Assistance for implementation plan)

1. Zones for the implementation of the land readjustment should be determined. Make a new layer of the zones beforehand (#EG8);
2. To estimate rough costs, overlay the zone (#EG8) with the land price map (#3300);
3. To calculate the influence population from the implementation, overlay the zone with the population density (#3501);

Figure 5.2.10 Structure of GIS Application (House Quality)



Source: JICA Study Team

Example 9:	Emergency Services (Carte No.9)
GIS data set:	
Spatial data: (Attributes)	#906: Public facilities for security
Supplemental data: (Physical)	#101 through #103: Settlement (Existing) #104 and #105: Settlement (Planned) #106: Commerce and residence (Option) #401 through #404: Road network
Supplemental data: (Socio-Economic)	#3501: Population distribution
Operation and effects:	

In the Dakar metropolitan area where urban area is expanding rapidly, the public administration fails to provide sufficient and efficient emergency services, such as police, fire fighters, and ambulance service. Examination of efficiency and possible improvement may be carried out by using the GIS as stated below:

(Identification of disadvantaged areas in terms of emergency service)

1. Create buffers (#906A) around the locations of emergency service stations (#906) including police, fire fighting and ambulance representing areas of service that could reasonably be provided by the stations;
2. Overlay the existing settlement map (#101 through #103) with the buffer (#906A);
3. Areas outside these buffers represent areas without adequate access to one service or another.

(Option)

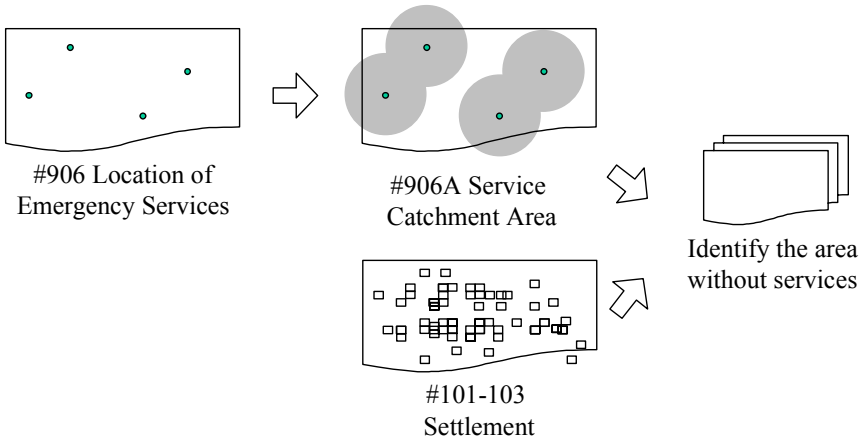
1. Using network module, roads network data (#401 through #404) and stations map (#906), clarify the farthest accession point and route within a desirable time;
2. Generate buffer from the route and overlay it with existing settlement data (#101 through #103);
3. Areas outside these buffers represent areas without adequate access to one service or another.

(Planning of new emergency stations)

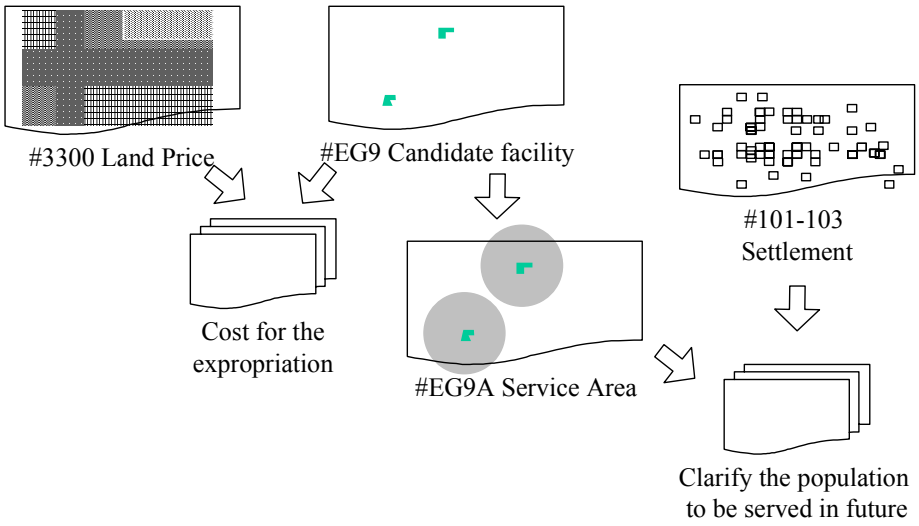
1. Create a new layer (#EG9) for candidate sites of new emergency service stations so as to provide coverage to areas currently without;
2. The cost for the expropriation of land can be calculated by overlaying with land price (#3300);
3. To give a priority among the candidate location, it is necessary to clarify the service population for each subject station. Generate a buffer (#EG9A) of the new facility (#EG9) and overlay it with the settlement data (#101 through #103).

Figure 5.2.11 Structure of GIS Application (Emergency Services)

(Identification of Disadvantaged Area in terms of Emergency Service)



(Planning of new emergency stations)



Source: JICA Study Team

Example 10:	Public Facilities at Neighborhood Level (Carte No.10)
GIS data set:	
Spatial data: (Attributes)	#901 through #912: Public facility maps #401 through #404: Road network
Supplemental data: (Physical)	
Supplemental data: (Socio-Economic)	#3501: Population distribution
Operation and effects:	

See the section 5.4 for detailed description.

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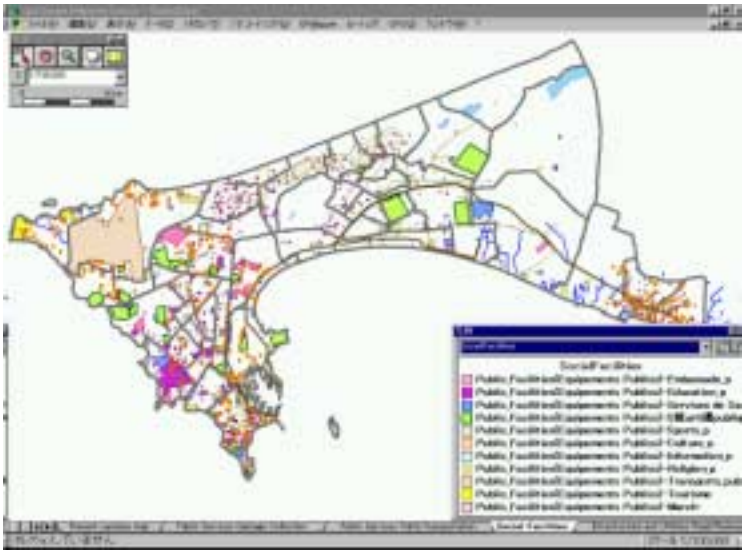
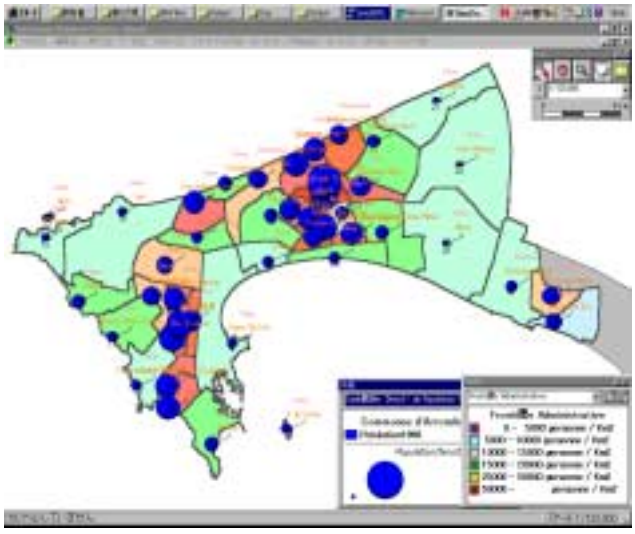
Figure 5.2.12 Output Example of Sector Information Reference Sub-System



Location of Public Facilities



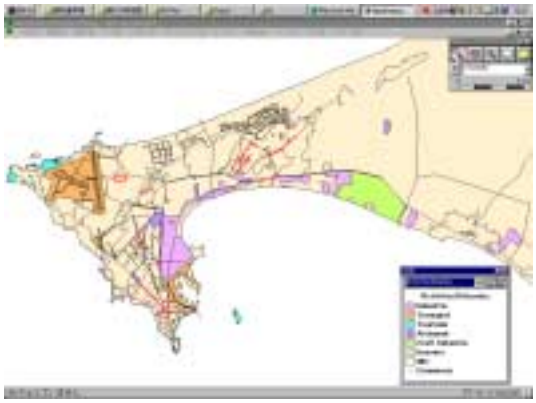
Population and its density

5.2.3 Other Applications

(1) Progress of Urbanization

This is a thematic map showing the urban evolution of the Study Area. This map indicates the extent of urbanization in the area, which arises from the population growth rate of 4 percent per year in the Dakar metropolitan area.

Figure 5.2.13 Output Example of Sector Information Reference Sub-System (1)



Zoning/Evolution of urbanization

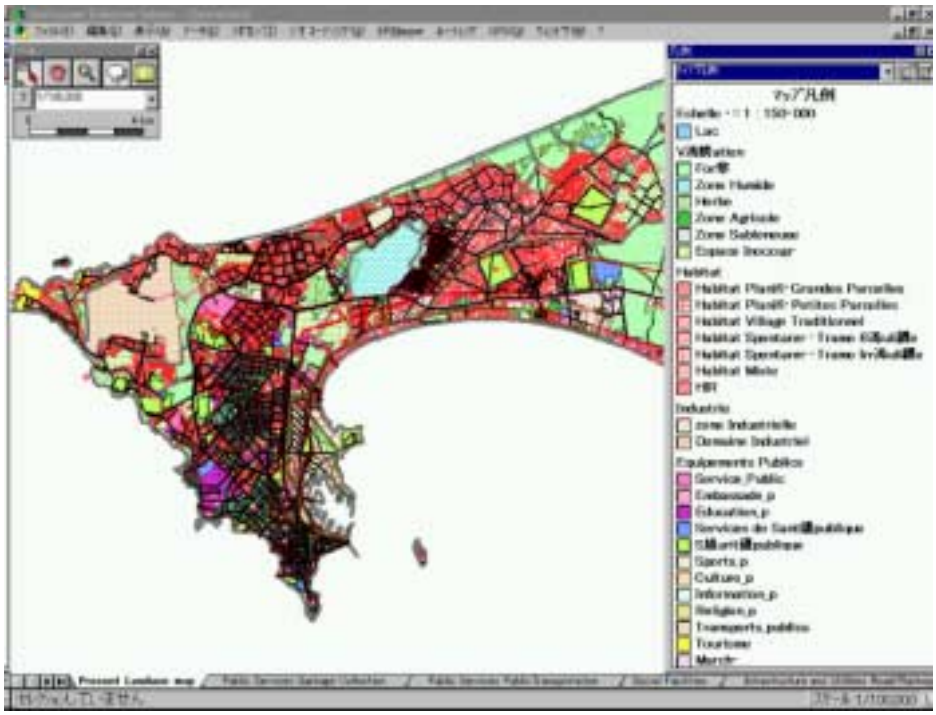
(2) Land Use Plan and Zoning

Information in this category includes land use plans and various building restrictions. There are more than 20 Detailed Urban Development Plans (PUDs) in the Dakar metropolitan area prepared by DUA, ADM and municipalities.

These plans include zoning, road plans, building restrictions and so on. If all the detailed area plans were digitized and input into the IIMS, DUA officials and municipal officials could identify the proposed sites of land development or building applications easily, with all the land use conditions that building applications should observe.

However, some PDUs are not approved, and more than half of the maps of approved plans are not available. Because of the limited accessibility to the relevant data, the initial IIMS contains only the land use plan as determined by 1987 PDU (thematic map No. 1401).

Figure 5.2.14 Output Example of Sector Information Reference Sub-System (2)



Present land use

5.3 Urban Development Control Sub-System

5.3.1 Purposes of the Sub-System

Among the daily tasks of DUA, there are two major tasks related to the urban development management: i.e., the issuance of urban planning certificate and the examination of building permit application.

The purposes of this sub-system are:

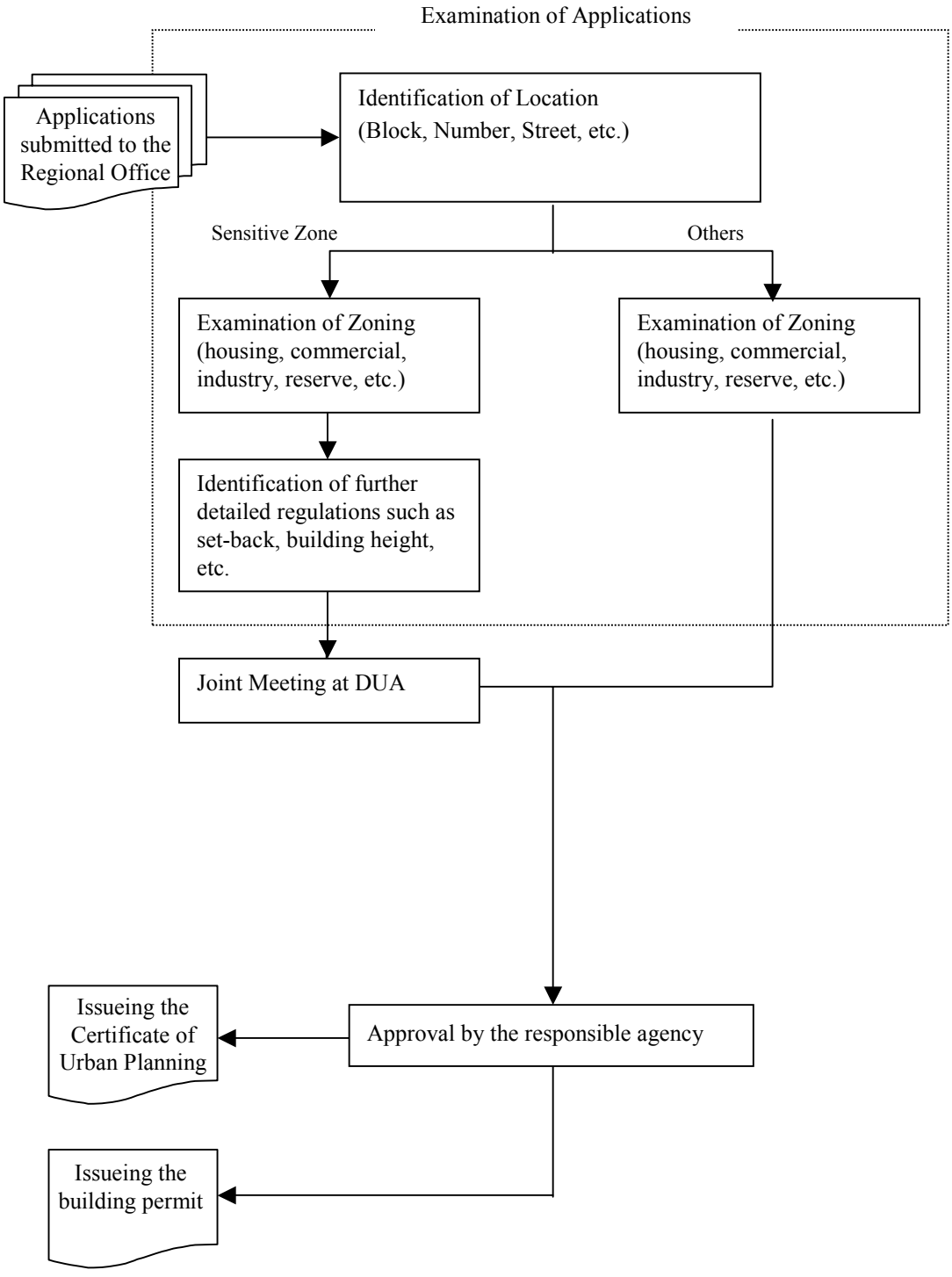
1 to facilitate efficient urban development control measures in DUA, and
2 to create a useful database of urban development control by using relational database function of GIS.

The urban planning certificate is a document issued by DUA explaining allowable development for a particular site. This is given when requested as a governmental service to the public, and therefore is not mandatory. However, one must obtain a building permit before construction.

This sub-system assists the examination of these applications and establishes a database of the applications and approvals by using the relational database function of GIS. The initial system includes only the Dakar Plateau area and Almadie where the urban planning regulations enacted in July 1986 are still in force. Different sets of detailed regulations are applicable for each of the nine sectors delineated within the Dakar Plateau, six special status zones, and six large facility zones in and around the Dakar Plateau. Similarly a set of regulations are applied to Almadie. Applications for sites within the subject area can be easily examined using the system. However, it is also obvious that the system will help DUA formulate future urban development policy options by its accumulated records of urban development.

The following Figure 5.3.1 shows the current work flow of the two tasks. Introducing IIMS will not cause significant changes to this work flow. However the existing reference to the land use plan or zoning map will be replaced by the map on the computer screen, and they can be printed as needed, such as to be attached to the certificate or permit. In addition, the application and examination records will be accumulated in the database. This will make it easier to provide urban development statistics or their analysis.

Figure 5.3.1 System Design of Urban Development Control Sub-System



Source: DUA, JICA Study Team

As stated above, the initial system includes only the Plateau area due to the time constraints. It is hoped that DUA will expand the system by including other sensitive areas for which it assists local authorities in the urban development control process. The required data for this Sub-System is shown in Table 5.3.1.

Table 5.3.1 Required Data for Urban Development Control Sub-System

Thematic Map	Name of Required Data	Thematic Map	Name of Required Data
1.	Development Management Plan for Plateau	3.	Development Management Plan for Other Sensitive Area
a.	Sector boundaries	a.-e.	Similar to 1. Above
b.	Allowable types of development by sector		
c.	Height and setback requirements by sector and by road width		
d.	Intersection area control		
e.	Other regulations		
2.	Development Management Plan for Almadie		
a.-e.	Similar to 1. Above		

Note: The thematic map of Development Management Plan will include attributes a-e as linked data.

Source: JICA Study Team

5.3.2 Examination of Applications

Examination of the urban planning and building permit applications is carried out according to the following procedure.

(1) Identification of the Location

As no complete addressing system has been established in the Dakar metropolitan area, the location of application will be identified on the digital map on the computer screen or digitizer.

As described before, an addressing project is being undertaken by a joint effort of DUA, DTGC and ADM. It is expected that the addressing in the Dakar metropolitan area will be available by the year 2003. When the addressing is ready, identification of the location will be much easier, by only typing in the address.

(2) Examination of the Urban Planning Regulations

Initially, the location of the application must be examined to establish which of the nine sectors within the Dakar Plateau it belongs to. Then, by clicking the location, the regulations to be applied will be displayed. Figure 5.3.2 illustrates a case for a site in the Dakar Plateau.

a) Urban Planning Certificate

The urban planner or architect verifies the urban planning regulations to be applied at the requested site and prints a detailed list of regulations to be followed by the applicant. An urban planning certificate can then be issued together with the printed materials.

At the end of the above process, the basic information on the application is stored in the database. An example of data form is shown in Table 5.3.2.

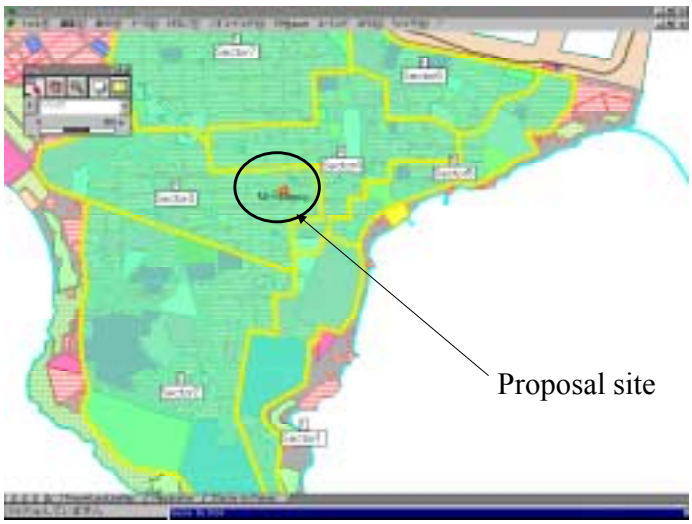
Table 5.3.2 Example of Data Form (Urban Planning Certificate)

Application Contents		
Number		
Application Date		
Applicant	Name Address	
Site Condition	Number of Site District Department/ Municipality	
Purpose of Application	(√) Purchase of Land ( ) Construction ( ) Others	
Certificate Contents		
Site	Minimum Area Road Condition	
Building	Type of Building Height Regulation Set-Back Regulation Others	

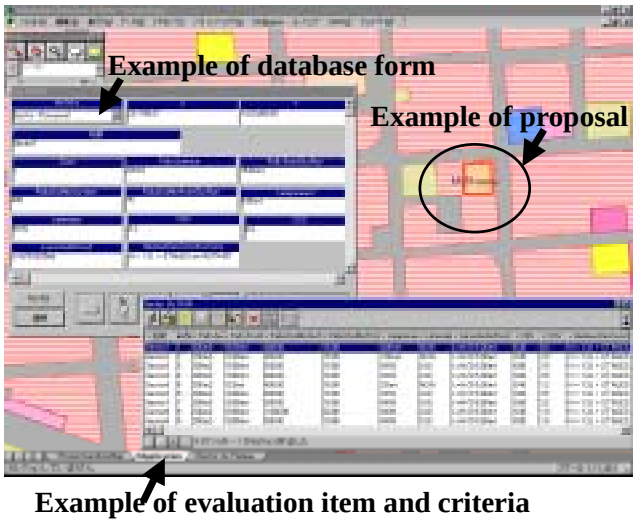
Source: JICA Study Team

Figure 5.3.2 Sample Display of Urban Development Control Sub-System

Sector map for building permission control in Dakar plateau



Example of evaluation form and criteria for building permission control



b) Building Permit

The urban planner or architect verifies the urban planning regulations applied at the requested site, as displayed on the screen, and examines whether or not the application meets the requirements. He then makes a list of items not conforming to the regulations, and sends his recommendations, together with the list, to the responsible municipal authorities, for action, approval or denial.

At the end of the examination process as above, the basic information of application is stored in the database. An example of data form is shown in Table 5.3.3.

Table 5.3.3 Example of Data Form (Building Permit)

Number		
Classification		(√) Dakar Plateau (√) Large Scale Project (√) Others
Application Date		
Applicant	Name Address Profession	
Site Condition	Site Number District Department/ Municipality	
Summary of Project	Number of Floors Building Area Total Floor Area Building Use Total Cost	Floors square meters square meters F CFA
Necessity of Alternation / Modification		( ) Yes ( ) No
Approval	Number of Approval Date of Approval	

Note: The line of "Approval" will be filled after the confirmation of approval.

Source: JICA Study Team

(3) Approval by the Authority

The result of the examination is proceeded to each responsible authority to be approved or issued.

The result of building permit examination is notified to DUA and the information is added to the data format example shown in Table 5.3.3.

5.3.3 Reference of the Database

The accumulated records will form the urban development control database. It should be useful for the formulation of future urban development master plan or policies. The progress of urbanization will be displayed on the computer screen or a printed map. DUA will be able to examine the gap between the actual development and those to be enforced by regulations, and to formulate appropriate land use plans and regulations.

This kind of accumulated database is the most useful in confirming building permit and urban planning certificate previously submitted and approved for any site in the Dakar metropolitan area, if such approval was indeed given for the site. It can be used for reference purposes in the case of a new application, and as a body of data showing actual urban development types over the area.

5.4 Urban Planning Support Sub-System

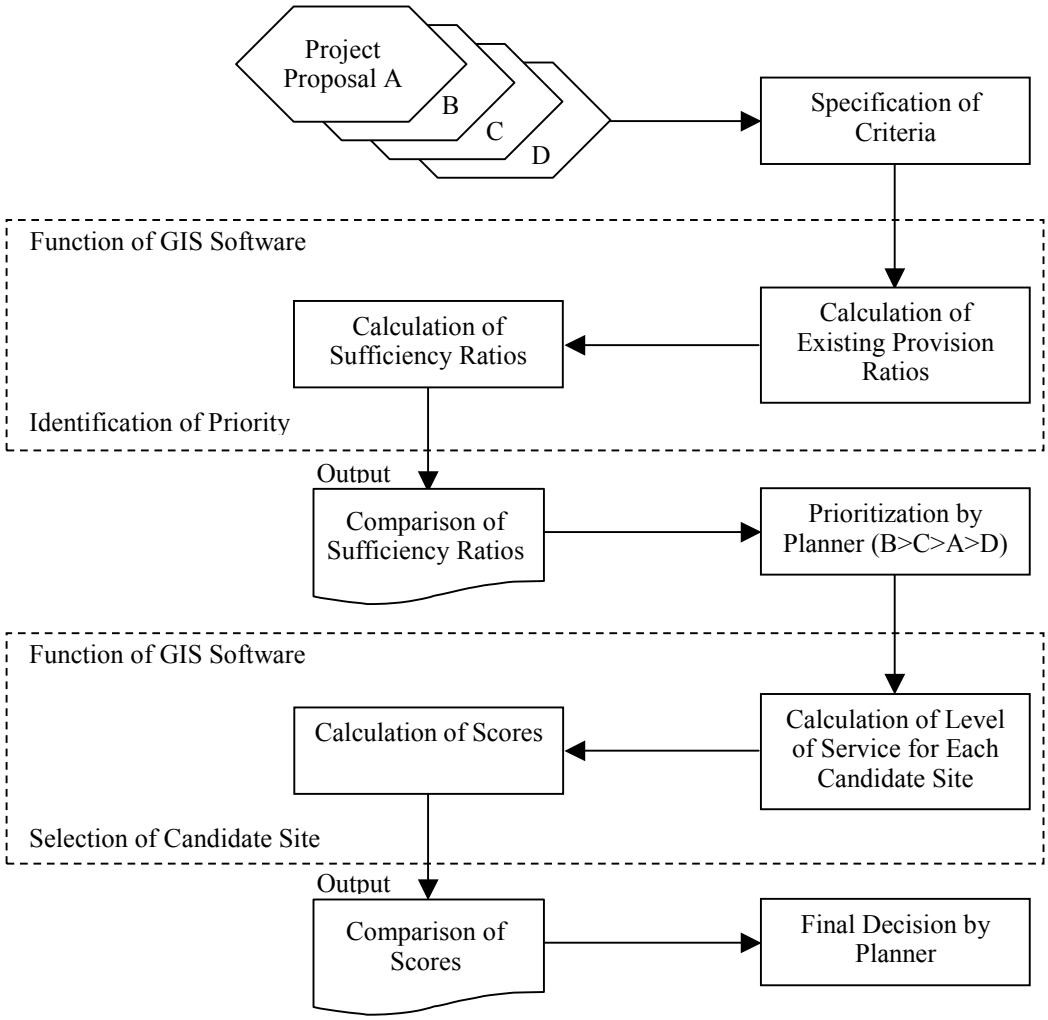
5.4.1 Purposes of the Sub-System

Appropriate provision of public facilities is essential for the creation of an agreeable urban environment. Unfortunately, a lack of appropriate public facilities within a convenient distance is one of the major urban problems in the Study Area, especially in the sprawling areas. Urban planners need to consider the distribution of population and the location and size of industries in the area when formulating future plans.

The Urban Planning Support sub-system will help planners identify areas lacking public facilities. Once the need for a new facility has been identified, this sub-system will give planners a tool for evaluating and comparing possible sites for the new facility.

The following Figure 5.4.1 shows a structural design of this sub-system.

Figure 5.4.1 Structural Design of Urban Planning Support Sub-System



Source: JICA Study Team

Required data is shown in the following Table 5.4.1. Urban planning support for the provision of health posts and primary schools will be incorporated into this sub-system.

Table 5.4.1 Required Data for Urban Planning Support Sub-System

Thematic Map	Name of Required Data	Thematic Map	Name of Required Data
1.	Public Facilities	2.	Population and its Density
a.	Health Posts	3.	Present Land Use
b.	Primary Schools		

Source: JICA Study Team

5.4.2 Evaluation Criteria

Generally, the degree of sufficiency of the public facilities can be indicated by a "sufficiency ratio", ranging from 0 to 1, which can be calculated by dividing the existing provision by the desirable provision.

The desirable provision is usually defined by a standard; e.g. one health post for 10,000 habitants, or one classroom for 500 habitants, etc. Table 5.4.2 shows some standards for various public facilities in the Study Area applied by DUA in the past at various times, although a definitive set of standards has not yet established by the Department.

Table 5.4.2 Standards for the Provision of Public Facilities

Health	
Health post	one post per 10,000 habitants
Hospital	one bed per 500 habitants
Education	
Primary school	one classroom per 500 habitants
Secondary school	one classroom per 1,000 habitants
Culture and Sports	
Culture center	one center per 30,000 habitants
Sports field	one stadium per 30,000 habitants
Commerce	
Market	one public market per 30,000 habitants
Religion	
Mosque	one mosque per 3,000 habitants

Source: DUA, JICA Study Team

5.4.3 Application of the Sub-System

The following describes the procedure of this sub-system application in two stages.

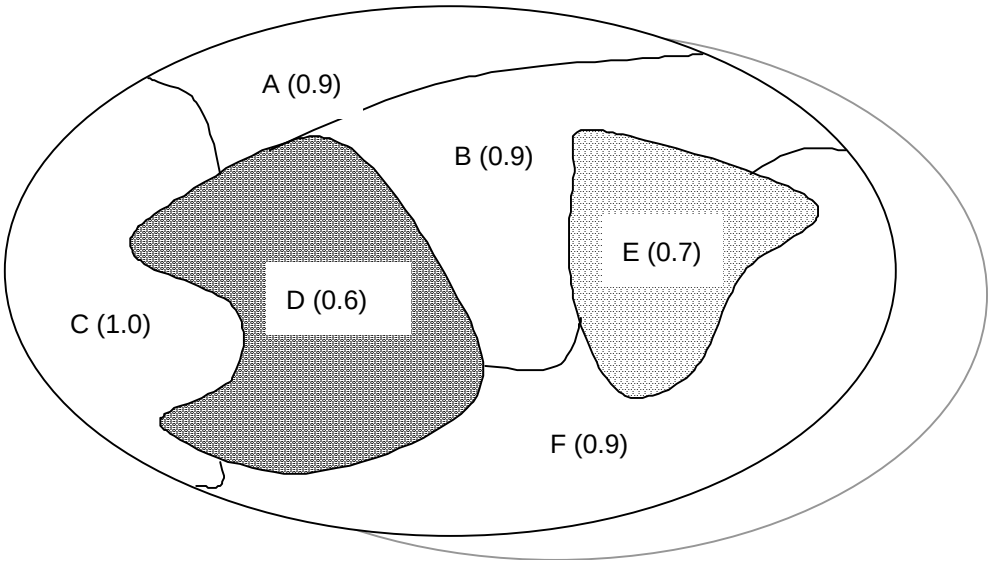
1 Identification of Priority Commune d'Arrondissement, and
2 Selection of Candidate Site.

(1) Identification of Priority Commune d'Arrondissement

Identification will be made by the comparison of level of needs among concerned communes d'arrondissement. Planners can utilize the IIMS as a tool to analyze the needs of each commune d'arrondissement.

1 Existing Provision Ratios (EPRs) for the subject public facility will be calculated by dividing the number of facilities by the population in each commune d'arrondissement.
2 Sufficiency Ratios (SRs) will then be calculated for each commune d'arrondissement by dividing the existing provision ratio determined above by the standard provision ratio given in Table 5.4.2.
3 The Sufficiency Ratio (SR) of the subject public facilities for each commune d'arrondissement will be presented in a classified map, by color-coding each commune d'arrondissement according to its level of sufficiency. Figure 5.4.2 shows an example of how this might look conceptually.
4 Planners will often give the highest priority to the commune d'arrondissement with the lowest sufficiency ratio. However, other factors, such as the absolute number of facilities, their distribution or the distances between them will also be taken into account, and may override the prioritization set by the model. Note that the Sufficiency Ratio (SR) only identifies commune d'arrondissements that may be under-served in relation to others, and that areas within an otherwise well-served commune d'arrondissement may not have adequate access to public facilities, or vice-versa.

Figure 5.4.2 Necessity of Public Facilities by Commune d'Arrondissement



Commune d'arrondissements A-F with their sufficiency ratios of Health Posts

Note: Shades correspond to the sufficiency ratios which indicate the degree of necessity for certain public facilities.

Source: JICA Study Team

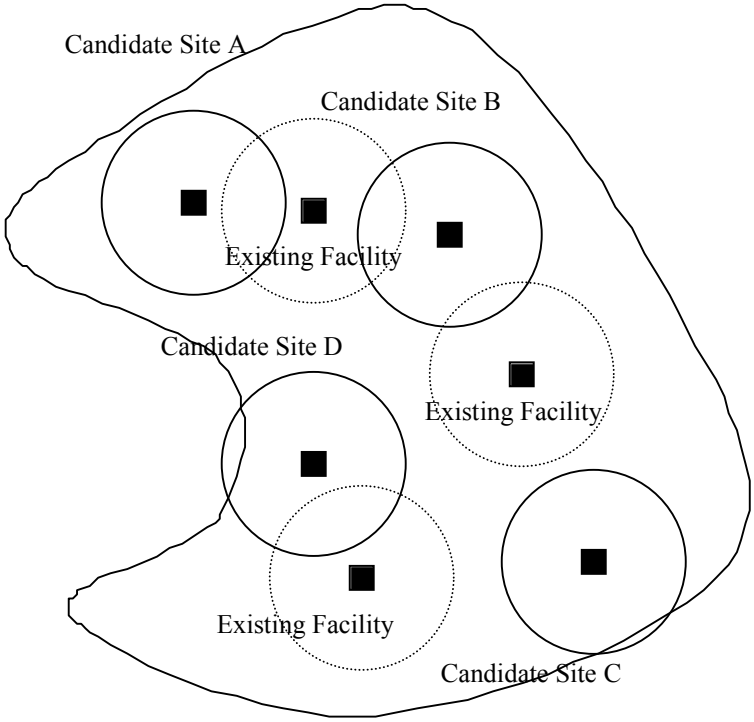
(2) Selection of Candidate Site

Once planners have decided for the provision of new public facilities in a certain commune d'arrondissement, selection and prioritization of candidate sites will be performed using the following process:

1 With the existing land use map, planners will choose candidate construction sites from vacant land or existing public facility sites.
2 Buffers will be drawn (tentatively at 500 m and 1 kilometer) around existing subject public facilities to determine current areas and levels of service.
3 Similar buffers will also be drawn around the candidate sites. Candidate buffers will be modified as follows:
4 Areas where the outer buffer for a candidate site overlaps the inner or outer buffer of an existing facility will be removed from the candidate's outer buffer area (see Figure 5.4.4).
5 Areas where the inner buffer for a candidate site overlaps the inner buffer of an existing facility will be removed from the candidate's inner buffer area (see Figure 5.4.4).
6 Areas where the inner buffer of the candidate site overlaps the outer buffer of an existing facility will be removed from the candidate's inner buffer area and added to the candidate's outer buffer area (see Figure 5.4.4).
7 Scores for each candidate site will be calculated using the following formula for affected population:
   - Score for affected population = Population inside inner buffer * 1.0 + Population inside outer buffer (but not also inside the inner buffer) * 0.5
8 Planners will examine those candidate sites with the highest scores more closely.
9 The final selection will be made taking additional factors, such as land price, into account.

Figure 5.4.5 shows an example of output from the Urban Planning Support Sub –System. It highlights the sufficiency of health facilities by relating the number and location of health posts to the surrounding population, and then using this as a basis for the site selection of new facilities.

Figure 5.4.3 Comparison among Candidate Sites (Health Posts)



Source: JICA Study Team

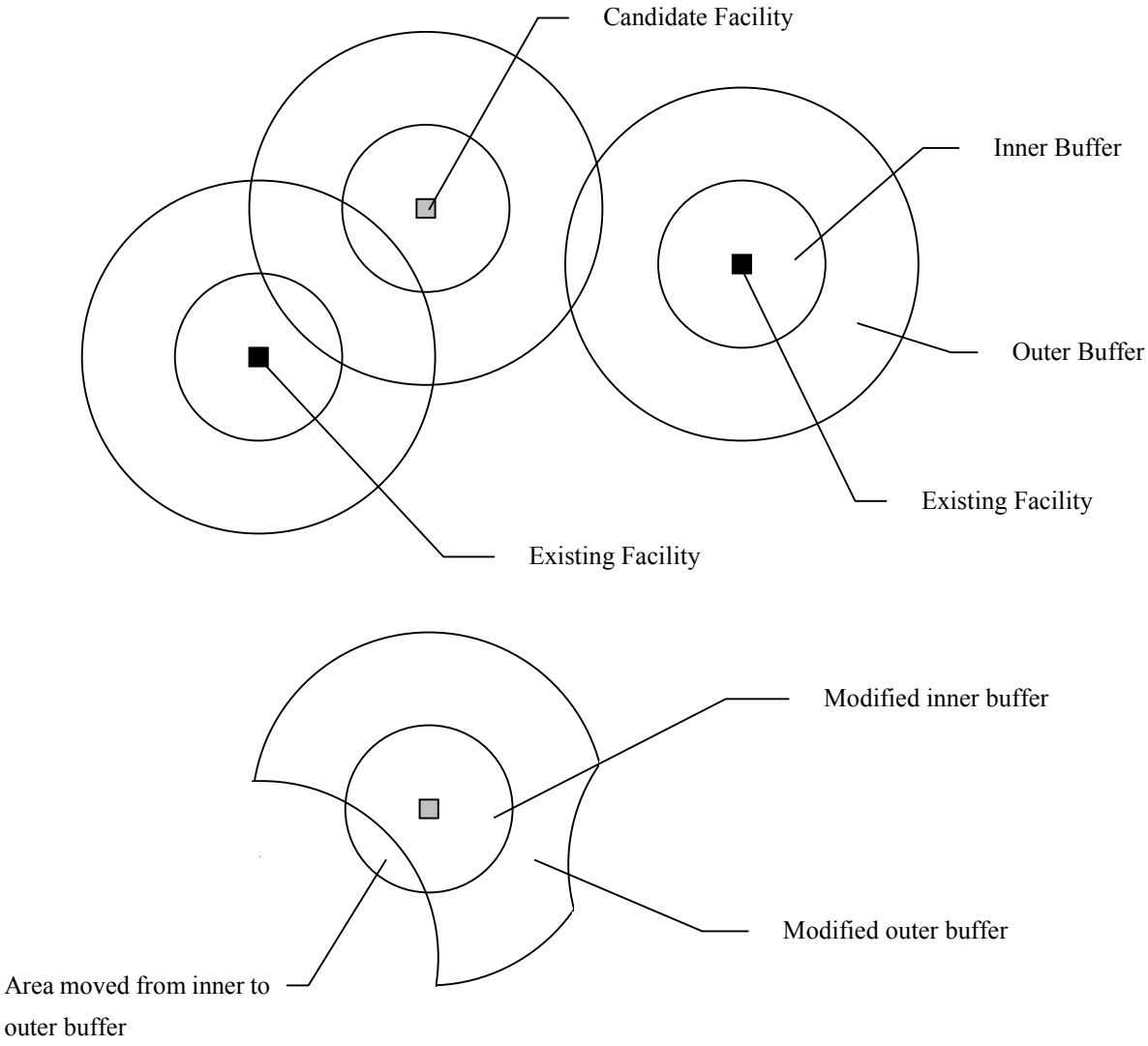
Table 5.4.3 Result of Examination

	Existing Service Area	Additional Service Area	Total
Candidate Site A	60,000 habitants	16,000 habitants	76,000 habitants
Candidate Site B	60,000 habitants	12,000 habitants	72,000 habitants
Candidate Site C	60,000 habitants	20,000 habitants	80,000 habitants
Candidate Site D	60,000 habitants	15,000 habitants	75,000 habitants

Source: JICA Study Team

This method can be applied to local communities with a variety of sizes, including commune d'arrondissement as well as smaller districts.

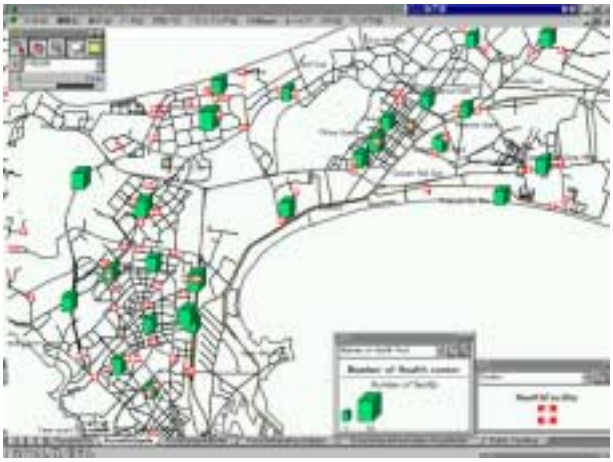
Figure 5.4.4 Inner Buffer and Outer Buffer



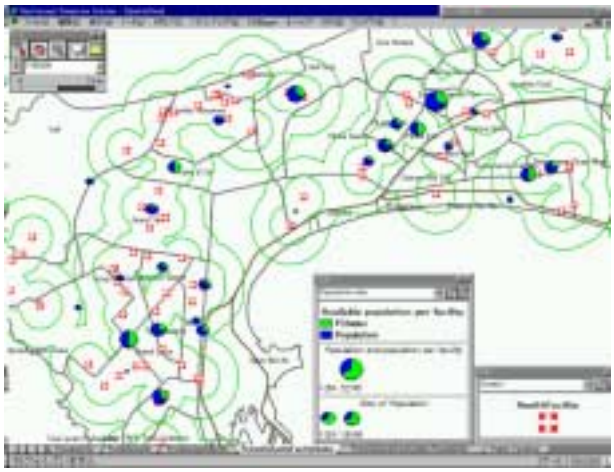
Source: JICA Study Team

Figure 5.4.5 Output Example of Urban Planning Support Sub-System

a) Number of health posts in each ward



b) Sufficiency of public facilities



c) Site selection of public facilities

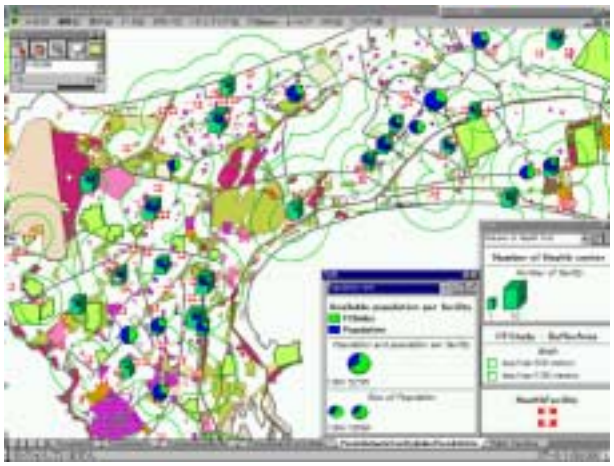


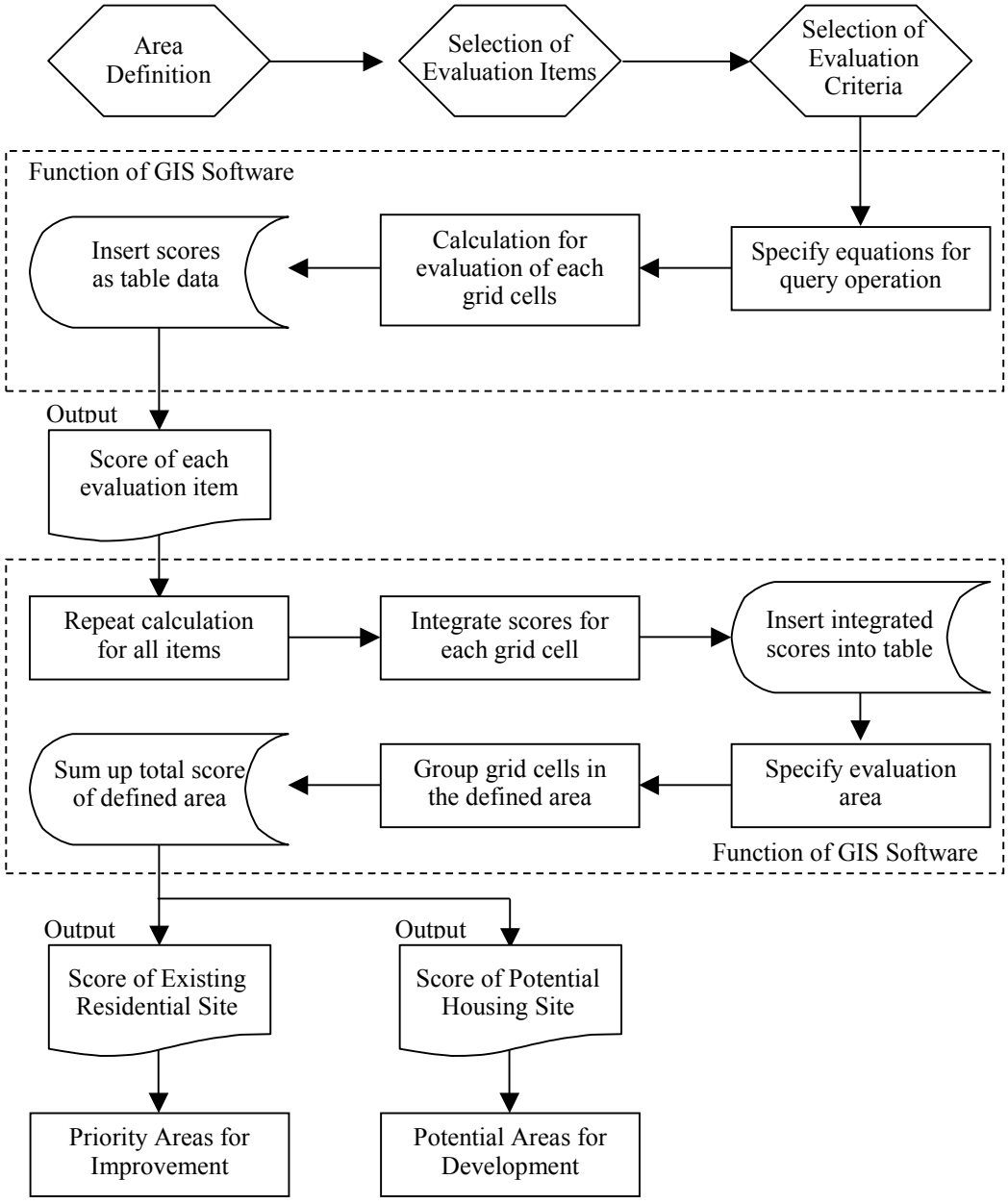
Figure 5.4.5 shows an example of output from the Urban Planning Support Sub –System. It highlights the sufficiency of health facilities by relating the number and location of health posts to the surrounding population, and then using this as a basis for the site selection of new facilities.

5.5 Residential Site Evaluation Sub-System

5.5.1 Purpose of the Sub-System

The fourth group of functions of the proposed IIMS is the evaluation of residential sites. Figure 5.5.1 illustrates the structural design of this sub-system.

Figure 5.5.1 Structural Design of Residential Site Evaluation Sub-System



Source: JICA Study Team

Every person concerned with urban issues in public and private sectors recognizes problems in the Study Area. They have their own evaluation criteria of each neighborhood from their own points of view. Quality of a settlement is a complex function of many variables, such as natural conditions, public facilities and services, population, density, security, and so on, each of which is weighted differently by a given individual. The Residential Site Evaluation Sub-System is a trial to establish a computer assisted land evaluation system.

Table 5.5.1 shows required data for this Sub-System.

Table 5.5.1 Required Data for Residential Site Evaluation Sub-System

Thematic Map	Name of Required Data	Thematic Map	Name of Required Data
1	Land slope	15	Secondary schools
2	Altitude	16	Community health centers
3	Depression	17	Hospitals
4	Reserves	18	Markets
5	Water surface	19	Garbage collection
6	Farm land	20	Bus routes
7	Distance to work place	21	SNCFS (Railway)
8	Land price	22	Major roads
9	Population	23	Community fountains
10	Built-up area ratio	24	Water distribution area
11	Road ratio	25	Drainage
12	Park and open space ratio	26	Sewage
13	House Density	27	Service area of electricity
14	Primary schools		

Source: JICA Study Team

5.5.2 Evaluation Criteria

The evaluation system proposed here examines each neighborhood from various points of view, making it possible to consistently evaluate the settlements in the Study Area. There are 27 proposed evaluation items, some of which are taken from the articles of the "National Land Development And Building Law" which is used for land development and building guidance, while the others are considered significant urban issues based on observations and interviews performed in relation to the urban *Carte* portion of this report. These evaluation items were discussed with representatives of DTGC and DUA during workshops, and from those discussions came this list. Table 5.5.2 shows the evaluation items with criteria and weights to be given.

The table below shows example weightings assigned to each of the evaluation items. Actual weights have yet to be determined, and will be set by means of a trial and error process which will include detailed discussions among concerned agencies.

Table 5.5.2 Evaluation Criteria for Residential Site

Evaluation Items			Criteria or Norms	Score*
Category 1	Category 2	Category 3		
		Land slope	less than 3 %	2
		Altitude	more than 5 m	6
Site Condition	Physical	Depression	No	4
(30 points)	Condition	Reserves	No	6
	(24 points)	Water surface	No	4
		Farm land	No	2
	Social Condition	Distance to work place	less than 20 km	4
	(6 points)	Land price	less than average	2
		Population	less than 500 persons/ha	5
Density		Parcel (built-up) ratio	less than 70 %	5
(25 points)		Road ratio	more than 20 %	5
		Park and open space ratio	more than 5 %	5
		Houses	less than 35 houses/ha	5
	Education	Primary schools	within 500 m	5
Public Facilities		Secondary schools	within 2 km	5
(25 points)	Sanitary	Community health centers	within 500 m	5
		Hospitals	within 2 km	5
	Commercial	Markets	within1 km	5
	Garbage collection	Collection routes	within 100m	2
Public Services	Transports publics	Bus routes	within 200 m	4
(10 points)		SNCFS	within 1 km	2
	Roads	Major roads	within1 km	5
Infrastructure	Water supply	Well or public taps	Yes	1
(10 points)		Individual distribution	Yes	1
	Sewage	Drainage	Yes	1
		Sewage	Yes	1
	Electricity	Individual distribution	Yes	1

Note: All the scores are tentative.

Source: DUA, JICA Study Team

5.5.3 Evaluation Method

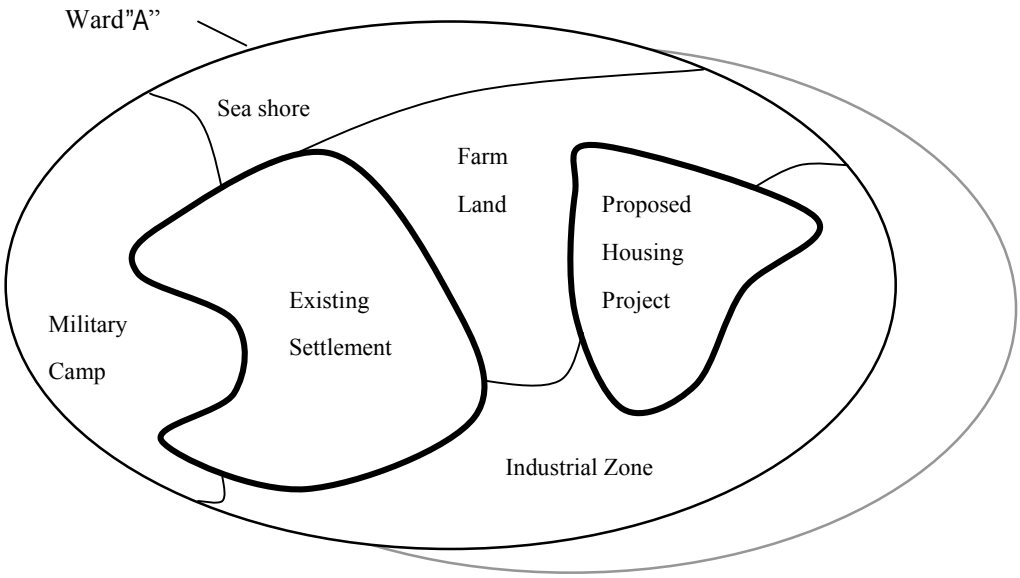
Both existing and proposed housing sites can be evaluated using this sub-system. Existing housing would be evaluated to identify deficiencies, while proposed sites are evaluated to identify strong candidates for future development.

The two different types of housing sites should be evaluated separately because the objectives of the evaluation are not the same. On the one hand, the system evaluates an "existing settlement" and offers information on how comfortable or convenient the neighborhood is. On the other hand, many evaluation items in Table 5.5.2 cannot be applied to the "proposed housing project site". Because there are no facilities constructed on the site, items such as park area ratio, accessibility to health posts, and water supply network cannot be criteria to assess the value of vacant land. The following example shows such an evaluation procedure for each type of site.

(1) Evaluation of Existing Settlement or Possible Development Site

A candidate site to be evaluated is generally located in a ward (Commune d'Arrondissment), which is represented by a polygonal area. Figure 5.5.2 shows a ward named "A". Existing housing areas will have been identified in the Sector Information Reference Sub-System, whereas proposed sites will be identified by planners and digitized into the GIS as polygonal areas - alternatively, the Proposed Housing Project polygon might be constructed by performing a grid to polygon conversion on a contiguous area of same-value grid cells. Note that this sub-system evaluates only polygonal areas flagged as existing or potential housing sites, (i.e. "Existing Settlement" and "Proposed Housing Project" shown in thick lines in Figure 5.5.2). Other polygonal areas such as seashore, farm land, military camp, and industrial zone, are not selected and are thus excluded from the analysis.

Figure 5.5.2 Identification of Candidate Areas



Source: JICA Study Team

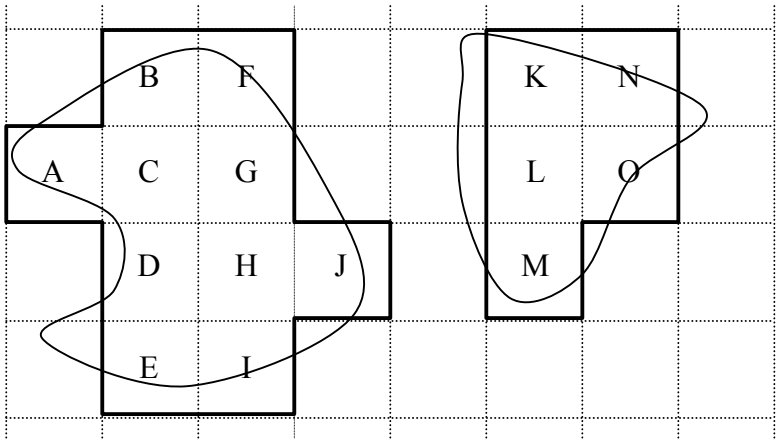
(2) Definition of Grid Cells

This evaluation system will make heavy use of raster data analysis, in which each housing site is divided into identical pixels or cells, called "grid cells". The effect is a bit like overlaying a window screen on a map of the ward. These cells are systematically assigned a value using a scoring algorithm based on the various evaluation criteria outlined earlier. Grid cells, naturally, cannot be subdivided.

A 100 meter cell size will be used for the following reasons:

1 The distance unit of 100 meters is considered the maximum for evaluating accessibility to a site. One should be able to differentiate between adjacent center distances of 100 meters and 200 meters as a measure of accessibility.
2 The most detailed socio-economic data in the subject area, such as population, are only available on the census tract level, which even in the dense areas were no finer than about 200 meters x 200 meters.

Figure 5.5.3 Definition of Grid Cells



Source: JICA Study Team

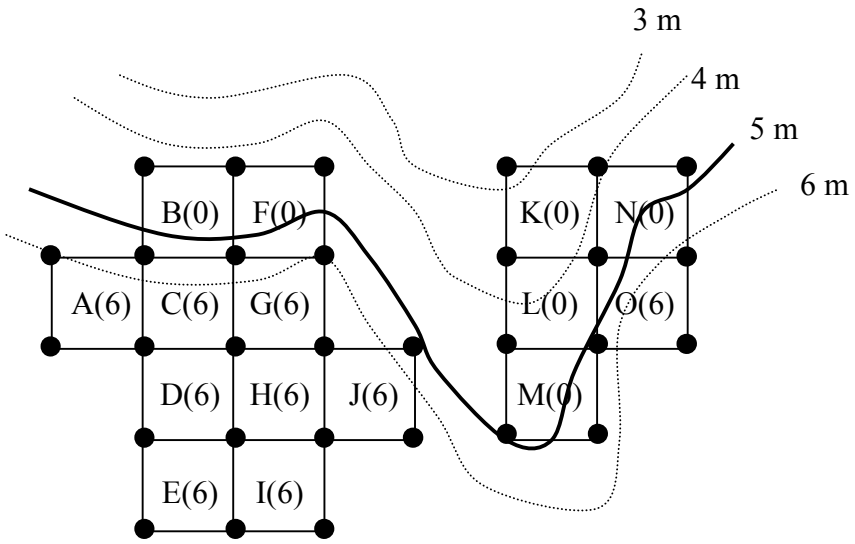
(3) Grid Initialization

At the beginning of the analysis procedure, all cells in the main scoring grid are assigned a floating point value of 0.0. A series of evaluation grids, each representing a criteria in Table 5.5.2, are initialized to integer 0. These grids will be used to track the values resulting from the individual analysis of each criteria, and will be summed at the end of the process. A mask grid will be created to screen out cells that do not fall in either the existing or proposed housing areas. A second mask grid will be generated to mask out cells that fall in the proposed housing developments, as required in the park area ratio calculation shown below. These masks will be created using a polygon to grid conversion function.

(4) Scoring Example of Land Height

According to the criteria of the Table 5.5.2, if the height of the land is more than five meters above sea level, the elevation-evaluation grid cell value is set to 6. The figure shows some contour lines and scores for each grid cell. The upper grid cells are assigned a value of 0 because they fall below the five meter contour line. When the five meter contour line lies across a cell, the cell is assigned the majority value. Thus, if the area that is below five meters is larger than the rest of the cell, the whole cell is defined as below five meters. Therefore, 0 is assigned to this cell value. Actual elevation analysis will be done by means of a re-sampled DTM. Another simpler method is to utilize the average DTM height value of the four edges of each grid.

Figure 5.5.4 Evaluation of Land Height



Note: Contours will not be used in practice. DTM level at four edges will be used.

Source: JICA Study Team

(5) Scoring Example of Park Area Ratio

The polygonal areas shown in the figure below indicate parks and open spaces in the existing settlement. If the park area ratio is greater than 5 percent, and the cell represents an existing settlement, then the park ratio evaluation grid cell is assigned a value of 5, as shown by the following pseudo-code:

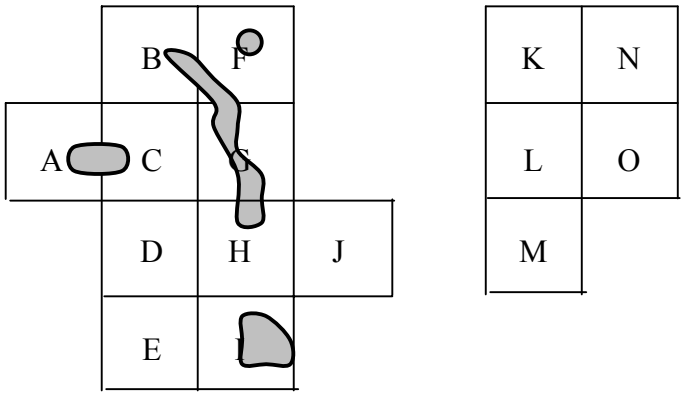
If [area of parks or open spaces] / [area of the grid cell] > = 0.05 then

set cell value to 5

Since there are no parks in the proposed housing development site yet, a mask is applied to screen out cells representing the proposed housing project, and these cells will remain at 0.

Knowing the area of grid cells and parks in the cells, which can be calculated by intersecting each cell with the parks data layer, and summing the areas of all park polygons, within the cell, this function calculates the park ratio for each cell, from cell A to cell J. The table that follows the illustration shows the park area ratio and score for each grid cell.

Figure 5.5.5 Evaluation of Park Area Ratio



Source: JICA Study Team

Table 5.5.3 Scoring of Park Area Ratio

Cells	A	B	C	D	E	F	G	H	I	J	Total
Park Ratio (%)	12	6	4	0	0	12	16	5	20	0	7.5
>= 5 %	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	No	-
Score	5	5	0	0	0	5	5	5	5	0	30

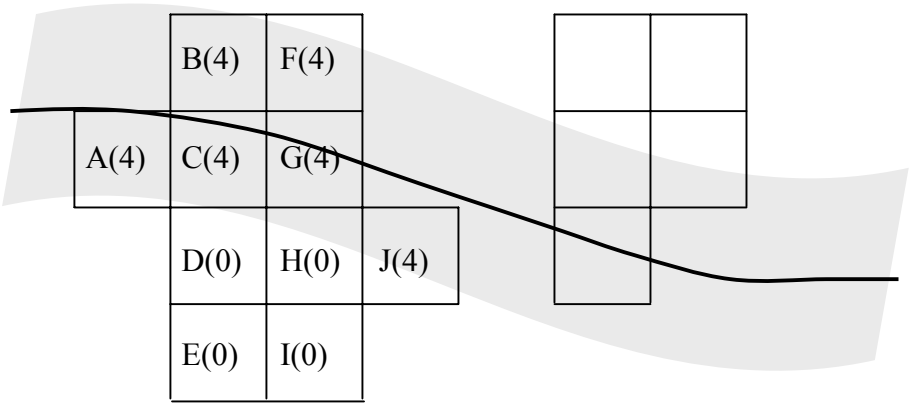
Source: JICA Study Team

(6) Scoring Example of Accessibility to Public Transportation

Accessibility to facilities or services can be evaluated by creating a 200 meters buffer surrounding a transit line, converting the resulting polygonal areas to a grid aligned with the transit evaluation grid, and analyzing which cells fall within the buffered areas.

The following illustration provides a conceptual explanation of the process. The thick line indicates a bus route. The Criterion in the Table 5.5.2 says that areas (or grid cells) which are within 200 meters of the bus route are given a score of 4. The gray area in the illustration below represents the area within 200 meters of the bus route. Therefore, cells with the majority of their area in this buffer have good access to public transportation and are assigned values. Scores (0 or 4) are shown in each grid cell from A to J.

Figure 5.5.6 Evaluation of Public Transportation Accessibility

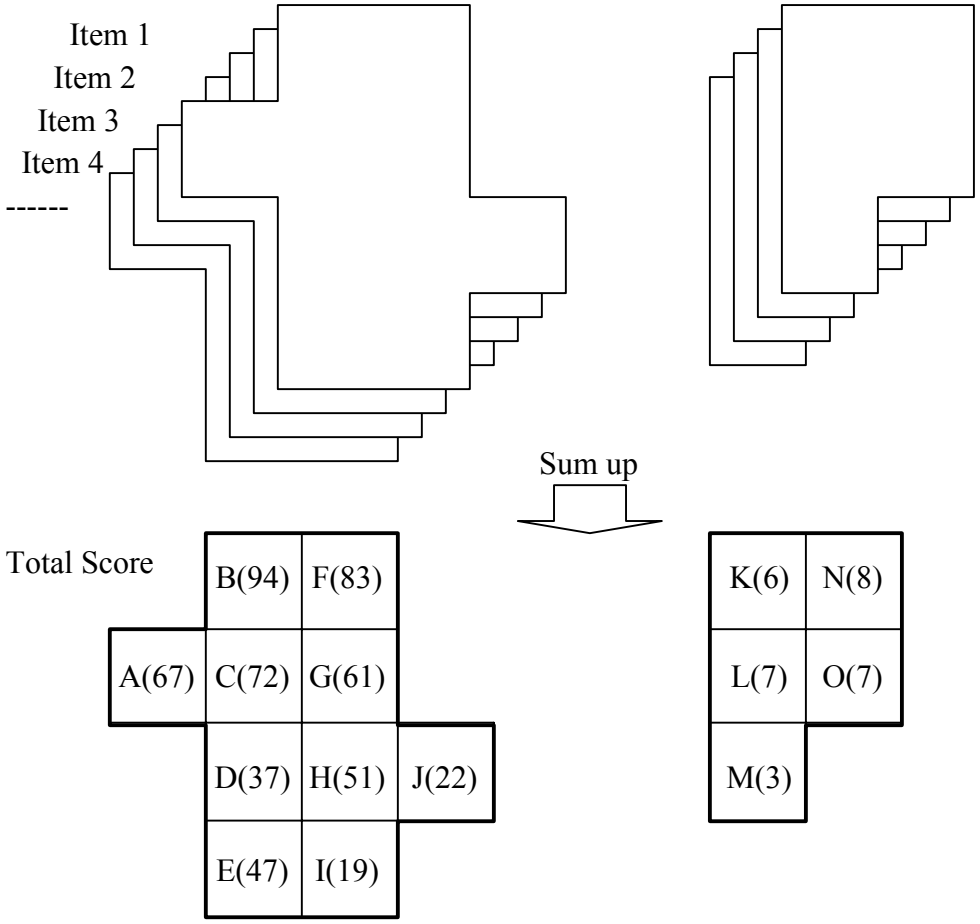


Source: JICA Study Team

(7) Compilation of Scores for Overall Evaluation

When the grid cells are examined with all the evaluation items based on the criteria in Table 5.5.2, individual analysis grids are summed and assigned to a main analysis grid, using the mask created earlier to ensure that all cells outside the evaluation areas have a value of 0. The final value cell value represents the total score. These values are then divided by the sum of the possible values that a particular cell could attain, in order to calculate the final score ratio. This ratio may be represented as a floating point number between 0 and 1, or it may be represented as a fraction. For example, 8/26 means that 8 points are given to a grid cell out of the possible total of 26.

Figure 5.5.7 Compilation of Scores



Source: JICA Study Team

5.5.4 Application of the Sub-System

Table 5.5.4 shows a summary score sheet of Housing Site Evaluation Sub-System of the IIMS.

The total score of each grid cell for both the existing settlement, and the proposed housing project site in the commune d'arronissement of "*Golf Sud*" is tentatively available in this table, for integrated evaluation of each area in relationship to the others.

Table 5.5.4 Evaluation Sheet of Grid Cells and Housing Sites

Municipality			Pikine															
Commune d'Arrondissement			Golf Sud															
Evaluation Site Type			Existing Settlement										Proposed Housing					Ward Total
	Evaluation Items	Note	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	
1	Slope	2	0	0	2	0	0	2	0	0	2	0	0	2	2	2	0	12/30
2	Height above sea level	6	6	6	6	6	0	6	6	6	6	6	0	0	0	0	6	54/90
13	Road ratio	3																
14	Park open space ratio	5	5	5	0	0	0	0	5	5	5	5	-	-	-	-	-	30/50
25	Primary schools	3	2	2	2													
26	*Cars Rapides* route	4	4	4	4	0	0	4	4	0	0	4	-	-	-	-	-	24/40
	Total Score	100	67	94	72	37	47	83	61	51	19	22	6	7	3	8	7	584/1,150
	TOTAL		553/1,000										31/150					584/1,150

Source: JICA Study Team

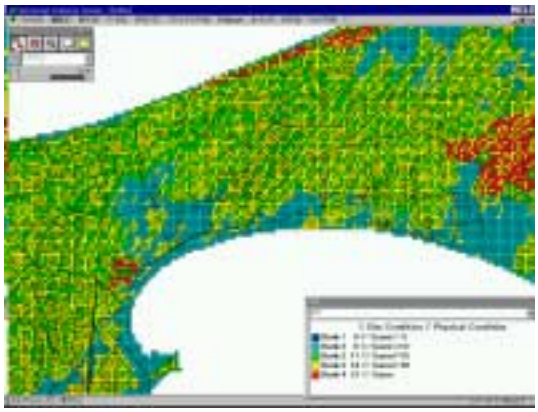
In case of existing settlements, a very low total score in comparison with the other grid cells, housing areas, or commune d'arrondissement, suggests that there are significant disadvantages within the boundary which may need improvement. There are complex relationships among urban problems, and very often, a concentration of urban problems are observed in particular parts of a urban district.

Therefore, when a neighborhood needs an area improvement project, most probably it would be an integrated operation with community participation rather than a simple sector improvement issue, as in the DUA/GTZ project which is trying to mitigate the urban disadvantages in the "Pikine Irrégulier" area. Planners can use this sub-system to help identify areas where urban improvement is urgently required.

In the case of the proposed housing projects or vacant land, a low total score suggests that the proposed site may not be suitable for the housing development due to natural environment or other constraints. If the total score is not very low, only some site improvements (e.g. adding a drainage system), or infrastructure investment outside the site (e.g. regional artery road) may be needed. Other factors such as public facilities, housing density, water supply, etc can be managed within the site to the extent that clears the criteria in the Table 5.5.2

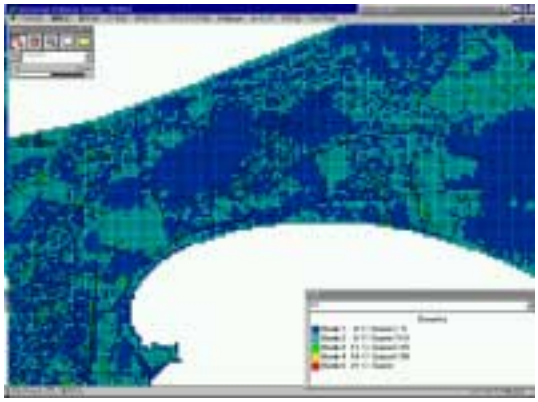
It is intended that this sub-system of the IIMS will remain flexible and will be expanded in the future. Adding additional evaluation criteria, or improving the geographic data improve the scope and accuracy of the housing site evaluation.

Figure 5.5.8 Output Example of Residential Site Evaluation Sub-System

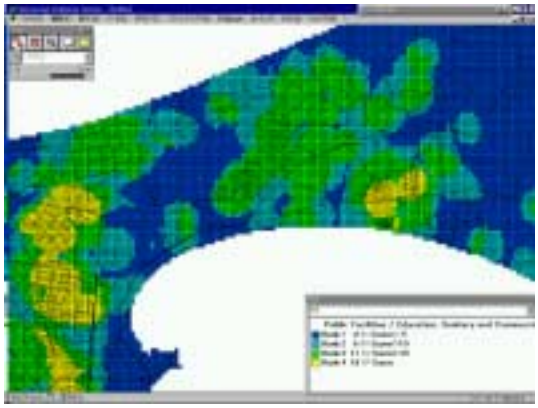


Grid analysis of physical condition

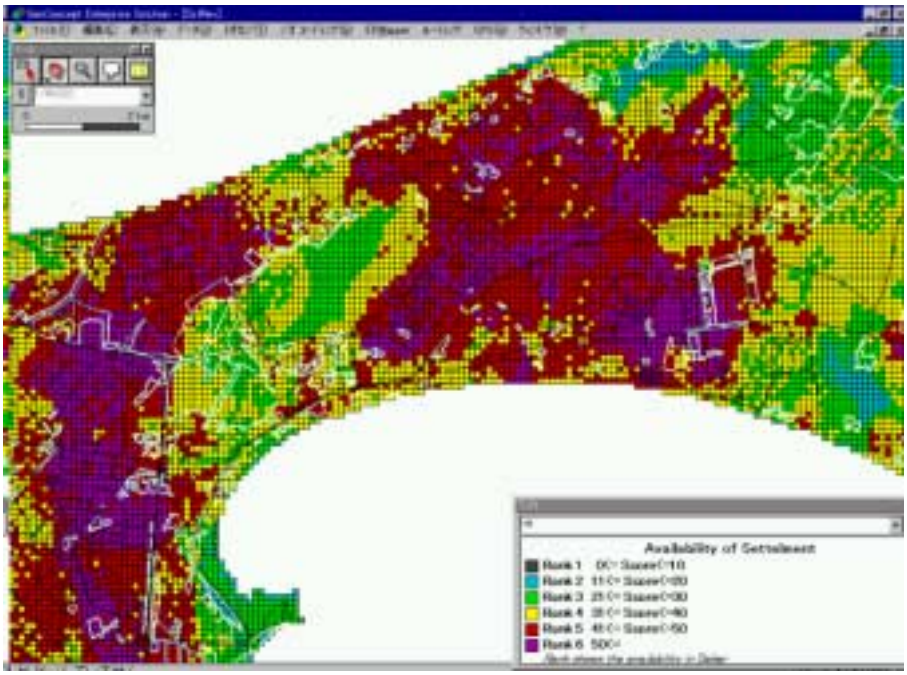
Grid analysis of utility sufficiency



Grid analysis of housing density



Grid analysis of public facility sufficiency



Evaluation of residential sites