Appendix E

GIS-Based Irrigation Block Mapping

THE STUDY
ON
INCREASING THE CAPACITY OF INTEGRATED MANAGEMENT
IN
IRRIGATION SECTOR
IN
SRI LANKA

Annex E GIS-Based Irrigation Block Mapping

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ANNEX E GIS-BASED IRRIGATION BLOCK MAPPING

Chapter 1 INTRODUCTION

1.1 General

A Geographic Information System (GIS) is a computerized information system to collect, manage and update, analyze, and display spatial data. Through utilizing its functions, important information, patterns and relationships can be identified which are previously unrecognized. This in turn gives us an in-depth understanding of the issues they face. And those let us bring more information and less conjecture to the problem-solving process.

The purpose of this part of Annex is to brief GIS application to irrigation management for the sample areas in Nachchaduwa Thuruwila, and Rajangana irrigation schemes covered under JICA Study. The Report consists of seven chapters. Chapter 1 explains objective of GIS-based Irrigation Block Mapping followed by target area and general work procedure by JICA Study Team. Chapter 2 deals with data used for constructing database. Since the work process is as important as product for the preparation of GIS-based irrigation block mapping, chapter 3 briefs data collection process from the field including rapid facilities assessment, land and FOs' activities assessment and soil survey. Based on such collected data, GIS database layer and component is described in Chapter 4. Chapter 5 delivers brief findings through performing analytical steps using collected data. Chapter 6 consecutively introduces practical and future operation using and/or developing/updating database constructed under JICA Study. Based on the discussion in the preceding Chapter, Chapter 7 raises recommendation recognized through the course of the preparation of GIS-based Irrigation Block Maps.

In addition, Attachment is enclosed herewith to introduce basic operation of ArcGIS. Although this brief note shows minimum requirement of GIS function, it will help users as a kick-off to communicate with the software and continue for further reference study. This paper should be hopefully revised and updated by users' as the database is developed and expanded.

1.2 Objectives of GIS-based Irrigation Block Mapping

What is GIS-based Irrigation Block Maps? Here, it is proposed as, "a management and analytic alternatives to support improving irrigation performance at sample blocks by putting spatial data related with irrigation management in an integrated system where it can be organized, analyzed, and mapped so as to find patterns and relationships that were previously unrecognized."

Objective of the GIS-based irrigation block mapping is, therefore, to construct irrigation database as a basic data at sample blocks so as to propose an alternative methodology of

irrigation development and management. The maps would be utilized particularly for irrigation asset management as first step and hopefully expanded according to the needs such as agricultural support program, marketing improvement activities and so forth.

1.3 Target Area

Six target areas, in Nachchaduwa, Rajangana and Thuruwila scheme, each of which is approximately 200 ha on average, are selected through the discussion among ID, IMD and JICA Study Team taking several qualitative criteria into consideration such as degree of crop diversification, level of income, O&M (appointing of Jalapalaka, collecting salaries, and attendance to shramadana) and other FO activities (general election, seasonal general meeting, monthly committee meting and accounting activity). Selected blocks are described in Table E1.3.1:

Table E1.3.1 Target Area

No.	Scheme	Area	FOs name
1	Nachchaduwa	HLD-36, 37, 38 and 39	Tissa
		LLD-5, 6 and 6A*	Isuru
2	Rajangana	RB Tract No.4	Saliya Gama
		RB Tract No.8	Mahasen
		LB Tract No.2*	Sri Udara
3	Thuruwila	Thuruwila (entire area)*	

Remarks: * marks mean the areas for which detailed survey (facilities and socio-economic survey) is carried out.

Out of all the blocks tabulated above, three blocks namely Nachchaduwa (Isuru FO) Rajangana (Sri Udara FO) and entire Thuruwila was selected for detailed survey (facilities and economic condition survey), while base maps, including canal alignment, structures location and plot boundary, were prepared for other three areas.

1.4 General Work Procedure

General work procedure is illustrated in Figure E1.4.1. Figure E1.4.2 is also referred to more clearly show specific data collected at each step. The works primarily consist of three steps as follows: Preparation of Base Maps (Step-1), Field Survey for supplemental data to finalize Irrigation Block Maps (Step-2), and Carrying out detailed survey and data input (Step-3).

Step-1: Preparation of Base Maps

Step-1 aims to (i) collect data (digital, paper-based and aerial photograph), (ii) processing and digitizing such data using GIS to prepare base maps. The works in this step are itemized as follows:

1) Confirmation of the grid system and conversion of available digital data (CAD-based topographic map and satellite imagery) into appropriate GIS format,

2) Review and comparison of blocking out plan and village plan with digital data to possibly identify canal network as well as structures' location, and
3) Digitization of canal alignment and plot of major structures on those canals, which can be identified using those digital data.

Step-2: Field Survey for collection of supplemental data to finalize Irrigation Block Maps

Base maps will be prepared through the Step-1 to the Step-2. The work of Step-2 is as follows:

4) Collecting supplemental data through field confirmation such as structures' location which cannot be identified in the preceding steps, and
5) Finalization of base map

Step-3: Carrying out detailed survey and data input

In the Step-3, detailed field survey is consecutively carried out. In this step, detailed field condition such as condition of irrigation facilities function, soil texture and drainage class, and socio-economic features such as land tenure and FOs' activities are assessed. The collected data are compiled and input in the GIS database.

6) Detailed field survey covering following subjects,
   (i) Facilities condition,
   (ii) Soil Survey including textual classification, drainage class and fertility, and
   (iii) Land and FOs' activities assessment consisting of type of land ownership, current land use and FOs' activities (attendance to shramandana, payment of O&M fee and membership)
7) Data Input and Finalization of the irrigation block maps

Chapter 2 AVAILABLE DATA

2.1 Available Data

Available data and information utilized for the mapping works are summarized in Table E2.1.1 and are briefly explained as follows:

Base Map Data

Topographic Map in CAD Format

Topographic maps which were prepared during the JICA Study for the Potential Realization of Irrigated Agriculture in the Dry and Intermediate Zones of Sri Lanka (2000), are used as the base map for the Nachchaduwa Irrigation Scheme. Those maps are provided in AutoCAD format and are transformed into GIS format as a basic layer.

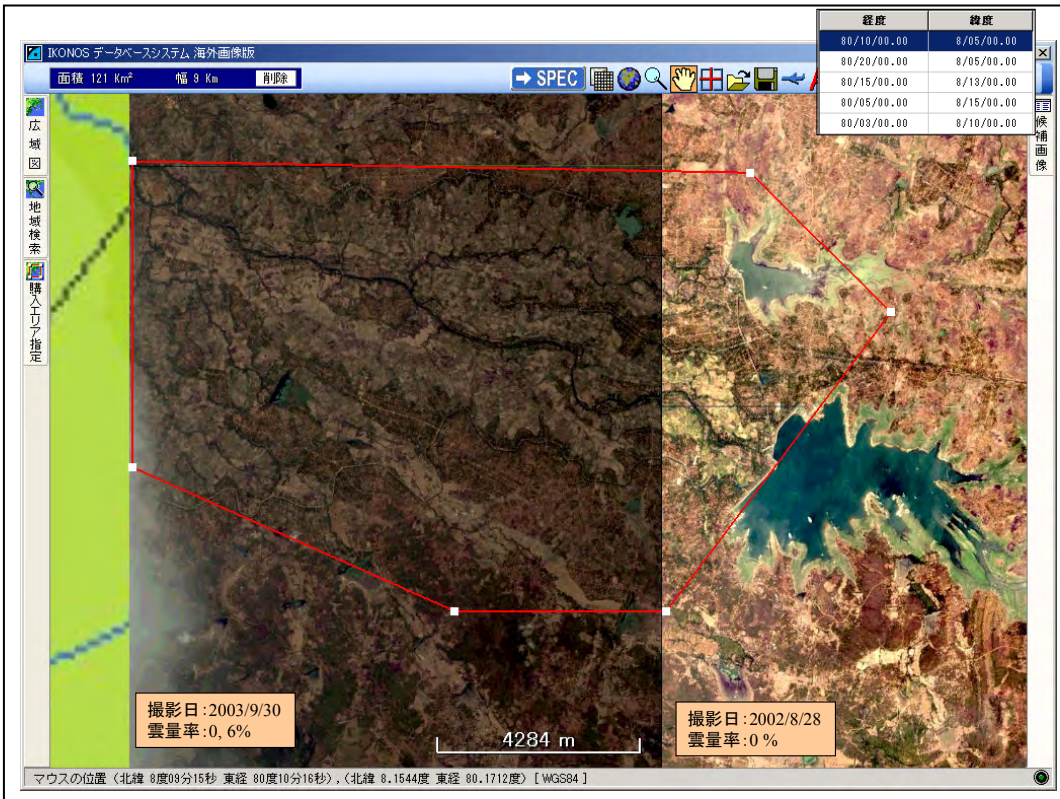
Satellite Image

In the case of Rajangana irrigation scheme, although there are kinds of satellite imagery under operated, the satellite imagery IKONOS is utilized for the preparation of base map. IKONOS, launched in 1999, is the world's first commercial satellite providing very high resolution (up to 1 m) imagery of the earth, simultaneously collecting one-meter resolution black-and-white (panchromatic) images and four-meter resolution color (multi-spectral) images. General information of IKONOS is summarized below:

General Information of IKONOS

Orbit		
Type	Sun-Synchronous	
Altitude	681 km	
Inclination	98.1 deg	
Descending node crossing time	10:30 am local solar time	
Period	98 min	
Off-Nadir Revisit	1.5 to 2.9 days at 40 degrees latitude	
Sensor Characteristics		
Viewing Angle	Agile spacecraft, along track and across track pointing	
Swath Width	11 km nominal at nadir	
Image Modes	Single scene: 13km x 13 km Strips: 11 km x 100 km up to 11 km x 1,000 km	
Metric Accuracy	12 m horizontal, 10 m vertical without GCP	
Radiometric Digitization	11 bits	
Spectral Bands	Wavelength (μ m)	Resolution
1 (blue)	0.40 – 0.52	4 m
2 (green)	0.52 – 0.60	4 m
3 (red)	0.63 – 0.69	4 m
4 (NIR)	0.76 – 0.90	4 m
Panchromatic	0.45 – 0.90	1 m

Source: Centre for Remote Imaging, Sensing & Processing



IKONOS Images Used for Rajangana Irrigation Scheme

Under the Study, IKONOS satellite imagery was purchased from the distributor in Japan as described below[1]:

- Distributor in Japan: Japan Space Imaging Co., Ltd.
- Address in Japan: Nitto-bo Build. 8F, 2-8-1, Yaesu, Chuo-ku, Tokyo, 104-0028, JAPAN
- TEL: +81-3-5204-2714
- FAX: +81-3-5204-2730

Aerial Photograph of Thuruwila (purchased from the Survey Department, Colombo) (No. 92.26/095)

Aerial Photograph

Aerial photographs that were shot in 1992 as shown are available at the Survey Department in Colombo that were utilized for the base map preparation of Thuruwila medium irrigation scheme. To purchase

[1] IKONOS is available at various different agents with different prices and delivery time. Following is also one of the agent common for the use of satellite imagery in Sri Lanka.
Satellite Imagine Southeast Asia Co., Ltd.
102 Loxley Building 14th Fl., Na ranong Road, Klongtoey, Bangkok 10110, Thailand
Tel.: 66-2240-3133, Fax: 66-2240-3134

photographs, an application should be prepared to the Ministry of Defense for their approval in advance. Photograph code number necessary for the target area should be checked at the Survey Department library prior to the application.

Other Supporting Data

Other supporting data used, most of which are paper-based, are collected from scheme IE's office, survey department in Anuradhapura and/or other relevant organizations as described below:

Issue Tree

Issue trees depicting canal net work, canal length and those command area prepared by ID for water management and kept generally at IE's office are utilized for identification and confirmation of canal alignment, structures' location as well as irrigation command area on the field.

Blocking Out Plan/Final Village Plan

Along with the issue trees, blocking out plans are available for Rajangana scheme which were originally prepared at the planning stage of the scheme. Since irrigation network does not have much difference with that in original plan, BOP can be a useful data to carry out field survey as well as data management after inputting. In the case of Thuruwila, medium scheme, final village plan are utilized as a reference data.

2.2 Preparation of Base Map

In general, digitization is required to prepare base map using the data explained in the previous section. It is the process by which coordinates from a map, image, or other information sources are converted into a digital format in a GIS. Points, lines, and areas on satellite imagery, photograph or maps represent real situation in irrigated field, therefore, these must be converted and recorded in digital forms before they can be used as GIS data. The coordinate values that defined the locations and shapes of objects that define the locations of such must be captured, that is, recorded as numbers and structured in the spatial database.

In principle, there are three types of digitization: (i) manual map digitization, (ii) scan digitization and (iii) on-screen digitization, characteristics of which are described below. In preparing GIS-based irrigation block maps for Nachchaduwa, Thuruwila and Rajangana scheme, the methods, (ii) and (iii), were principally utilized.

(i) Manual digitization[2]

[2] Manual digitization was carried out for the preparation of soil maps based on soil survey results, briefs of which are also explained in 3.3..

Manual digitization is manpower-guided coordinate capture method. An operator securely attached a hard copy map to a digitizing surface and traces lines or points with an electrically sensitized puck. If there is no base information other than paper-based map, this method could be applied to prepare base map. The method requires digitizing tables and appurtenant equipment.

(ii) Scan digitization

Scan digitization is the method through optical scanning to convert hard copy documents into digital formats, which are used for converting aerial photograph of Thuruwila medium scheme into GIS format. Scan digitization usually requires some form of skeltonizing, particularly if the data are to be converted into a vector data format (such as canal and road alignment). One of several pixels may be selected to specify the position of a given portion of the alignment. The same holds true for points. A pixel near the center of the point or line is typically chosen, with the center of a line defined as the pixel nearest the center of the local perpendicular bisector of the line. Such skeltonizing works reduces the widths of lines or points to a single pixel. High quality scanning equipment is quite expensive, however, the work can be carried out through out-sourcing with relatively low cost.

(iii) On-screen digitization

On-screen digitization, also called heads-up digitization, would be considered a combination of (i) manual map digitization and (ii) scan digitization. This method is generally used to create GIS-based maps for Nachchaduwa and Rajangana, by way of utilizing CAD and/or satellite imagery. It involves manually digitizing on a computer screen, using a scanned map, converted data from CAD or image as a backdrop. On-screen digitization offers advantages over both map and scan digitization. Manual map digitization is often limited by the visual acuity and pointing ability of the operator. On-screen digitization also gets rid of the need for a digitizing table. Large digitizing tables are an additional piece of equipment and require significant working space. Digitizing tables are specialized for a single purpose of use, therefore, such removal would make this work cost-effective.

Chapter 3 FIELD SURVEY

3.1 Facilities Survey

3.1.1 General

Facilities conditions considerably affect irrigation water management. Facilities' function assessment was, therefore, carried out to identify and assess current functionality of facilities. The survey largely consists of two parts: (i) canals and (ii) related-structures. Details of the survey are explained in the next sub-section.

3.1.2 Survey Procedure

The format used in the field survey is attached in this report (FORM-A and FORM-B).

(1) Canals (see FORM-A)

Form-A was utilized for an assessment of Main, D and F-Canals. The following general information was investigated and given in every survey form.

- coordinate of intersection measured using GPS,
- date of the survey
- name of the chief surveyor and survey members
- type of canals (main, D-, F-canal or drains) and canal number
- access to the location
- dimensions
- problems of the canals (sediments, vegetation, erosion, leakage, overflow, illegal checking and the condition of canal road)
- evaluation of the function
- sketch
- photograph

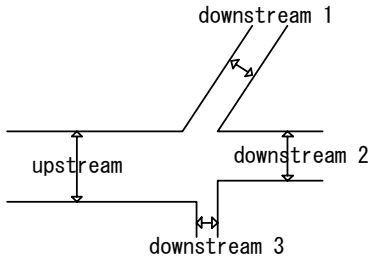


Figure E3.1.1 Diversion Point where Canal Condition were Assessed

Points for the survey were at; (i) the beginning point of each canal (BP), (ii) the end point of the canal (EP), and (iii) diversion point of the canal (DP) as illustrated above. The survey interval was set approximately 200 m for each line of canal.

The following dimensions are measured at each survey point:

- top width of the canal (B)
- bed width of the canal (b)
- depth of the canal (H)
- water depth in the canal, if any (h)

Visual information is useful for understanding the condition in the database. Therefore, a photograph was also taken with an illustrative sketch with the location of problems and direction of the photograph taken, which are incorporated into GIS database.

(2) Structures (see FORM-B)

Form-B was applied for an assessment of irrigation related-structures on Main, D- and F-Canals. The following general information was given in every form through the field survey.

- coordinate measured using GPS
- date of the survey
- name of the chief surveyor and survey members
- type of structure (turnout, duckbill weir, diagonal weir, drop spillway, culvert, filed inlet and others) and number
- access to the location
- problems of the structure (gate, operation, corrosion, cracks leakage, downstream damage and measuring device)
- evaluation on the function
- sketch
- photograph

As same as canals, photographs of the structures are attached to clearly visualize those conditions in the database.

In order to implement facilities survey, Engineering Assistant (EA) of the scheme, surveyor, Development Assistant (DA) attached to ID and IMD, and local guide, mostly from field canals group, were organized as a team to assess facilities condition from both engineering and farmers' view points in facilities function so as to bridge gap of understanding between both parties since facilities function is not only assessed by appearances from technical point of view but also those operability which are recognized well by user FOs.

Tips: Rapid Facilities Assessment -How can we get sufficient result of function evaluation through the activities?

Evaluation of canals and structures function is carried out with four levels of qualitative criteria as follows:

A: Fully functioning
B: Partly deteriorated, but functioning in a satisfactory range
C: Not functioning well and/or affecting the downstream flow
D: completely not functioning

Advantage of qualitative assessment is its easiness, however, the result often becomes inconsistent if assessment teams have different understanding and criteria. Therefore, prior training is imperative to obtain satisfactory results. Training to survey team would include: facilities purpose explanation and definition, assessment criteria discussion and definition, trial field assessment and so forth.

3.2 Land and FOs' Activities Assessment

3.2.1 General

Land and FOs activities were surveyed for three target blocks with the main purpose of grasping present social condition in the target areas. Although survey item is limited, part of sociological background in the target areas can be identified through this survey.

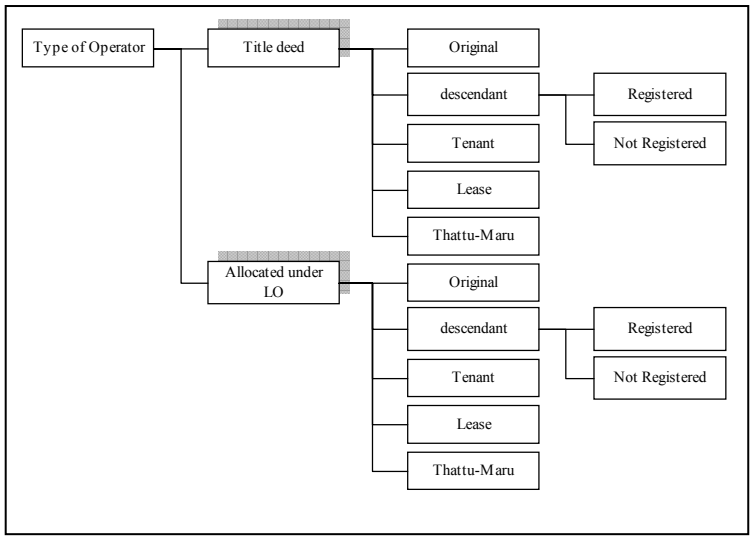
3.2.2 Survey Procedure (see FORM-C)

Following five items of information was surveyed in this exercise and recorded using FORM-C.

- type of land ownership (owner operator, tenant operator and/or others), category of which used in the survey is depicted in Figure E3.2.1 in accordance with the characteristics of target area[3]
- land use (paddy, OFC, banana and others)
- membership to FOs
- payment of water fee
- attendance to shramadana

Land and FOs' Activities Assessment at Rajangana Scheme (January 2nd, 2005)

Prior to the survey, scheduling meeting was organized and carefully prepared survey schedule in consideration of farmers' cultivation practice. The survey was then carried out through interviews to chief and member of field canal group (FCG) and transect walk with those members.



[3] Owner operators can be categorized into two types: (i) operators owning land which is inherited by law or tradition and (ii) operators with farm land allocated under Land Ordinance (LO). In case of Nachchaduwa major scheme and Thuruwila medium scheme, farmers settled in distant past, therefore, land are owned and inherited by farmers themselves. While, in new settled scheme such as Rajangana major scheme, lands were allocated in accordance with LO in 1960s when they were settled.

3.3 Soil Survey

3.3.1 General

The main purpose of the soil survey is to identify: (i) textual classification, (ii) drainage class and (iii) fertility of the soils in the target areas to obtain basic information that helps to promote agricultural extension programs as well as giving technical guidelines for future agricultural development plan in the target areas.

3.3.2 Survey Procedure

It took approximately two weeks for field survey and a week for data compilation and the report preparation for target three blocks. The work consists of (i) preparatory work, (ii) soil profile observation in the field and (iii) preparation of maps and compilation of data and other information, each of which is explained as follows:

(1) Preparatory work

The preparatory work is performed in order to smoothly and efficiently carry out survey. The meeting was held among the soil survey team and project staff concerned to discuss matters such as suitable legend and review and collect available data for the target areas including topographic map and regional level soil maps.

(2) Soil mapping in the field

Actual performance of soil mapping in the field over two weeks is briefed below:

Table E3.3.1 Soil Mapping Works in the Field

Day	Work
1st and 2nd	- Proceeding to the site, logistics arrangement including accommodation, local guide and hired labor - Checking the layout and access road of the target areas
3rd to 7th	- Actual field mapping work along the grid lines at the rate of roughly 2.5 km per day
8th	- Meeting among survey team to summarize field findings, identify constraints and comparison of results
9th to 13th	- Continuation of field mapping along the grid lines at the rate of 2.5 km per day and final corrections in the field
14th	- Breaking camp and returning

The field work generally consists of following steps:

(i) Map unit selection

The separations of area delineations on a soil map represent combinations of soil series that occur in foreseeable patterns in the field. These foreseeable combinations are soil map units and are identified by a unique name and symbol as shown in Table E3.3.2. Prior to the survey, such mapping units are determined based on the Sri Lankan standard.

Table E3.3.2 Soil Mapping Unit and Its Description

	Legend	Description	Land Suitability	Land Use Recommendation
1.	WD	Well drained reddish brown earth (RBE)	U1	If supplemental water supply by irrigation, deep rooted perennial crops such as mango, banana, papaya, cashew and citrus is recommended.
2.			U2	Similar to U1, same kinds of crops would be proposed, however, particularly for Yala season
3.			U3	Annual crops such as onion, tomato, chilies, wild rice, sunflower, peanut, maize, green gram, soybean with drip/sprinkler irrigation
4.	MWD.d	Moderately well drained deep RBE	U1	As described above.
5.	I.d	Imperfectly drained deep RBE	U5R2	Annual crops such as onion, tomato chilies etc. are recommended subject to adequate drainage facilities.
6.	LHG.d	Deep low humid gley (LHG) soil	U5R1	Similar to U5R2. If crop diversification is not promoted, wetland rice with supplemental flood irrigation and with Yala season flood irrigation is recommended.
7.	LHG. vpd. d.		R1	Wetland rice in Yala with supplemental irrigation and in Maha with flood irrigation
8.	Al.d.	Deep alluvial soil	U5R1	As explained above.
9.	Al.vpd.d		R1	As explained above.

Note: Legend and land suitability classification is derived from GIS-based Irrigation Block Mapping. Here, land use recommendation is shown at the initial, however, this should usually finalized after field observation is concluded.

(ii) Survey point selection

The mesh grid with the interval of 250 m is drawn in the target area and basically intersecting points are selected as sampling observation points.

(iii) Observation

Holes are dug at each sampling point to examine the soil layer. Key observation points includes: color, texture, structure, and other characteristics of the different layers. The soil profile, a vertical section of soil through all horizons, at each hole is compared with other soil profiles in the area. In addition, survey team record other landscape on the map such as slope gradient, streams, drains and so on.

(3) Preparation of maps

Based on the field survey, paper-based maps depicting textual classification, drainage class and fertility are prepared. The JICA Study, for instance, prepared paper-based maps with the scale of 1:5,000. Maps are subsequently scanned and digitized using GIS as final

products. This process including paper-based map preparation and data digitization required two weeks in total.

3.4 Man-power Required for the Work

Man-power necessary for the survey, data digitization and input is approximated and summarized in Table E3.3.3 as a reference:

Table E3.3.3 Man-power required for the Survey

No.	Work item	Work Capability (ha/day/team)	Man-power Required/team
	Data Digitization, Input and GIS Operation		
M-1	Aerial photograph processing	200	1 GIS expert
M-2	Digitization		
M-2-1	Outer boundary	500	1 GIS expert
M-2-2	Canal alignment and facilities location	30	1 GIS expert
M-2-3	F-canal command area	50	1 GIS expert
M-2-4	Facilities Condition	100	1 GIS expert
	Field Survey		
F-1	Outer Boundary Confirmation	500	1 surveyor 3 survey assistants 1 local guide
F-2	Canal Alignment and Facilities Location Confirmation	20	1 surveyor 3 survey assistants 1 local guide
F-3	F-canal Command Area Confirmation	30	1 surveyor 3 survey assistants 1 local guide
F-4	Facilities Survey	15	1 surveyor 3 survey assistants 1 local guide

Remarks: Man-power necessary for query building and manual preparation cannot be easily estimated since work quantity is extremely different depending upon the purpose of database.

Chapter 4 GIS DATABASE

4.1 General

Data on irrigation block was compiled using following specifications.

- Software: Environmental Science and Research Institute (ESRI) ArcView Version 9.0, and Microsoft Access Version 2002
- Data Format: ESRI Shape file Format
- Map Projection: Transverse Mercator
- Spheroid: Everest
- Datum: Kadawala

4.2 Data Component

There are six GIS data layers containing (i) canal alignment, (ii) canal evaluation, (iii) facilities evaluation, (iv) road, (v) socio-economic condition (land and FOs' activities) and (vi) soil information as tabulated in Table E4.2.1 and summarize in Table E4.2.2 below. Images on GIS and attribute tables are illustrated in Figure E4.2.1 and E4.2.2 thereafter.

Table E4.2.2 Summary of Basic GIS Layers

Type of Data	Feature	Sub-features	Definition
1. Polyline	Canal features	-	
	Main Canal		
	D-Canal	-	
	F-Canal	-	
	Drainage Canal	-	
2. Polyline	Road	-	
3. Point	Main Canal (evaluation)	-	Field assessment result for main canals
	D-Canal (evaluation)	-	Field assessment result for D-canals
	F-Canal (evaluation)	-	Field assessment result for F-canals
4. Point	Turnout	-	Structures on canals that divert water to D- and/or F-canal
	Duckbill Weir	-	Structures on canals (as the name implies)
	Diagonal Weir	-	Structures on canals (as the name implies)
	Drop	-	Structures on canals (as the name implies)
	Spillway	-	Structures on canals (as the name implies)
	Culvert	-	Structures on canals and/or drains (as the name implies)
	Farm Turnout	Concrete	Division structures made of concrete on F-canal diverting

Type of Data	Feature	Sub-features	Definition
			water to commanding field
		no structure	Ditto (but no structure)
		PVC	Ditto (using PVC)
	Other Structures	Overcrossing	Structures on canals and/or drains (as the name implies)
		Trough	Or it is typically called Aqueduct
		End regulator	Structures on the end of the canal
		Farm crossing	Crossing structures on canals and/or drains (as the name implies)
		Diversion Turnout	Structures on canals that divert water to other two or more canals
5. Polygon	Socio-economic condition	-	Socio-economic condition (Type of land ownership, land use, FOs activity etc.)
6. Polygon	Textual classification	-	Soil classification based on FAO
	Drainage class	-	Drainage class based on FAO
	Fertility	-	The state of being fertile in specific area

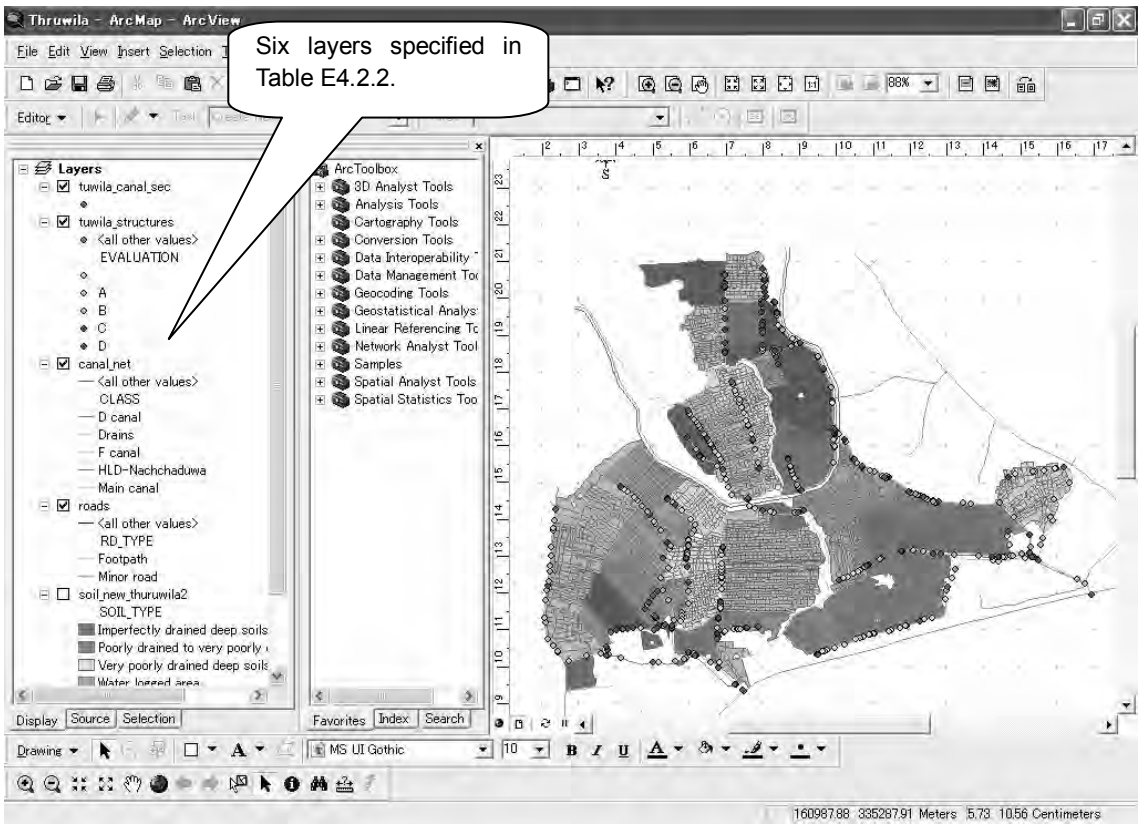
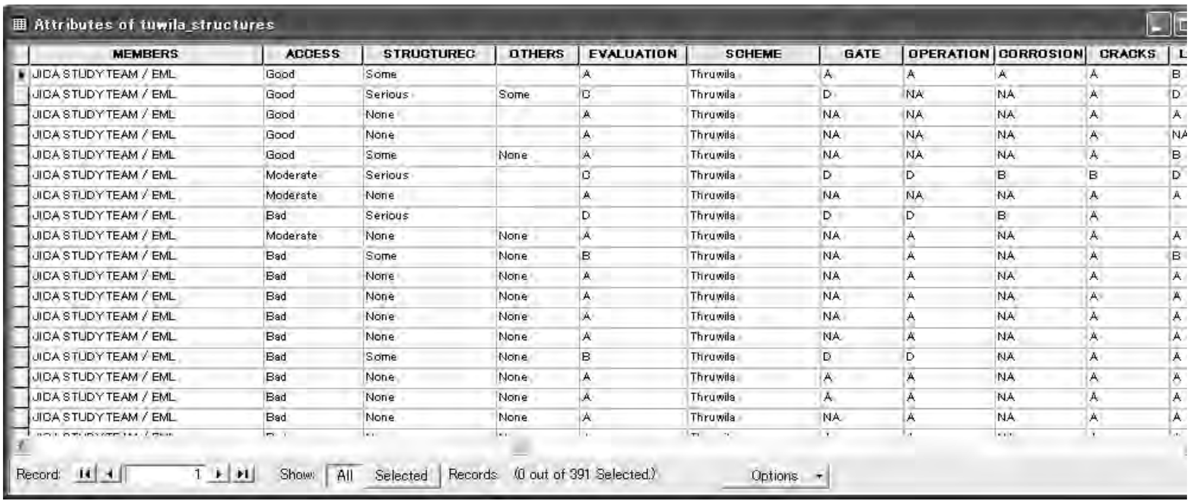


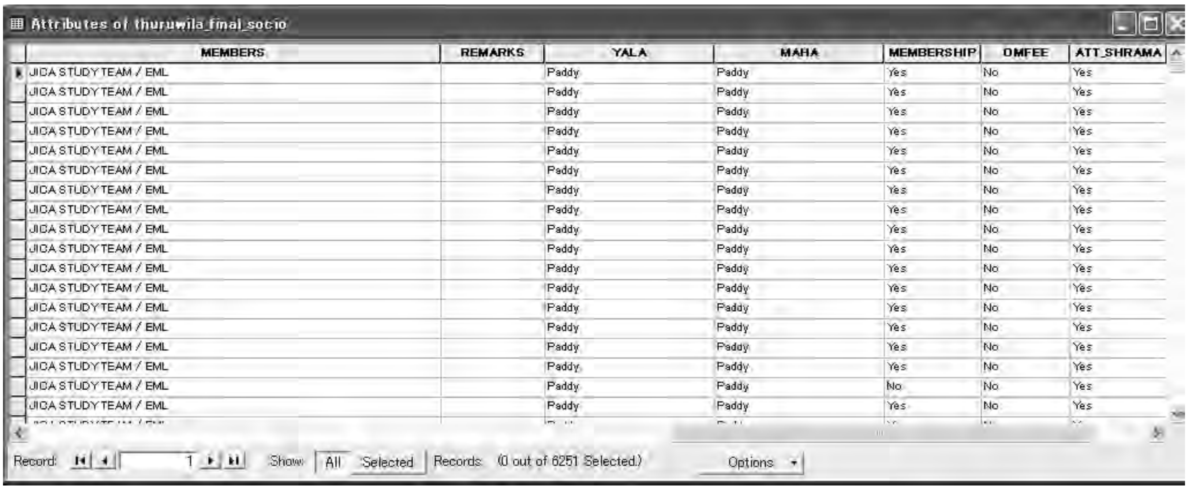
Figure E4.2.1 Images of GIS Database (Thuruwila Medium Irrigation Scheme)



Attributes of tuwila_structures

MEMBERS	ACCESS	STRUCTUREC	OTHERS	EVALUATION	SCHEME	GATE	OPERATION	CORROSION	CRACKS	L
JICA STUDY TEAM / EML	Good	Some		A	Thruwila	A	A	A	A	B
JICA STUDY TEAM / EML	Good	Serious	Some	C	Thruwila	D	NA	NA	A	D
JICA STUDY TEAM / EML	Good	None		A	Thruwila	NA	NA	NA	A	A
JICA STUDY TEAM / EML	Good	None		A	Thruwila	NA	NA	NA	A	NA
JICA STUDY TEAM / EML	Good	Some	None	A	Thruwila	NA	NA	NA	A	B
JICA STUDY TEAM / EML	Moderate	Serious		C	Thruwila	D	D	B	B	D
JICA STUDY TEAM / EML	Moderate	None		A	Thruwila	NA	NA	NA	A	A
JICA STUDY TEAM / EML	Bad	Serious		D	Thruwila	D	D	B	A	
JICA STUDY TEAM / EML	Moderate	None	None	A	Thruwila	NA	A	NA	A	A
JICA STUDY TEAM / EML	Bad	Some	None	B	Thruwila	NA	A	NA	A	B
JICA STUDY TEAM / EML	Bad	None	None	A	Thruwila	NA	A	NA	A	A
JICA STUDY TEAM / EML	Bad	None	None	A	Thruwila	NA	A	NA	A	A
JICA STUDY TEAM / EML	Bad	None	None	A	Thruwila	NA	A	NA	A	A
JICA STUDY TEAM / EML	Bad	None	None	A	Thruwila	NA	A	NA	A	A
JICA STUDY TEAM / EML	Bad	Some	None	B	Thruwila	D	D	NA	A	A
JICA STUDY TEAM / EML	Bad	None	None	A	Thruwila	A	A	NA	A	A
JICA STUDY TEAM / EML	Bad	None	None	A	Thruwila	A	A	NA	A	A
JICA STUDY TEAM / EML	Bad	None	None	A	Thruwila	NA	A	NA	A	A

Record: 1 Show: All Selected Records (0 out of 391 Selected.) Options



Attributes of thuruwila_final_socio

MEMBERS	REMARKS	YALA	MAHA	MEMBERSHIP	OMFEE	ATT_SHRAMA
JICA STUDY TEAM / EML		Paddy	Paddy	Yes	No	Yes
JICA STUDY TEAM / EML		Paddy	Paddy	Yes	No	Yes
JICA STUDY TEAM / EML		Paddy	Paddy	Yes	No	Yes
JICA STUDY TEAM / EML		Paddy	Paddy	Yes	No	Yes
JICA STUDY TEAM / EML		Paddy	Paddy	Yes	No	Yes
JICA STUDY TEAM / EML		Paddy	Paddy	Yes	No	Yes
JICA STUDY TEAM / EML		Paddy	Paddy	Yes	No	Yes
JICA STUDY TEAM / EML		Paddy	Paddy	Yes	No	Yes
JICA STUDY TEAM / EML		Paddy	Paddy	Yes	No	Yes
JICA STUDY TEAM / EML		Paddy	Paddy	Yes	No	Yes
JICA STUDY TEAM / EML		Paddy	Paddy	Yes	No	Yes
JICA STUDY TEAM / EML		Paddy	Paddy	Yes	No	Yes
JICA STUDY TEAM / EML		Paddy	Paddy	Yes	No	Yes
JICA STUDY TEAM / EML		Paddy	Paddy	Yes	No	Yes
JICA STUDY TEAM / EML		Paddy	Paddy	Yes	No	Yes
JICA STUDY TEAM / EML		Paddy	Paddy	Yes	No	Yes
JICA STUDY TEAM / EML		Paddy	Paddy	No	No	Yes
JICA STUDY TEAM / EML		Paddy	Paddy	Yes	No	Yes

Record: 1 Show: All Selected Records (0 out of 6251 Selected.) Options

Attributes of soil_new_thuruwila2

FID	Shape*	SOIL_CODE	SOIL_TYPE	CATEGORIES	AREA_HA_
0	Polygon	WD.d	Well drained deep soils	Redish Brown Earths	14.93
1	Polygon	WD.d	Well drained deep soils	Redish Brown Earths	22.33
2	Polygon	Water logged area	Water logged area	Water logged area	2.16
3	Polygon	Al.vpd.d	Very poorly drained deep soils	Alluvial soils	55.51
4	Polygon	PD.d to VPD.d	Poorly drained to very poorly drained deep soils	Low Humic Gley Soils	6.35
5	Polygon	PD.d to VPD.d	Poorly drained to very poorly drained deep soils	Low Humic Gley Soils	20.86
6	Polygon	ID.d	Imperfectly drained deep soils	Redish Brown Earths	105.14
7	Polygon	WD.d	Well drained deep soils	Redish Brown Earths	4.74
8	Polygon	WD.d	Well drained deep soils	Redish Brown Earths	17.86
9	Polygon	WD-md	Well drained modertely deep soils	Redish Brown Earths	1.39

Record: 1 Show: All Selected Records (0 out of 10 Selected.) Options

Figure E4.2.2 Images of Attribute Table (Structures Evaluation, Land and FOs' Survey and Soil Survey)

Chapter 5 FINDINGS THROUGH THE SURVEY AND THE ANALYSIS

5.1 Preliminary Findings

The comparison of extent between ID's data and GIS maps is tabulated as follows:

Table E5.1.1 Basic Information of Target Areas

No.	Scheme	Area	FOs name	Extent (ha) comparison		No. of Plot	Canal Length (km)
				ID	GIS		
1	Nachchaduwa	HLD-36, 37, 38 and 39	Tissa	214	209	1,968	29.8
		LLD-5, 6 and 6A*	Isuru	125	137	1,569	24.7
2	Rajangana	RB Tract No.4	Saliya Gama	179	182	4,164	26.1
		RB Tract No.8	Mahasen	181	183	5,669	24.2
		LB Tract No.2*	Sri Udara	173	173	11,103	28.6
3	Thuruwila	Thuruwila (whole area)*		188	143	6,251	18.7
	Total			1,060	1,027	30,724	152.1

Although Isuru area of Nachchaduwa shows approximately 10 % larger than original data, the area of target blocks of Nachchaduwa and Rajangana major scheme is nearly same as original extent. It used to be said that the cultivation area has been expanded through encroachment and new settlement, however, actual expansion is not so remarkable. On the other hand, area of Thuruwila medium scheme obtained through GIS indicates 25% smaller than original ID's data. In actuality, there was no any detailed map for this area prior to this study, therefore, an actual data is finally obtained from the study.

Survey items under mapping works, as discussed above, include: (i) qualitative irrigation facilities assessment (canals and structures) and (ii) land and FOs activities assessment (type of land ownership, land use, FOs activities consisting of membership, payment of O&M fee and attendance to shramadana). The result of preliminary analysis is explained as follows:

5.1 Condition of Irrigation Facilities

Location of facilities are shown in Figure E5.1.1 to 5.1.3 while those evaluation result is illustrated separately in Figure E5.1.4 to 5.1.6.

5.1.1 Canals

Function and condition of canals are qualitatively evaluated using following check points.

Check point

Sediment, vegetation, erosion, leakage, overflow, illegal checking, and condition of canal road

Finally, overall evaluation is given to each section of the canals as the criteria described below:

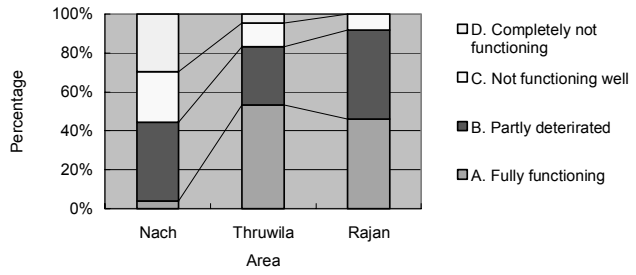


Figure E5.1.7 Summary of Canals Condition

Overall evaluation

A: Fully functioning,
B: Partly deteriorated, but functioning in a satisfactory range,
C: Not functioning well and/or affecting the downstream flow, and
D: Completely not functioning

Comparison of the result among three schemes in this assessment are shown in Figure E5.1.7. The result clearly explains that the canal condition in Nachchaduwa is far behind Rajangana and Thuruwila. Better canal condition in Thuruwila can be easily explained since canals are being rehabilitated under Anuradhapura Water Supply Scheme implemented by the National Water Supply and Drainage Board (NWSDB) since 2004 even the progress of the works are delaying. Although facilities in both Nachchaduwa and Rajangana were rehabilitated under MIRP in 1989, however, situation significantly differs. Actually, after the rehabilitation by MIRP, target area in Rajangana was utilized for the experimental study on tertiary water management. Therefore, maintenance work was intensively carried out by ID which contributes to maintaining better facilities condition.

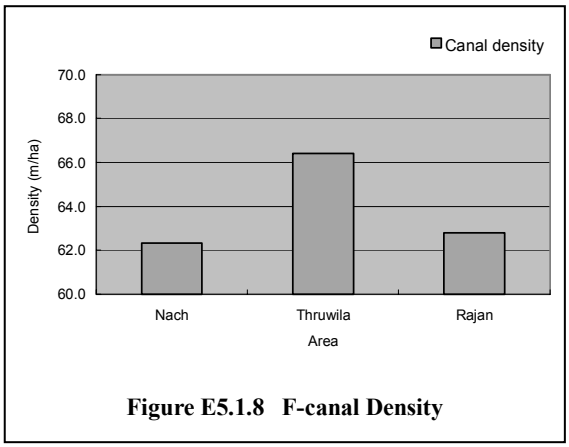


Figure E5.1.8 F-canal Density

As one of the indicators showing the level of tertiary development, F-canal density is calculated and compared as depicted in Figure E5.1.8. Tertiary canal density ranges between 62 to 67 meters per hectare, which could be nearly standard value to improve the irrigation canal network.

Illegal tapping is also one of the issues which are jeopardizing security of the facilities as well as equal water distribution among FCGs. It is difficult to judge through the field

survey whether the water tapping from F-canals is in legal or illegal manner. In the study, however, as preliminary analysis, the field survey clarified the number and the location of farm turnout on F-canals, type of which are classified into three categories: (i) permanent concrete structure, (ii) PVC and (iii) no structures (diverting water without any structures but temporary embankment and/or bags). Legal status cannot be respectively surveyed, however, latter two categories, (ii) and (iii) would be envisioned as illegal tapping. The survey results in Figure E5.1.9 is showing that more than 30 % of all farm turnouts in Thuruwila, highest ratio among three areas, is categorized in "PVC" and/or "no structure" which indicates that farm turnout development is necessary to properly manage irrigation water within F-canal level.

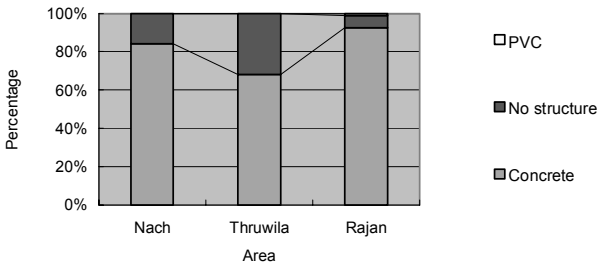


Figure E5.1.9 Summary of Type of Farm Turnout

5.1.2 Structures

As same as canals, function of the structure is evaluated in qualitative manner, check point and overall evaluation of which are described below:

Check point

Gate availability, operation, corrosion, cracks, leakage, downstream damage, and measuring device

Overall evaluation

A: Fully functioning,
B: Partly deteriorated, but functioning in a satisfactory range,
C: Not functioning well and/or affecting the downstream flow, and
D: Completely not functioning

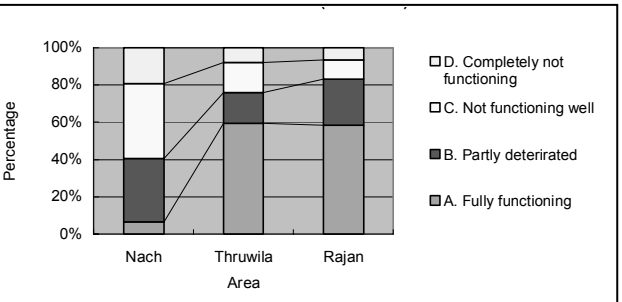


Figure E5.1.10 Summary of Structures Condition

Comparison of overall evaluation result among three target areas are shown in Figure E5.1.10. As similar tendency of the evaluation result of canals, structures in Rajangana and Thuruwila schemes are much better than those in Nachchaduwa. This situation would be justified by the same reason as canal condition. As far as distribution facilities are concerned in Nachchaduwa, for instance, it was clarified during the field survey that most of the turnout gates have leakage problems

or even missing which hinder fair water management particularly between the upstream and the downstream.

5.2 Land and FOs Activities Assessment

As mentioned above, land and FOs activities assessment includes five items: (i) type of land ownership, (ii) land use, (iii) membership, (iv) O&M fee payment and (v) attendance to shramadana. The results are illustrated in Figure 3.6.12 to 3.6.20 and briefly described as follows.

5.2.1 Type of land ownership

Type of land ownership is categorized into four forms: original (including descendant), tenant, lease, and Thattu-Maru.[4]

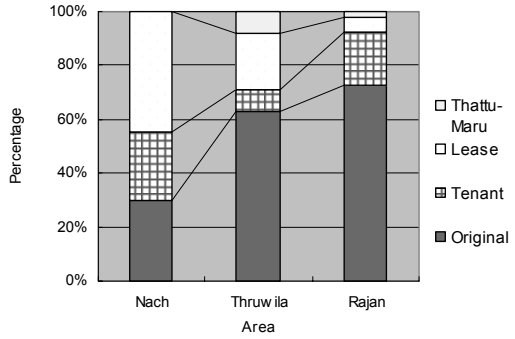


Figure E5.2.4 Summary of Type of Land Ownership

The result of the survey on type of land ownership is illustrated from Figure E5.2.1 to 5.2.3 and the summary is shown in Figure E5.2.4. Although the original owner appears relatively high, this includes mainly descendant farmers, either registered or not registered. Therefore, the common points it can be said is that that generational shift has been progressing in all the schemes. Farm land operated by tenant or lease farmer is high, approximately 70 % of total land in Nachchaduwa since its old settlement while such category is comparatively lower in Rajangana and Thuruwila.

5.2.2 Land use

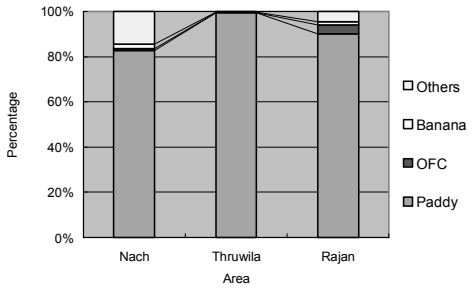


Figure E5.2.8 Summary of Land Use (Maha)

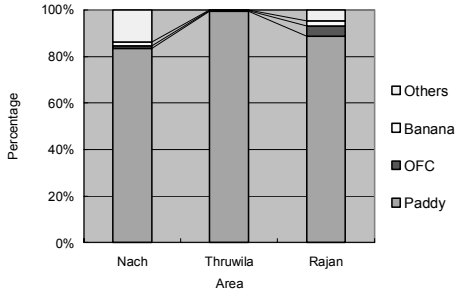


Figure E5.2.9 Summary of Land Use (Yala)

[4] Although sub-section 3.2.2 explains that type of land ownership was categorized in twelve forms during field survey, data is summarized using six forms for easy understanding. For example, original owner and land owner, land of which were allocated under LO is classified into same category, "Original."

Taking field condition into consideration, land use is categorized into four for this survey namely: (i) paddy, (ii) OFC, (iii) banana, and (iv) others (such as vegetables). The survey result for Maha season cultivation is illustrated in Figure E5.2.5 to F5.2.7. In addition, summary of both Maha and Yala season cultivation is depicted in Figure E5.2.8 and F5.2.9.

Significant features seen in the figure is the difference of the degree on crop diversification in the area. Ratio of OFC, Banana and other crops cultivated in Nachchaduwa is highest showing more than 15 % of entire area in both Maha and Yala season. Diversification of Rajangana is less promoted and nearly 100 % of the area is concentrated on utilizing for paddy cultivation in Thuruwila medium scheme at present.

5.2.3 Membership

The result of farmers' enrollment ratio in FOs is shown from Figure E5.2.10 to F5.2.12 and summarized in Figure E5.2.13. Thuruwila medium scheme have more membership in FOs than in the other two schemes. Highest membership rate shown in Thuruwila scheme is because owner farmers are the main category in this area as explained above. On the other hand, although owner farmers are main category in Rajangana scheme as similar to Thuruwila, membership ratio shows lowest figure. This can be convinced by the situation that not negligible number of farmers are more or less far from the village therefore, such groups are not closely involved in FOs activities in accordance with the interview survey on the field.

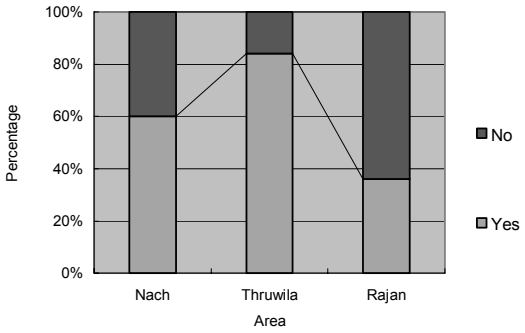


Figure E5.2.13 Summary of Membership

5.2.4 O&M fee payment

O&M fee payment in each target area is illustrated in Figure E5.2.14. Although, it is shown that less than 4 % of farmers in Rajangana scheme pay O&M fee, all FOs in the target areas are not collecting in the form of O&M fee from member farmers. Interviews during field survey disclosed that FOs irregularly collect facilities' repairing cost from member

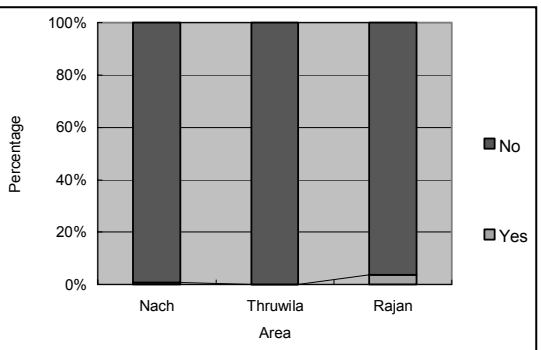


Figure E5.2.14 Summary of O&M Fee Payment

farmers for purchasing materials when facilities need minor rehabilitation by FOs.

(5) Attendance to Shramadana

Present ratio of attendance to Shramadana (collaborative work) such as preparatory facilities' maintenance works for cropping, canal desilting and bund forming is illustrated in Figure E5.2.15. The ratio in Nachchaduwa is high followed by Rajangana and Thuruwila schemes. This value cannot necessarily demonstrate the quality of maintenance work performed by FOs since, as mentioned above, the facilities condition in Nachchaduwa were judged worst although attendance to shramadana herewith appears high. Poor condition of facilities in Nachchaduwa seems to be caused by poor maintenance, therefore, awareness program for FOs should be considered in the future plan to improve quality of Shramadana activities.

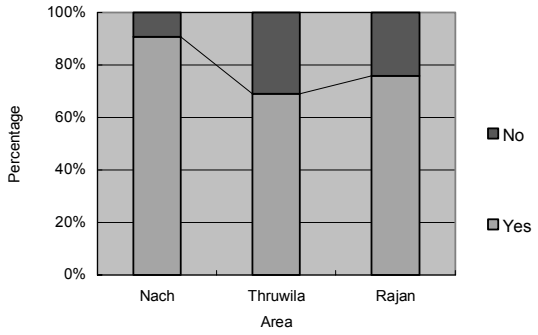


Figure E5.2.15 Summary of Attendance to Shramadana

5.3 Soil Survey

5.3.1 Textual Classification[5]

The main purpose of the soil survey is to identify: (i) textual classification, (ii) drainage class and (iii) fertility of the soils in the target areas to provide basic information that helps to promote agricultural extension programs as well as giving technical guidelines for agricultural development plan in the target areas. The result is attached in Figure 5.3.1 to F5.3.3.

The legend of textual classification is explained below:

(a) Reddish brown earths

- well drained deep soils
- well drained moderately deep soils
- well drained moderately shallow soils
- moderately well drained deep soils
- imperfectly drained deep soils

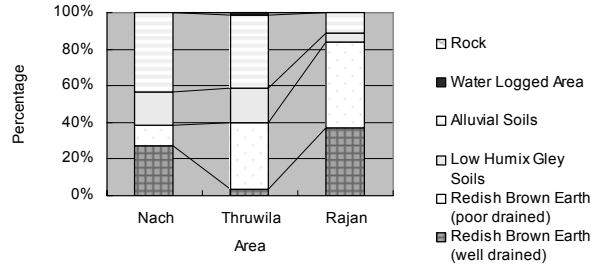


Figure E5.3.4 Summary of Soil Survey

[5] Table E3.2.2 should be also referred for soil mapping unit and its description.

(b) Low humid gley soils

(c) Alluvial soils

(d) Water logged area, and

(e) Rock

The result is summarized in Figure E5.3.4 showing that well drained Reddish Brown Earth (RBE) occupies 30 to 40 % of the entire area in Nachchaduwa and Rajangana major schemes. Therefore, from soil textual view points, those schemes have possibilities on promoting crop diversification in the areas covered by such soil characteristics. On the other hand, Thwurila medium scheme is primarily dominated by alluvial soils which is characterized by poorly drained and ground water table as well as perched water table action is evident in the profile according to the survey. The area is, therefore, suitable for paddy cultivation. Preliminary land suitability assessment based on soil textual classification is shown in Table E5.3.1 and E5.3.2.

Some Zoning Examples based on the Survey Result

Since the most of the area in Thuruwila medium scheme is occupied by poor drained alluvial soils, focusing on the intensification of rice cultivation would be regarded as main strategy. On the other hand, Nachchaduwa and Rajangana scheme will have a potential on promoting cropping diversification subject to the reservation of sufficient rice production. Some zoning example of those two scheme is explained as follows:

Isuru FO (Nachchaduwa major scheme)

From the view point of soil characteristics, upstream along LLD-6, LLD-6-FC-1 and FC-2.1 is mainly occupied by RBE (well-drained deep soil) which are suitable for crop diversification. According to the field survey, one of the most active vegetable cultivators in Isuru FO is located in the command area of LLD6A-FC-1. In addition, LLD-5-FC-1.1 command area (right bank of LLD-5) is somehow utilized for others such as vegetable crops. However, other RBE-covered area is not necessarily cultivated with other crops. Therefore, such areas would have potential for the promotion of crop diversification in the future, activities of which should be planned based on farmers' needs. In addition, for instance, among such potential areas, LLD5-FC1, is shown with poor facilities condition, therefore, activities of farmers' awareness on facilities rehabilitation and its implementation should be considered in parallel. Because the form of land tenure in this area is dominated by "lease", the aspect of awareness program prior to the activities should be carefully planned.

Definitely, crop diversification is not only focused on RBE areas since other poor drained area according to the result is cultivated with vegetables such as LLD6-FC6 command area (left bank of LLD6), which slightly have well-drained condition due to its topographic condition. Farmers carry out farming based on sufficient knowledge on land capability obtained from long practice. Therefore, as mentioned, needs assessment is carefully designed and conducted for the planning of crop diversification.

LLD5-FC1 command area
Crop diversification promotion, awareness program on facilities rehabilitation and its implementation

Sri Udara FO (Rajangana major scheme)

RBE (well drained deep soil) is distributed primarily along D-1 canal, FC-7 (left bank of D-1) and FC-15, FC-16, FC-17, FC-18 and FC-19 command area (right bank of D-1). However, those areas are presently cultivated with paddy except for the midstream of D-1 canal in the command area of FC-12. Since facilities are well maintained at present, abovementioned-areas can be selected as sample areas for crop diversification on the basis of farmers' needs.

FC-15
Crop diversification demonstration area, awareness on water management including drainage, facilities maintenance and water management

Chapter 6 PROPOSED APPLICATION OF GIS-BASED IRRIGATION BLOCK MAPPING

6.1 Irrigation Asset Management

Improper operation and maintenance (O&M) shorten the life of irrigation facilities as widely observed in Sri Lanka. In addition, in accordance with empirical evidences, rehabilitation investment falls into much higher after fundamental deterioration is recognized. Since it is desired to build and manage social infrastructure utilizing recently reduced capital and recurrent budget allocated from the government, introduction of new approach on facilities' development and management is imperative for long-term sustainability of project life. Establishment of the system for providing regular diagnosis & assessment, maintenance and repair on the basis of judging appropriate period for the rehabilitation of facilities is, therefore, important to improve longevity of facilities and to reduce replacement cost.

The concept of Asset Management Plan (AMP) is illustrated in Figure E6.1.1 as follows:

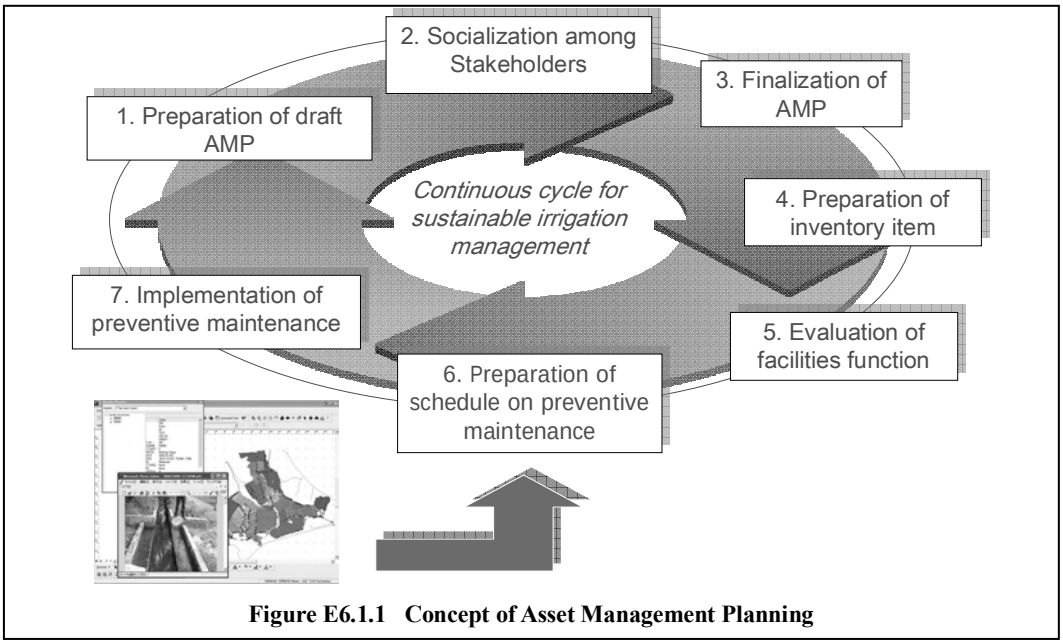


Figure E6.1.1 Concept of Asset Management Planning

In order to support this process, GIS can be effectively utilized for facilities data management, prioritization and monitoring and evaluation of the activities. The process of AMP is briefly explained as follows:

Step-1 ***Preparation of draft AMP*****:** This step consist of preparation of basic approach for new management system, arrangement of management team, and drafting of overall schedule for introducing management system. Management team would include: EA, WS and the representative of FCGs.

Kick-off Meeting at Rajangana Scheme (December 22nd, 2005)

Step-2 ***Socialization among stakeholders*****:** Based on the draft approach, consensus building is imperative at the initial stage to revise draft plan into more functional system. This should be carried out through the series of workshop gathering representative of FO, engineering staff of the project office (IE, EA and WS) and community members. Map preparation by GIS can facilitate understanding among those stakeholders.

Step-3 ***Finalization of AMP*****:** Through the course of step-1 and -2, overall schedule and working team is finalized.

Step-4 ***Preparation of inventory item***: Asset inventory items for facilities are prepared based on the discussion among technical staff and farmers on the basis of agreeable level of services. In this stage, detailed schedule on diagnosis and assessment of degradation is prepared by considering longevity and necessary frequency of diagnosis for those facilities. Such schedules are managed using database to help providing timely maintenance (see FORM-A and –B as references of facilities' inventory item). In order to carry out field evaluation, training of evaluation team is important in this stage to enable them to have same evaluation criteria and standard.

Step-5 ***Evaluation of Facilities' Function*****:** Transect walk should be applied to confirm the condition of facilities to judge function level using qualitative criteria such a way that would consist of four grades: grade A fully functional; grade B minor functional shortcomings; grade C seriously reduced functionality; and grade D ceased to function.

Transect Walk for Facilities Assessment at Nachchaduwa Scheme (January 7th, 2005)

Step-6 ***Preparation of schedule on preventive maintenance***: Preventive maintenance schedule is prepared based on evaluation exercise. Using the survey data obtained, detailed survey is carried out by EAs to prepare rehabilitation cost. Budget arrangement is also important in this stage. Based on the analysis of historical Capital Expenditure (CAPEX) and Operational Expenditure (OPEX), the cost model is prepared as a basis for future projection.

Step-7 ***Implementation of preventive maintenance*****:** Preventive maintenance is periodically implemented by ID, FO and members of farmers according to the schedule. This activity is monitored and evaluated by RDI Anuradhapura Office through the support of GIS. The effectiveness of the process is routinely reviewed through the series of activities (see Attachment for "how to update attribute table").

6.2 Agricultural Support

ID has commenced detailed survey on farmers' cultivation practices since May 2006 such as pre-cultivation activities, status on land preparation activities and so forth. Data cannot directly input into GIS and needs to be coded and summarized, however, it can show the

characteristics of each F-canal group so that agricultural support can be effectively planned and implemented in accordance with the needs of those FCGs.

In addition, other agencies data such as the data surveyed by Agricultural Instructor (AI), Department of Agriculture (DOA) focused on soil fertility and yield estimation, contents of which includes as follows:

Yield estimation of one acre demonstration –Anuradhapura

- Serial no.
- District
- AI Area
- Variety
- Organic matter (straw, green manure, cow dung)
- Yield

Soil test data (Mahailuppallama 2002)

- No.
- District
- Name
- Crop
- pH
- EC
- P
- K
- OM
- Texture
- Year

Although survey area is limited at the moment, such data will be able to contribute to zoning, agricultural development direction as well as identification of the needs for agricultural extension services required if survey is carried out at the target area. In order to integrate various types of data including irrigation, agriculture and marketing, coordination among relevant organization should be strengthened to effectively collect data and to develop database.

Data Coding and Summarization

Field survey and database construction should be simplified wherever possible to meet purpose and requirement. In addition, not all the data can be necessarily input into the database. For example, FORM-1, currently utilized for the survey on pre-cultivation activities by ID since 2006 April, is as follows:

Report on Pre-Cultivation Activities Yala 2006 **Form No 1**
Week No From To

1 Name of Farmer Organization:

2 Name of Distributory Canal: 3 Name of Field Canal:
2.1 Length of D-Canal: 3.1 Length of Field Canal:

4 Date of Pre Kanna Meeting:
5 Date of Kanna Meeting:
6 Agreed date of completion of Maintanance works:

7 Progress of Maintanance activities

No	Name of Farmer	Lot No	Extent	Tenure*	Length of canal to be maintained	Awareness on planted dates of season **	Actual date of completion of maintanance works		Mode of work and duration		
							Dist Canal	Field Canal	Shramadana	Individual	Contract/ Paid Labour

*O - Own, T - Tenant, L - Leased
** G - Good, B - Bad, F - Fair

Name and Signature of FC Representative
Date:

Name and Signature of Development Assistant
Date:

Prepared by Irrigation Department

Generally, it is not realistic to input such comprehensive data for each plot or farmer basis every cropping season. Instead, collected data are summarized for each F-canal before inputting with the aim of delineating the tendency of each F-canal group. Through reviewing FORM-1, data input approach is described below.

Survey item	How to input in the database?	Remarks
Name of farmer:	Not input	Since existing attribute table does not correspond to input new farmers
Lot No	Not input	BOP number or unique ID has been already given in the database, therefore, it is not necessary to be filled.
Extent	Total cultivation extent in each F-canal group should calculated and input.	Using polygon layers, total extent can be calculated, however, actual cropping area would change every year.
Tenure	Percentage of each category: (i) own, (ii) tenant and (iii) leased is	Previous survey data has been already input into the database

	calculated and input for each F-canal group.	showing characteristics of land tenure. Although land tenure slightly change every cropping season, it is high work load to update every season for each plot basis. Alternatively, characteristics of each F-canal group is given through the survey.
Length of canal to be maintained	Not input	Total length of canal is automatically given in the database.
Awareness on planed dates of season	Not input	Generally, such attitude can be judged by comparing planned date and actual completion date of designated work.
Actual date of completion of maintenance	Percentage of farmers of each F-canal group who have completed maintain ace work in time is calculated and input.	In order to judge degree of positive attitude of each FCG
Mode of work and duration	As shown in the format mode of work is classified into three: (i) shramadana, (ii) individual and (iii) contract/paid labour. Percentage of each category is calculated and input.	To clarify how the work is carried out

Chapter 7 RECCOMENDATION

7.1 Scope and Purpose Clarification

Purpose and scope of mapping works, particularly the contents of detailed field survey, should be clearly determined prior to the commencement. Though, through the course of the survey under JICA Study, GIS-based irrigation block mapping has been re-realized as one of the effective tools for irrigation management, work volume and necessary cost is significantly different depending upon information to be collected and input into thedatabase.

7.2 Utilization of Appropriate Data

In association with scope and purposes mentioned in 7.1, appropriate data should be selected meeting with the scope of work. The satellite imagery with high-resolution is not necessarily perfect to prepare database because of its significant high cost and necessary processing equipment and period. On the other hand, aerial photograph available at the Survey Department in Colombo is sufficient enough if the purpose of GIS-based irrigation block maps focuses on irrigation asset management and agricultural support program.

7.3 Recognition of GIS and Database Function

GIS is not a panacea for irrigation development and management. Rehabilitation works, for example, requires both horizontal and vertical information to plan as well as to estimate work volume. Horizontal information namely, geographical distribution and general function status of canals and structures can be clearly depicted and managed using GIS. It, however, weakly function in managing vertical information such as elevation and more detailed condition for estimating work volume if survey is not carried out in parallel. Longitudinal and cross-sectional survey is prerequisite for formulating rehabilitation plan and design.

It should be kept in mind that conventional paper-based method is, first and foremost, basic option for management implementation and GIS is just as one of its supporting tools. Table 7.3.1 explains advantage and disadvantage of GIS in irrigation management by comparing GIS and paper-based method.

Table E7.3.1 Comparison between GIS and Paper-based Method in Irrigation Management

	GIS	Paper-based
Data collection	Same, both GIS and paper-based method requires regular field survey for data collection	
Presentation	Easy to prepare map, which can facilitate process of development and rehabilitation	Difficult to prepare “beautiful” map

	GIS	Paper-based
	planning	
Data compilation and management	Easier, and convenient for monitoring and evaluation	Hard and time-consuming
Availability of human resources	Requires technical skills, especially in the initial stage, out-sourcing should be also considered to maintain database	Can be (hopefully) managed using existing human resources
Cost	In the short term, cost is high (initial investment and organizational establishment). In the long run, however, cost would be lower if system smoothly works.	Lower, but in the long run, higher than GIS if GIS application is successful
Others	Software should be updated regularly (at least every 5 years), requiring additional cost.	Data durability is questionable.

7.4 Gradual Scaling-up

Introduction of GIS as well as preparation of complete database is not easy, straightforward and cannot be simply classified as a technical exercise involving calculated choices of appropriate techniques. The database should be, therefore, developed with satisfying minimum requirement at the initial stage and accordingly scaling-up when necessary.

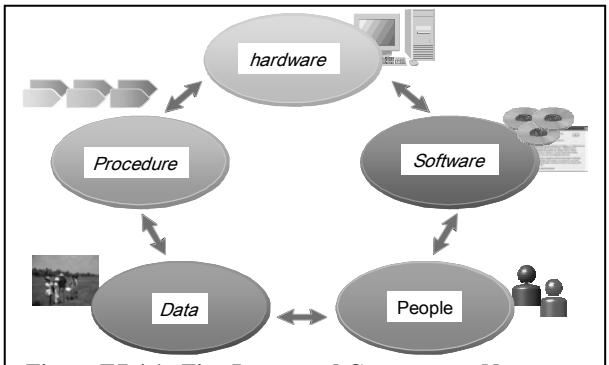


Figure E7.4.1 Five Integrated Components Necessary for Successful GIS Database

Through the trial of GIS in the JICA Study, it is clarified that successful GIS application to various sector including irrigation development and management requires five integrated components: a computer system (*hardware*) where the *software* (ArcGIS) run, *people* (from the Head to the field level) who collect the *data* (facilities and agriculture data) with which people work followed by *procedures* to solve problems or perform a task (how to update, frequency and so forth). Gradual scaling –up approach would, therefore, foster preparedness of those five integrated components to establish sustainable database construction and management.

7.5 Data Update Frequency

In order to maintain database, data should be regularly collected and updated mentioned as one of the important component in 7.4. However, frequency of data collection and update differs among items. Through the course of the study, assessment results on facilities consisting of canal and structures and land and FOs' activities are collected and compiled as database. It is proposed that facilities condition should be assessed once a year (every two cropping season) by establishing transect walk team.

On the other hand, purpose of the collection of data on land and FOs' activities is to identify characteristics of each sample brocks from social view point. It is not necessarily required to update regularly since such characteristics does not significantly change in the short term. Therefore, this data would be used as basic layer for planning additional survey. And the data itself should be updated every five years or so.